

Pakistan

Saeed Akhtar* and Mohammad Z. Haq†

PAKISTAN is one of the developing countries of Southeast Asia and has borders with India in the southeast, Afghanistan and Iran in the northwest and the Arabian Sea on the south. The area of the country is 0.8 million sq km, and is comprised of four provinces: Punjab, North-West Frontier Province (NWFP), Sind, and Baluchistan as well as northern (tribal) areas. Pakistan is divided into ten agro-ecological zones. The temperature during winter ranges from -13°C in the northern dry mountain zone to 7°C in the southern irrigated plains with corresponding mean summer temperature 30°C and 42°C respectively. The mean monthly rainfall ranges from 2–236 mm in various agro-ecological zones.

The mountainous area of Pakistan is comprised of: (i) *wet mountains* in districts of Punjab and NWFP, characterised by a series of mountainous ranges divided by wide and narrow valley plains. These mountain ranges are 1000 to 1500 metres high with forest-covered slopes; (ii) *northern dry mountains* with several peaks up to 8000 metres high, located in NWFP and tribal areas. These are extremely arid but have abundant water from the glacier-fed streams of terraced fields; (iii) *western dry mountains*, which cover parts of NWFP and Baluchistan, are characterised by barren hills of 1000 to 3000 metres altitude. Due to the steep slopes soil erosion is severe with virtually no vegetation except poor grasses.

The *southern irrigated plains* zone covers a large proportion of Punjab and Sind. Irrigation in these plains is carried out mainly through canals originating from the major rivers.

The human population of Pakistan is 84.3 million, and 70% of the population live in rural areas. The Punjab and Sind are highly populated provinces comprising 56.5 and 22.6% of the total population respectively. The NWFP (including the tribal areas) and Baluchistan have 15.7 and 5.2% of the population respectively.

Of the total area of 198.6 million acres, 26.6% is cultivated, 2.5% is under forests and 68.0% is rangeland. The overall economy of Pakistan has remained agricultural which contributes about 30% to gross domestic product (GDP). The agricultural sector employs 54% of the labour force and accounts for 75% of the total foreign exchange from exports.

Livestock

Livestock production is an integral part of the farming system and plays a significant role in the development of the agriculture sector. Livestock occupies a key position in the rural economy of the country by bringing in cash income and for improving the quality of life of the resource-poor rural population.

The annual growth in the livestock sector is about 2%. Livestock contributes about 28% of agricultural sector GDP. Trade in livestock products (leather, wool, hair, hide, skins and carpets) contributes 11% of total export valued at US\$350 million. Livestock contribution in terms of traction power is equivalent to 0.3 million tractors. About 85% of livestock resources are possessed by small landholders or even landless livestock owners.

There are about 4.6 and 4.4 million production units for cattle and buffaloes respectively. The proportions of small, medium and large herds/flocks of ruminants are shown in the country statistics. About 72.4% of cattle and 91.5% of the buffalo populations of Pakistan are in Punjab and Sind. About 50% of sheep are in Baluchistan. Goat flocks are more or less uniformly distributed throughout the country.

History of Foot-and-Mouth Disease

Foot-and-mouth disease (FMD) outbreaks were reported in the Pakistan region as early as 1943 and have continued to be a frequent occurrence in the region. FMD is economically the most important viral disease of farm animals in Pakistan where it

* Animal Sciences Institute, National Agricultural Research Centre, Islamabad, Pakistan.

† Veterinary Research Institute, Lahore, Pakistan.

is endemic. No areas of the country can be considered free from the disease (Ahmad & Khan 1988) although the incidence of the disease is poorly understood in field conditions. There is no mention of virus typing in annual reports of provincial livestock departments but virus typing carried out for military dairy farms between 1954 and 1962 at the World Reference Laboratory (WRL), Pirbright, United Kingdom, showed serotypes O, A, Asia 1 and C in 13, 7, 6, 4 outbreaks respectively. No virus was recovered from 10 outbreaks (Yasin & Huq 1960; Huq 1961). From 1962 samples were collected from outbreaks in private and government herds (civil and military) from all over the country for virus typing and the Foot-and-Mouth Disease Research Centre (FMDRC) at Lahore was established. During the period of 1963–65, FMD virus serotypes O, Asia 1, A and C were recovered from 44, 36, 5 and 1 outbreaks respectively, whereas, no virus could be recovered from 23 outbreaks (Hussain et al. 1965). Since then efforts are made to collect FMD blister samples from all the outbreaks in the country for typing. The results are described in the epidemiology section of this paper.

Epidemiology

The records of disease outbreaks were obtained from FMDRC. Table 1 shows spatial distribution of four (O, A, C and Asia 1) of seven recognised serotypes of FMD virus during the last 30 years. During the last five years, however, only serotypes O and Asia

1 have been typed from a total of 257 reported outbreaks (Table 2) and most of these outbreaks occurred in Punjab, Sind and NWFP provinces.

Cattle and buffaloes were the most affected species, with only a few reports of FMD outbreaks in small ruminants (Table 3). Cattle were more severely affected than buffaloes. Mouth lesions were more pronounced in cattle and foot lesions were more severe in buffaloes. The course of FMD was shorter in buffaloes than in cattle. The exotic cattle breeds (Australian Illawarra Shorthorn, Jersey and Holstein-Friesian) and their crossbreeds with local breeds were more severely attacked by FMD than indigenous breeds (Sahiwal and Red Sindhi). Calves/heifers up to one year of age were more susceptible than adults (Sheikh 1960).

The disease is prevalent throughout the year with no major seasonal pattern (Table 3). A slight increase in the number of outbreaks occurs during January–March and May–June each year, however, possibly due to environmental stress and movements of animals during these months to local and national livestock fairs.

No national figures of economic losses due to FMD are available. However, in a 1966 study losses that occurred during an outbreak at a livestock research station were extrapolated to the national livestock population giving an estimated loss of US\$34 million (Kazimi & Shah 1966). In another study (Macfarlane & James 1978) the estimated FMD-related annual losses in bovine alone were US\$63 million in Pakistan.

Table 1. Spatial distribution of foot-and-mouth virus serotypes in Pakistan, 1962–92.

Province	FMD virus serotypes						Per cent of total samples
	A	O	C	Asia 1	NVD	Total	
Punjab	152	451	—	286	295	1184	85.8
NWFP	17	35	2	16	39	109	7.9
Sind	8	17	—	2	28	55	4.0
Baluchistan	1	9	—	—	20	30	2.2
Northern areas	—	—	—	—	1	1	0.1
Total	178	512	2	304	383	1379	
%	12.9	37.1	0.2	22.0	27.8		

NVD = No virus detected
 — = Not detected

Table 2. Number of epidemics of foot-and-mouth disease and FMD virus serotypes in Pakistan, 1988-92.

Year	FMD virus serotypes				
	O	Asia 1	NVD	Total	Per cent of total samples
1988	45	4	33	82	31.9
1989	22	3	26	51	19.8
1990	8	—	26	34	13.2
1991	40	—	20	60	23.3
1992	19	—	11	30	11.7
Total	134	7	116	257	
%	52.1	2.7	45.1		

NVD = No virus detected

— = Not detected

Table 3. Seasonal and species-specific distribution of samples tested at the Foot-and-Mouth Disease Research Centre, Lahore, 1962-92.

Month	Livestock species					Per cent of yearly total
	Buffaloes	Indigenous cattle	Exotic/crossbred cattle	Small ruminants	Total	
January	78	33	17	6	134	9.7
February	51	58	8	7	124	8.9
March	36	34	56	7	133	9.6
April	43	22	36	—	101	7.3
May	58	38	56	5	158	11.5
June	149	44	17	9	219	15.9
July	33	16	8	3	60	4.5
August	53	45	11	1	110	8.0
September	10	21	17	—	48	3.5
October	32	32	39	17	120	8.7
November	30	9	25	—	64	4.6
December	59	11	39	—	108	7.8
Totals	632	363	329	55	1379	

— = Nil

Facilities

All diagnostic work and vaccine production is carried out at FMDRC Lahore. However, FMD research is also carried out at other institutes (Akhtar & Naem 1985). The information about most epidemics reaches FMDRC from state livestock and military dairy farms. The staff of veterinary extension services are reluctant to report field epidemics to the respective directorates, however, and the reported number of epidemics during the last 30 years has only exceeded 100 per year on two

occasions. FMDRC has the necessary tissue culture facilities for virus isolation, characterisation and typing using the compliment-fixation test (Rauf et al. 1981). The staff of FMDRC has the necessary resources in terms of logistics and an operational budget for field investigation of FMD outbreaks and for laboratory diagnosis. However, the staff of veterinary extension services, who are responsible for FMD vaccination twice a year do not get sufficient vaccine doses and face other logistical problems. Therefore, the desired level of vaccination coverage is not attained.

COUNTRY LIVESTOCK AND FMD EPIDEMIOLOGY STATISTICS

Pakistan: 4 provinces

LIVESTOCK STATISTICS

Production unit (for animal health programs): farm

Animals per owner: estimated averages — 2 beef cattle (also used for dairy and work purposes); 1 buffalo; 2 pigs; 2 sheep and goats

Livestock	Number (million) ^a	Draft use %	Meat use %	Milk production %	Estimated international movements/year ^b	
					Entering	Leaving
Cattle	17.5	30.3	53.7	16.0	0	2600 ^c
Buffaloes	15.7	0.6	76.5	22.9	0	0
Sheep	23.3	na	na	na	na	na
Goats	29.9	na	na	na	na	na

^a the annual growth rate of the livestock sector is approx. 2%

^b Legal

^c Mainly Sahiwa cattle for breeding programs in Malaysia and Indonesia

Herd size: cattle/buffaloes — 89% small (1-6); 11.5% medium (7-20); 0.5% large (> 21)
buffaloes — 90% small; 9.5% medium; 0.4% large
sheep/goats 87-96 small flock (1-30)

FMD EPIDEMIOLOGY

Seasonal incidence: no major seasonal pattern (see Table 3)

Geographic frequency: more frequent in Punjab, Sind and NW Frontier Provinces probably due to the larger population of susceptible animals in these provinces

Disease outbreaks and vaccinations

	1988	1989	1990	1991	1992	1993
No. of outbreaks ^a	82(33)	51(26)	34(26)	60(20)	30(11)	13(4)
Provinces involved ^b	1,2,3	1,2,3	1,2,3	1,2	1,2	1
Serotypes recorded	O,Asia 1	O,Asia 1	O	O	O	O
Species involved	C,B	C,B	C,B	C,B	C,B	C,B
Vaccine use	O,Asia 1	O,Asia 1	O,Asia 1	O,Asia 1	O,Asia 1	

^a Figures in brackets are the number of outbreaks for which the virus was typed

^b 1 = Punjab; 2 = Sind; 3 = NW Frontier Province

Facilities

Veterinary centres: 21

Veterinary officers: staff of divisional/district laboratories and FMDRC; 4000
veterinary stock assistants

Diagnostic laboratory: FMD Research Centre, Lahore

Cost per diagnostic test (\$US): 0.5

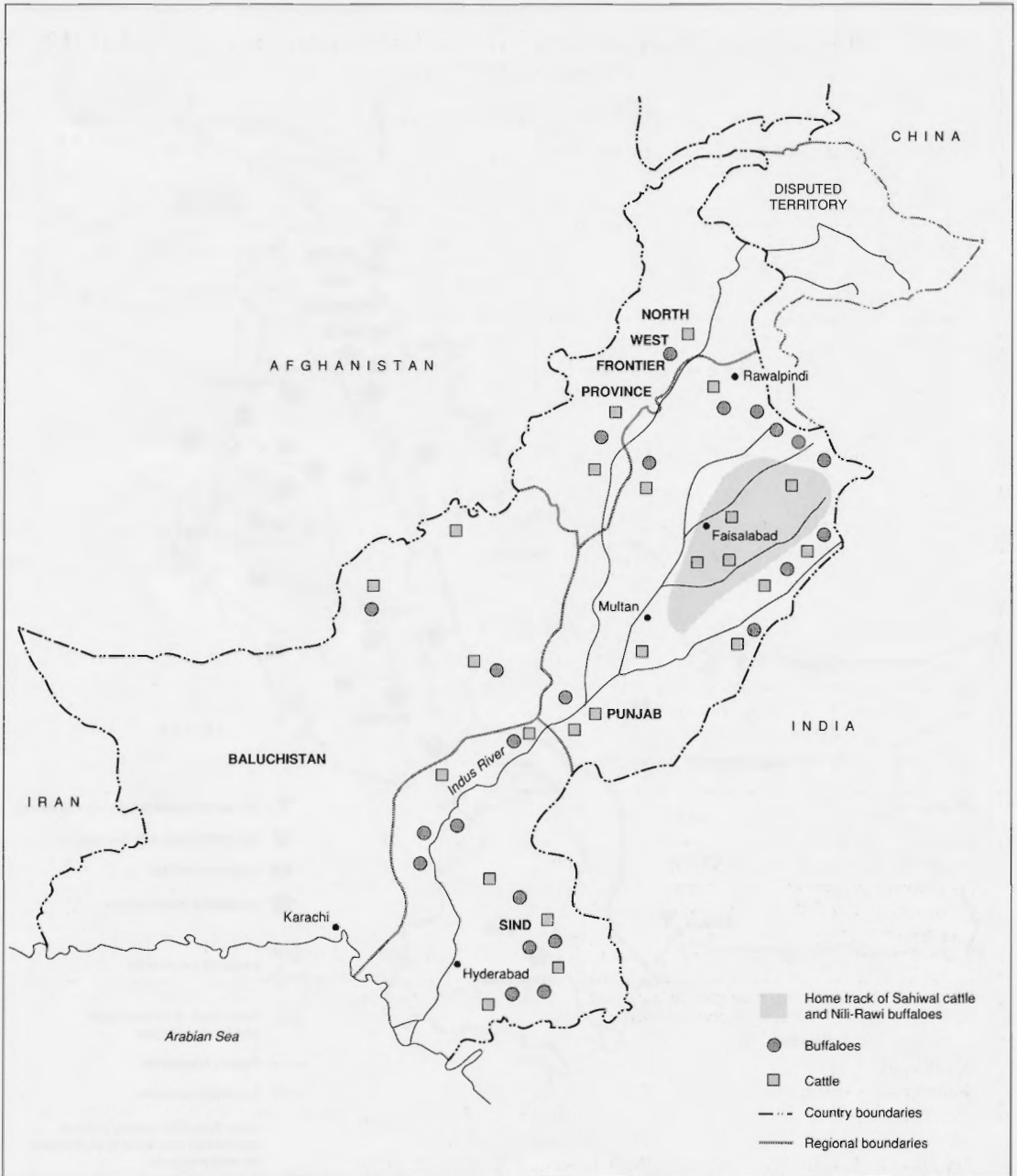
Vaccine

Vaccine supply: 100% locally produced at FMDRC, Lahore

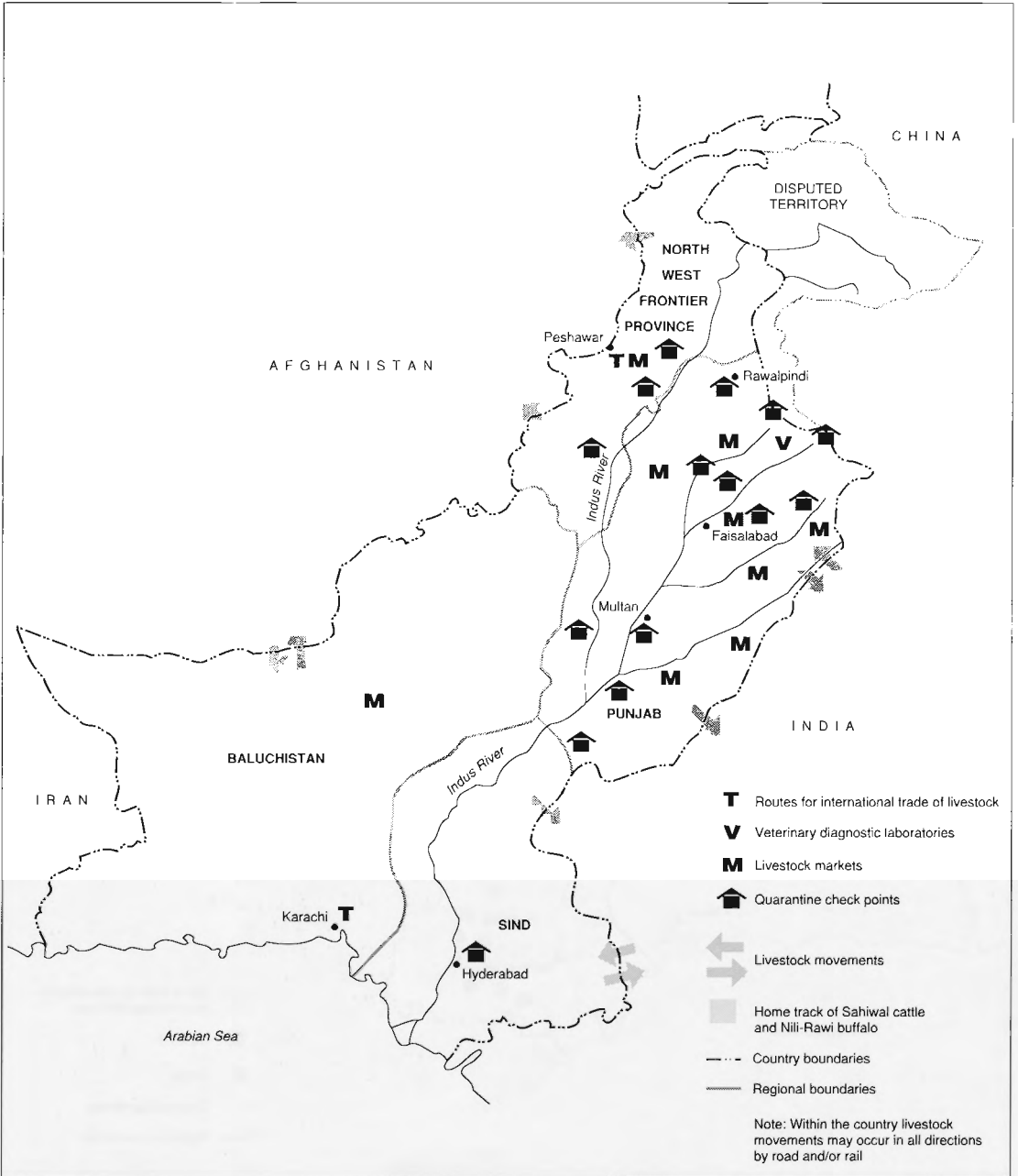
Cost per dose (\$US): 0.2

Vaccine strategy:

- (i) outbreak ring vaccination
- (ii) universal vaccination (only on state and military dairy farms)
- (iii) As requested by livestock holders



Map 1. Main livestock areas in Pakistan.



Map 2. FMD outbreaks, facilities and livestock movement patterns in Pakistan.

Vaccine

Soon after the establishment of FMDRC, FMD vaccine production commenced initially using Belin's technique in buffalo calves (Afzal & Ilahi 1966). Later a polyvalent (serotypes A, O and Asia 1) cell culture vaccine was produced using BHK monolayer culture (Brooksby & Rogers 1957). More recently, bivalent cell culture vaccine containing O and Asia 1 serotypes is being produced. Over the last 10 years about 4.1 million doses of vaccine have been produced and distributed in the field. Presently FMDRC has the capacity to produce 0.5 million doses annually which are sold at the cost of US\$0.2 per dose.

The vaccine is sold at the FMDRC and interested farmers and district authorities of veterinary extension services and managers of state-owned livestock herds, make their own arrangement to procure vaccine according to their needs. Presently, FMD vaccine is not imported from other countries.

Stock Movements

National

Livestock movement generally occurs from July to October from the interior of Punjab to Sind and NWFP. The animals transported are pregnant and/or freshly calved cattle and buffaloes to cater for milk requirements in those areas. When these animals are dried off they are either sent back or slaughtered. The small ruminants are brought to Punjab and Sind from NWFP and Baluchistan for marketing and for sacrifice during the Eid-ul-Azha festival. The transportation of livestock is carried out by trucks and rail. The district and *thesil* (local) level livestock markets (where all the species of livestock are traded) are held quite frequently.

Exports

Pakistan has exported approximately 15 000 Sahiwal cattle during the last 5 years, mainly for breeding programs in various countries including Malaysia and Indonesia. These cattle originated from the home tract of this breed in Punjab. Other breeds of livestock have only rarely been exported.

Control/Eradication Strategies

Before the establishment of FMDRC in 1962, vaccine was not available for immunisation of livestock. When an epidemic occurred control measures were enforced including restriction of the movement of animals and animal products, isolation of infected animals and disinfection of contaminated premises. When an FMD outbreak occurred in any locality, all cattle fairs were banned in surrounding

areas. In some indigenous herds apthisation was practiced but it was not safe in imported and crossbred herds (Qureshi & Anwar 1972).

With the start of FMD vaccine production in 1962, the sanitary control measures were supplemented with immunisation procedures. Initially vaccination was confined to government or private commercial farms and valuable imported (exotic) and crossbred stock. Furthermore, ring vaccination is now carried out around epidemic areas to prevent the spread of disease. The veterinary extension services at district level implement a program of prophylactic vaccination based on the known pattern of disease occurrence and livestock movements. This is an expensive procedure because the fast waning vaccinal immunity warrants immunisation twice a year in February and October (Veterinary Research Institute 1980). Furthermore, far fewer vaccine doses are produced in the country each year than are actually needed. Therefore, 99% of the total susceptible population still remains unvaccinated (Raja 1990). The socioeconomic factors affecting the immunisation program are described elsewhere in this paper.

Currently, vaccination at state farms and of valuable livestock is carried out. Once an epidemic occurs, hygienic measures are undertaken to minimise the severity of the disease and to restrict the spread of infection. When disease appears in a particular locality, all cattle fairs are banned in that area and ring vaccination is carried out to prevent the spread of infection. Mass vaccination is carried out by about 4000 veterinary stock assistants stationed at veterinary centres, dispensaries and mobile camps supervised by veterinary officers in the country. The vaccination program is hampered by a number of socioeconomic factors including shortage of vaccine, cost of vaccine, small livestock holdings, logistic problems of vaccinators, farmers ignorance about affects of FMD on livestock, productivity etc.

The information gathered by staff of FMDRC during field and laboratory investigations of FMD outbreaks is used to direct vaccine production and to identify the foci of infection. Staff of veterinary extension services are alerted and a rigorous vaccination program run in that area.

Currently, there is no official program for monitoring the effectiveness of vaccination. The reports on FMD outbreaks are sent by veterinary officers — who are always reluctant to report — and are passively received at the provincial directorate of veterinary extension services who then contact FMDRC to seek their help for field investigation, sample collection and laboratory diagnosis.

Future Priorities

Animal production is a major part of the agricultural economy of the country. Therefore, the immediate effect of FMD and the rapidity of its spread has stimulated growing concern among veterinary services. Recently, the FMDRC has been given substantial financial support to enhance vaccine production so that a recommended level of 80% vaccination coverage of susceptible cattle and buffalo (Henderson 1970) can be achieved. Furthermore, the Government has started to issue licenses to the private sector for the import of vaccine from other countries such as Turkey and the United Kingdom. Efforts are underway to streamline the distribution and storage of vaccine. The policy of mandatory notification of FMD outbreaks will be further reinforced.

Improvements are being made in the efficiency of veterinary services and district level diagnostic laboratories are being equipped and staffed with qualified diagnosticians.

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Philippines

Yvonne G. Vinas* and Bemis G. Mondia†

THE PHILIPPINES is an archipelago made up of approximately 7107 islands and islets. This geographical subdivision is grouped into three major islands namely: Luzon, Visayas and Mindanao. The human population is currently estimated to be 65 million. There are 13 political subdivisions, Regions 1 to 12 and the Cordillera Autonomous Region (CAR) in the north. The regions are further divided into 78 provinces.

The Philippines has an area of about 300 000 sq km and is bounded on the north by Taiwan; on the east by the Pacific Ocean; on the west by the China Sea and on the south by the Celebes Sea. It has several major mountain ranges and volcanoes, including the Mayon Volcano in Albay and the Taal Volcano in Batangas. The Philippines has two distinct seasons — the wet and dry.

The Philippines is basically an agricultural country highly dependent on crop production, livestock and fisheries/marine production. Rice is produced as a staple crop while corn is cultivated primarily for use as animal feed. Livestock production shares equal importance, not only for its food value, but also for draft purposes. The current animal populations of each region are shown in Table 1.

History of Foot-and-Mouth Disease

Foot-and-mouth disease (FMD) was first reported to have occurred in the Philippines on June 30, 1902 as a result of the importation of beef cattle from Hong Kong to Manila. Within the same period, four shipments of animals coming from Thailand and possibly other countries were infected.

* Department of Agriculture, Region IV, 4th Floor, ATI Building, Diliman, Quezon City, Philippines.

† Regional Quarantine Officer, Veterinary Quarantine Service, Port of Cagayan de Oro City, Region X, Philippines.

The first major outbreak of FMD in the country occurred in Sorsogon and Bukidnon in 1920 and after this the disease became widespread in the Philippines. Sporadic cases were observed in Luzon Province. Samples taken from affected bovine and swine in Luzon in 1959, 1966, 1972 and 1975 were sent to the World Reference Laboratory (WRL), Pirbright, United Kingdom, and were identified as serotype O subtype 1.

Serotype A subtype 2 was also identified from samples submitted in 1975 as a result of another outbreak in Central Luzon, Central Visayas and Cotabato.

In February 1976, serotype C subtype 3 was first isolated from provincial cases in Central Visayas. Since that time all three serotypes have been alternatively diagnosed in outbreaks occurring from province to province.

In 1984–1986, the disease was again reported to have occurred in Luzon mainland, with a few sporadic cases in Masbate and South Cotabato in 1986–88.

Epidemiology

No major outbreak of FMD was reported from 1989–92 except for some sporadic cases in Regions 1 to 5 and CAR in Luzon (see Table 2).

Table 3 summarises the results of the typing of 303 samples submitted by the different regions in 1989–1991 as compiled at the National Animal Disease Diagnostic Laboratory (NADDL), Bureau of Animal Industry. Of the 303 FMD-positive samples, 7% were type A, 57% were type O and 34% were type C.

Origin and spread of outbreak

The outbreak in Albay was a result of an illegal shipment of pigs from Rasario, Batangas. The affected animals were immediately slaughtered and vaccination of susceptible animals was undertaken in a 10 kilometre radius to prevent spread of the disease.

Table 1. Animal distribution and livestock markets in the Philippines by regions (1993).

Regions	Main islands	Cattle	Carabao ^a	Pigs	Goats	Livestock markets (no.)
CAR	North Luzon	60 479	91 014	202 113	21 847	1
1	Northwest Luzon	209 692	156 677	482 604	211 931	11
2	Northeast Luzon	77 179	206 586	454 021	42 766	5
3	Central Luzon	135 743	228 224	1 024 788	122 394	4
4	Central Luzon (incl. Manila)/ Mindoro/Palawan	185 371	165 528	1 140 151	136 972	16
5	South Luzon/Masbate	103 658	240 351	568 849	87 919	7
6	Panay	124 152	278 449	581 588	272 213	26
7	Negros/Cebu/Bohol	217 653	144 017	750 265	352 346	17
8	Samar/Leyte	26 025	158 339	574 210	56 912	8
9	West Mindanao/Jolo/Basilan/ Tawitawi	83 561	161 180	439 050	201 967	5
10	North Mindanao	210 322	147 091	589 967	201 630	7
11	East Mindanao	127 473	239 739	820 828	268 587	6
12	Southwest Mindanao	97 458	262 554	393 163	261 973	7
Total		1 658 766	2 479 749	8 021 897	2 239 457	120

^a Water buffaloes**Table 2.** Incidence of FMD based on field reports 1989-92.

Region	No. of animals affected			
	1989	1990	1991	1992
CAR	0	0	22	0
1	37	0	64	0
2	0	0	0	0
3	100	173	29	0
4	464	608	12	0
5	0	23	0	0
Total	601	804	127	0

Table 3. FMD serotype results (by ELISA and CFT), 1989-91.

Region/Provinces	Serotype		
	O	A	C
Region 2			
Isabela			+
Region 3			
Balacan	+	+	+
Region 4			
Batangas		+	+
Metro Manila	+	+	+
Region 5			
Albay		+	
Camarines Sur		+	

Source: National Animal Disease Diagnostic Laboratory, 1989-91

Samples collected and tested revealed serotype C. The outbreak in a cargo ship with 54 pigs for shipment to South Cotabato was contained by not allowing unloading of the pigs and immediate destruction of the animals on board. The virus infection may have been contracted from Manila by the shipment.

Facilities

The disease situation is continuously monitored through field officers or through coordination with the agencies involved in animal movement. Any suspected cases are immediately reported for investigation and follow-up. Laboratory capabilities are being strengthened and improved to facilitate immediate identification of prevailing serotypes.

The Department of Agriculture maintains 13 regional offices and 78 field offices in the country with an estimated livestock personnel of approximately 1000 who are responsible for monitoring the FMD situation in the Philippines. Communication may be through radios, telegrams, telephones, verbal report, written reports or any other forms of communication available in a particular area.

The Department of Agriculture, Bureau of Animal Industry maintains a Foot-and-Mouth Disease Laboratory Unit in the NADDL located in Diliman, Quezon City. It is presently staffed with 3 highly trained veterinarians who conduct the testing and research of FMD in the country. Diagnosis of FMD is conducted using ELISA and complement fixation tests (CFT).

COUNTRY LIVESTOCK AND FMD EPIDEMIOLOGY STATISTICS

Philippines: 13 regions (1 to 12 + Cordillera Autonomous Region); 78 provinces

LIVESTOCK STATISTICS

Animals per owner: estimated averages — 2 beef cattle (also used for dairy and work purposes); 1 buffalo; 2 pigs; 2 sheep and goats

Livestock	Number (million)	Draft use %	Meat use %	Milk production %	Estimated international movements ('000 per year)	
					Entering	Leaving
Cattle	1.7	2	95	5	2-3	0
Buffaloes	2.5	50	40	10	0	0
Pigs	8.0	na	90	na	10	0
Sheep and goats	2.2	na	90	10	1	0

FMD EPIDEMIOLOGY

Seasonal incidence: most outbreaks occur during the rainy season and late summer

Geographic frequency: most prevalent around Luzon

Disease outbreaks and vaccinations

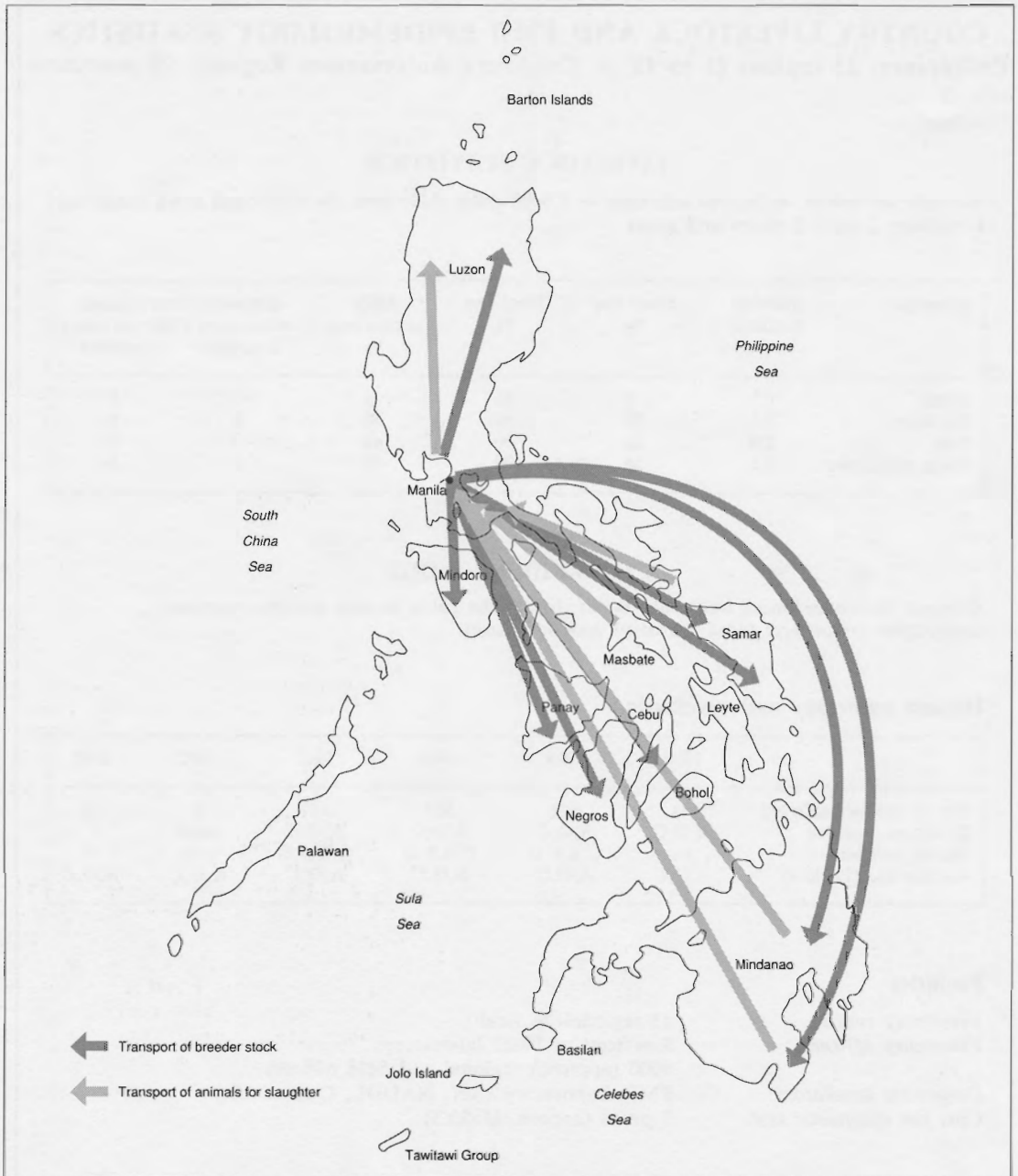
	1988	1989	1990	1991	1992	1993
No. of animals affected	na	601	804	127	0	na
Serotypes recorded	A,O,C	A,O,C	A,O,C	A,O,C	none	C
Species involved	na	C,B,P,G	C,B,P,G	C,B,P,G	none	P
Vaccine use (Table 4)	A,O,C	A,O,C	A,O,C	A,O,C	A,O,C	A,O,C

Facilities

Veterinary centres: 13 regional/78 field
Veterinary officers: 3 officers at FMD laboratory;
 1000 (approx.) regional and field officers
Diagnostic laboratory: FMD Laboratory Unit, NADDL, Quezon City
Cost per diagnostic test: 7 pesos (approx. US\$0.5)

Vaccine

Vaccine supply: imported
Cost per dose (\$US): 1.8 (1992)
Vaccine strategy: (i) ring vaccination
 (ii) declaration of infected areas under quarantine
 (iii) restriction of animal movement, especially for FMD-free zone



Map 1. Livestock movements in the Philippines.

Vaccine

The country does not have the capability to produce its own FMD vaccine. Instead, FMD vaccine is normally imported from other countries. Table 4 shows the number of doses and value of imported vaccines from 1988-93 and Table 5 shows the distribution of vaccines to FMD affected regions.

Table 4. FMD vaccine importation by year 1988-93.

Year	No. of doses	Type	Value (US\$)
1988	950 050	Trivalent	306 052
1989	754 778	Trivalent	249 339
1990	1 748 000	Trivalent	573 265
1991	913 790	Trivalent	406 217
1992	270 250	Trivalent	146 288
1993 Jan-June	474 980	Trivalent	266 992

Table 5. FMD vaccine distribution (doses), 1988-92.

Regions	1988	1989	1990	1991	1992
CAR			21 500	26 600	
1	66 829	16 420	510 450	77 200	
2	7 240		248 000	16 380	
3	123 750	104 670	1 099 550	106 320	25 508
4	149 229	12 030	727 750	256 080	17 000
5	123 651	20 000	50 890	23 350	
11		98 220	98 000	16 100	2 500
Total	470 699	251 340	2 756 140	522 030	45 008

Stock Movements

Scattered all over the country are 120 strategically located livestock markets which enables continuous trading and movement of animals intended for breeding or slaughter purposes (see Table 1). Map 1 shows the major routes of animal movement in the country. The focal point of trading is in Pampanga where animals basically intended for slaughter or breeding purposes are moved/transported inwards

or outwards depending on the requirement of each province. There is no movement of live animals outside the country.

There is an imposed restriction on the movement of susceptible animals into the recognised FMD-free areas. Regular serological testing is conducted in the FMD-free zone for monitoring purposes. On a limited and case-to-base basis, shipment of breeders into these areas are allowed after undergoing close observation, serological testing and isolation of animals. To maintain a negative status, only animals not vaccinated against FMD are allowed into the FMD-free zones.

For other transport/animal movement activities, licenses and permits are regularly issued to breeders or traders that transport livestock. These permits are routinely issued by veterinary quarantine officers to effect interprovincial movement.

FMD-Free Status

As discussed above, no major outbreak has been recorded since 1989 except for a few sporadic cases reported in fifteen provinces in Luzon. This development in the disease situation warranted application for FMD-free status of some specific areas in the country. So far, ASEAN has recognised the FMD-free status of Northern Mindanao (Region 10), Southern Mindanao (Region 9), the island of Batanes in Region 2 and the island of Palawan in Region 4.

At present the whole of Mindanao island has been declared by the Bureau of Animal Industry, with approval by the Department of Agriculture, as FMD-free. Three regions of the Visayas, namely: Regions 6, 7 and 8 have also been recommended to be FMD-free as well as the two remaining regions of Mindanao, Regions 11 and 12. Evaluation by ASEAN representatives and FAO has been conducted and the Bureau of Animal Industry is only waiting for the result of serological examination from Pirbright before formal declaration will be made, possibly in the early part of 1994.

Sri Lanka

Susima N. Kodituwakku*

SRI LANKA is an island located in the Indian Ocean with an area of 65 610 sq km and a human population of 17 million. It has a central mountainous region surrounded by narrow plains which widen in the northern half of the island. The country has 3 major climatic zones. The *dry zone* occupies two-thirds of the island comprising the northern half and eastern parts; the *hill country wet zone* and *lowland wet zone* occupying the southwestern quadrant. The country is divided into 9 provinces and 25 administrative districts.

Livestock

Approximately 39% of the land is available for livestock production. Livestock farming activity in Sri Lanka is integrated with agriculture, especially in the dry zone for paddy farming and hill country for tea plantations. There are over 0.6 million family holdings owning livestock. The contribution of livestock to family income varies from 30–60%. In 1992, the livestock contributed to 5.6% of agricultural products and 1.2% of gross domestic product (GDP), the main contributor being the dairy subsector.

The North-Western Province has a very dense cattle and buffalo population amounting to 22.2% and 21.5% of the national total, respectively (Table 1). Nearly 90% of the national population of pigs are in the western coastal belt of the country and are reared by small and medium-scale farmers.

Indigenous and crossbred Indian cattle are mainly reared in the dry zone and in an intermediate agricultural zone called the coconut triangle.

The pure and crossbred European cattle are reared in the hill country wet zone. The purebred temperate breeds are kept in small-holdings and are managed under limited grazing systems. Animals are tethered by day and housed at night.

Table 1. Distribution of cattle and buffalo population ('000), 1993.

Province	Cattle	Buffaloes
Central (C)	167.2 (8.8)	81 (8.1)
East (E)	231.8 (12.2)	169 (16.9)
North (N)	313.5 (16.5)	33 (3.3)
North-Central (NC)	220.4 (11.6)	199 (19.9)
North-West (NW)	421.8 (22.2)	215 (21.5)
Sabaragamuwa (Sab)	74.1 (3.9)	70 (7.0)
South (S)	167.2 (8.8)	114 (11.4)
Uva (U)	161.1 (8.5)	37 (3.7)
West (W)	136.8 (7.2)	82 (8.2)
	1.9 million	1.0 million

Note: Figures in brackets are per cent of national total.

In the dry zone, large herds of cattle and buffaloes collectively graze on natural pastures and river beds. Some animals may be confined at night. These animals provide the main source of draft power.

History of Foot-and-Mouth Disease

Foot-and-mouth disease (FMD) in cattle was recognised in Sri Lanka far back in 1869, but the first official record was made only in 1902. Although the disease has been declared a notifiable disease, the serious economic effects were felt only after cross-breeding programs with exotic breeds were implemented.

An island-wide epidemic in 1962 resulted in FMD control program with assistance from the FAO to set up a diagnostic laboratory. The serotypes O and C have been recorded in the country. Type O was recorded in 1962 while type C was first recorded in 1970 through cattle imported from India, causing disease in the northwestern part of the country.

Records of disease outbreaks since 1902 indicate that the disease assumes epidemic proportions in 4–6 years. Available figures of prevalence of FMD in the various provinces indicate greatest incidence of disease in the Eastern Province and it is also accepted that island-wide epidemic originated in the

* Gannoruwa, Peradeniya, Veterinary Research Institute, Sri Lanka.

eastern parts of the country where domesticated animals are in close contact with wildlife.

In 1977-82 and 1987-88, clinical disease was recorded in all domestic ruminants including goats and sheep and also in pigs.

Epidemiology

Outbreaks of FMD have been recorded in cattle and buffaloes every year from 1988-1992 (Table 2). These outbreaks have been due to type O virus. Type C was last recorded in 1984.

Table 2. FMD cases, 1988-1992.

Year	No. of cases	Deaths	Provinces ^a
1988	6448	175	C, E, N, NW, Sab, S, N, NC, Sab
1989	313	1	E, N, NC, Sab
1990	176	06	E, N, NC, NW
1991	1879	59	NC, NW, S, U, W
1992	1110	62	C, U
1993	1 outbreak		C

^a See Table 1 for Province abbreviations

There is variation in susceptibility of the various bovine species to the disease. The exotic European breeds and their local crosses show severe clinical signs. Calf mortality among these breeds is reported to be 2-3%. The clinical picture in the indigenous bovine appear to be variable; lesions may be mild or severe.

The disease is endemic in localised areas of the country and two foci of infection have been identified (Map 1). In the map the island is divided into: an endemic zone; a buffer zone; and a disease-free zone. The endemic zone is the area from which the disease originated. The buffer zone is the area surrounding the endemic area to a breadth of 32-48 km to which the disease can infiltrate by the uncontrolled movement of animals. The disease-free area is the rest of the island.

FMD outbreaks tend to occur during the North-east Monsoon between December and February. This coincides with the return of livestock from seasonal grazing areas in the jungles of the southeastern region where the disease is endemic. The cattle and buffalo population in this region is in small units with much local movement in a 16-24 km radius.

Economic importance of FMD

FMD is regarded as important for cattle and buffaloes (but not so much for pigs, sheep or goats)

because of the loss of daft power, decline in milk production and restrictions on the movement of animals.

Facilities

The Department of Animal Production and Health provides a field veterinary service through 137 dispensaries manned by 143 veterinarians and 559 livestock development inspectors. Disease investigation service is further strengthened by six regional investigation centres located at Central, Eastern, Northern, North-Central, North-Western and Southern Provinces.

An outbreak of disease in the field is generally brought to the notice of the veterinarian by the farmer or supporting staff. The veterinarian carries out preliminary investigations and seeks the assistance of the diagnostic laboratory for confirmation.

A FMD diagnostic facility is available at the Veterinary Investigation Centre located in the Central Province. Samples are received at this laboratory for diagnosis mainly from field veterinarians. The approximate cost is US\$1 per diagnostic test which is borne by the Government. The ELISA test is been used for serotyping of FMD virus. The assistance of the World Reference Laboratory (WRL), Pirbright, United Kingdom is also sometimes sought. The particulars of samples received for diagnosis of FMD from 1982-92 is given in Table 3.

Table 3. Results of serotyping of FMD virus.

Year	No. of samples				Province ^a
	Received	Positive for FMD virus	Type O	Type C	
1982	29	11	11	Nil	E, NC, S
1983	11	8	7	1	C, NC
1984	47	37	30	7	C, E, NC, NW, U
1985	10	6	6	Nil	E, NC
1986	20	9	9	Nil	NC
1987	127	58	58	Nil	C, E, NC, Sab, U, W
1988	47	26	26	Nil	C, NW, S
1989	14	4	4	Nil	E, N, NW
1990	2	1	1	Nil	E
1991	19	14	13	Nil	NCP, NW, S, U, W
1992	35	25	25	Nil	C, U

^a See Table 1 for Province abbreviations

COUNTRY LIVESTOCK AND FMD EPIDEMIOLOGY STATISTICS

Sri Lanka: 9 provinces

LIVESTOCK STATISTICS

Production unit (for animal health programs): farm

Animals per owner: estimated averages — 1.4 dairy cattle; 4.5 working cattle; 1.7 buffaloes; 2.2 pigs; 1.8 sheep/goats

Livestock	Number million	Draft use %	Meat use %	Milk production (million head)
Cattle	1.9	na	na	0.5
Buffaloes	1.0	na	na	0.2
Pigs	0.1	na	na	na
Sheep and goats	0.5	na	na	na

International movement: minimal

FMD EPIDEMIOLOGY

Seasonal incidence: most outbreaks occur during the Northeast Monsoon (December–February)

Geographic frequency: endemic zone is in the east of the island with two main foci of infection (see Map 1)

Disease outbreaks and vaccinations

	1988	1989	1990	1991	1992	1993
Serotypes recorded	O	O	O	O	O	O
Species involved	C,B,G	C,B	C,B	C,B	C,B	C
Vaccine used	O	O	O	O	O	na

Facilities

Veterinary centres: 6 regional investigation centres; 137 field veterinary dispensaries

Veterinary officers: 143 veterinarians; 559 livestock development inspectors

Diagnostic laboratory: Veterinary Investigation Centre, Central Province

Cost per diagnostic test (\$US): 1.0

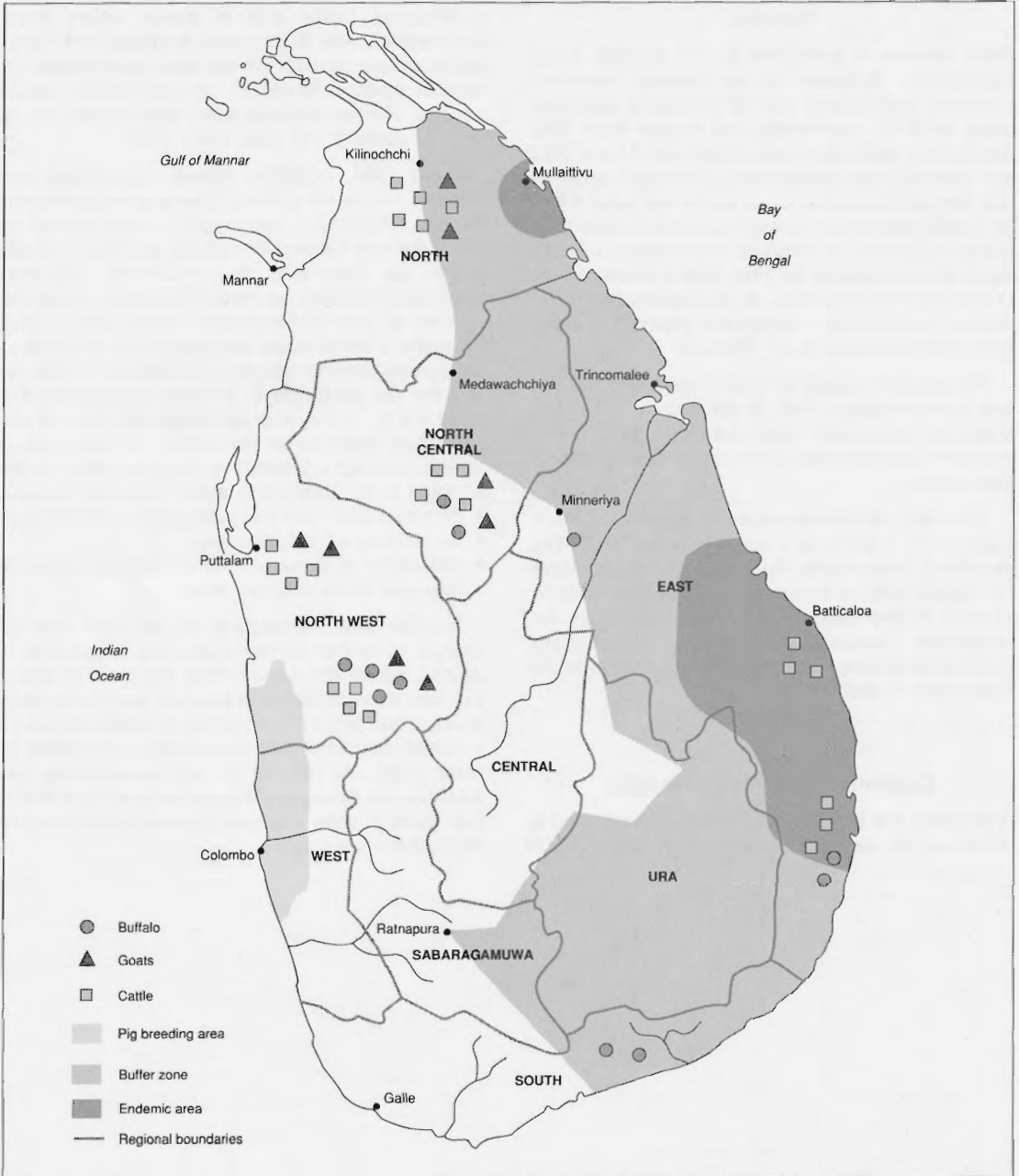
Vaccine

Vaccine supply: 100% of vaccine prepared at the Animal Virus Laboratory, Polgolla, Central Province

Cost per dose (\$US): 0.16 (local monovalent vaccine); 0.33 (imported)

Vaccine strategy:

- (i) outbreak ring vaccination
- (ii) control zone(s) vaccination
- (iii) as requested by livestock owners



Map 1. Main livestock areas and FMD endemic and buffer zones in Sri Lanka.

Vaccine

FMD vaccine is produced at the Animal Virus Laboratory, Polgolla in the Central Province. Currently monovalent type O vaccine is produced using BHK-21 suspension cell system with BEI inactivation and saponin as an adjuvant. Use of BEI and saponin was introduced in 1990 and prior to this formalin was used as an inactivant since 1964. Sri Lanka has to supplement local production with imported vaccine to meet the requirements of field vaccination programs. In 1992, 50 000 doses of type O vaccine was imported. A consignment of 5000 doses of monovalent vaccine was received as a gift from the Government of Thailand.

The production cost of local monovalent vaccine was approximately US\$0.16 per dose in 1992. The imported vaccine cost approximately US\$0.33. The vaccine is supplied free of charge to farmers by the government.

The FMD vaccine produced at the Animal Virus Laboratory is stored at a central vaccine bank. The vaccine is issued from this bank to the provinces for disease control programs. A limited quantity of vaccine is also been stored in the provinces for emergency vaccinations. The field veterinarians involved in disease control programs ensure that the cold chain is maintained.

Control/Eradication Strategies

The policy for FMD control which was adopted in 1964 was the vaccination of high quality stock in

government farms and in places where stock improvement was in progress. Animals were vaccinated at four months of age and revaccinated six months later, followed by annual booster vaccinations. No vaccinations have been carried out in the hill country wet zone since 1980.

From 1984, extensive annual vaccination was adopted within the endemic (parts of Northern and Eastern Provinces) and buffer zones (parts of Northern and Eastern Provinces) and buffer zones (parts of Northern, North-Central, Eastern, Sabaragamuwa and Southern Provinces) during the months of July to September. From 1993, a supplementary vaccination was adopted in addition to the annual vaccinations during February to March, to cover the young stock. Routine vaccinations are confined to cattle and buffaloes but due to the prevailing situation in the north and east, vaccination coverage is limited. A slaughter policy is not adopted in Sri Lanka but other measures include:

- detection and laboratory diagnosis of the disease
- declaration of affected area
- restriction of movement of susceptible livestock into and from affected areas

Vaccine and vaccination is provided free of charge. In case of an outbreak, ring vaccination is carried out in the surrounding disease-free areas. For routine vaccination in endemic and buffer zone areas, a satisfactory vaccination coverage cannot be achieved due to ethnic disturbances prevailing in these areas. At present we are investigating the possibility of developing a program to achieve FMD-free status in areas which are accessible for extensive vaccination coverage.

Thailand

Wantanee Hanyanum, Kamol Awaiyawanon, Rapeepong Wongdee and Pinai Musikul*

THAILAND covers an area of 513 115 sq km with an approximate human population of 62 000 000. The country borders with Myanmar in the north and northwest, Laos in the northeast, Cambodia in the northeast and east and with Malaysia in the south. The total length of the borders is approximately 4500 km. The country is administratively divided into four areas (Central, Northern, Northeastern and Southern) which are further divided into nine regions.

History of Foot-and-Mouth Disease

Foot-and-mouth disease (FMD) has been endemic in Thailand for more than 40 years. Type A15 was first reported in 1953 and type Asia 1 and O were subsequently identified in 1954 and 1957 (Punya-Upapat 1986). These three types of FMD virus are presently endemic throughout the country except for the south which has been announced free of the disease.

Epidemiology

Susceptible animals

The immune status of the animal is the most important host-related factor in FMD epidemiology (Mann and Sellers 1990). Sufficient herd immunity, either acquired by exposure to the virus or by vaccination, results in decreased virus circulation. Insufficient FMD vaccine, improper vaccine handling, a poor vaccination program and the health status of the animals can all result in insufficient immunity which facilitates the spread of virus in the herd.

Virus

FMD virus is disseminated from infected animals in lesion exudates, secretions, excretions, and in the droplets of the exhaled air (Mann and Sellers 1990). The virus remains infectious for extended periods in most livestock products and on several inanimate objects (Cottral 1969). Transmission occurs by direct or indirect contact with infected animals or their excretions, secretions or tissues. Aerosol transmission can result in a rapid spread of infection (Sellers and Forman 1973).

After recovery from FMD, a chronic persistent infection may occur in the posterior pharyngeal areas with a low detectable level of virus for up to 6 months (Graves 1979). These animals are of concern as potential sources of virus for new outbreaks.

Animal husbandry

Herd size and density are important factors in the spread of the disease due to close contact between animals. They can also induce stresses or affect the nutritional status of the animals resulting in an increase in susceptibility to infections. When the density of animal populations is higher there is a larger risk of disease spread. The number and distribution of livestock populations in Thailand in 1992 are shown in Table 1.

Due to the high density of cattle and buffaloes in Region 3 and 4 and cattle in Region 5 and 6, most of the FMD outbreaks were reported in these regions. FMD in swine was prevalent in Region 7 where the populations of pigs is very high. As the people in the southern regions prefer growing rubber or mining which offer higher incomes and are less time consuming than raising livestock, the population of livestock animals is much lower in this part of the country and as a result Regions 8 and 9 have been announced free of the disease since 1956 and Region 2 since 1989.

* Department of Livestock Development, Phythai Road, Bangkok 10400, Thailand.

COUNTRY LIVESTOCK AND FMD EPIDEMIOLOGY STATISTICS

Thailand: 4 areas; 9 regions

LIVESTOCK STATISTICS

Livestock	Number (million)	Draft use %	Meat use %	Milk production (kg/day)	Estimated international movements/year	
					Entering	Leaving
Cattle	7.12	85.7	11.2	719 120	9092	2519
Buffaloes	4.73	93.2	6.8	na	5367	771
Pigs	8.19	na	67.1	na	1244	40
Sheep	0.18	na	na	na	na	10326
Goats	0.16	na	na	na	na	na

FMD EPIDEMIOLOGY

Seasonal incidence: none

Geographic frequency: most outbreaks occur in Central, North and Northeast Areas

Disease outbreaks and vaccinations

	1988	1989	1990	1991	1992	1993
Serotypes recorded	O,A,Asia 1	O,A,Asia 1	O,A,Asia 1	O,A,Asia 1	O,A,Asia 1	O,A,Asia 1
Species involved	C,B,P	C,B,P	C,B,P	C,B,P	C,B,P	C,B,P
Vaccine used	O,A,Asia 1	O,A,Asia 1	O,A,Asia 1	O,A,Asia 1	O,A,Asia 1	O,A,Asia 1

Facilities

Veterinary centres (research and diagnostic laboratories): Northern VRDC (Veterinary Research and Diagnostic Center), Hang Chat; Foot-and-Mouth Disease Center (FMDC), Pak Chong; Northeastern VRDC, Khon Kaen; Southern VRDC, Nakhon Srithammarat; National Animal Health and Production Institute (NAHPI), Bangkok^a

Cost per diagnostic test (\$US): ELISA — 6; CFT — 4; tissue culture — 14

^a Now the National Institute for Animal Health (NIAH)

Vaccine

Vaccine supply: FMDC, Pak Chong

Cost per dose (\$US): monovalent — 0.26; bivalent — 0.40; trivalent — 0.60

Vaccine strategy:

(i) mass vaccination of cattle and buffaloes, twice yearly;
 (ii) ring vaccination within 15 km around infected area, using monovalent or trivalent vaccine if FMD virus type is not specified.

Table 1. Livestock population in Thailand, 1992.

Region	Cattle	Buffaloes	Goats	Sheep	Pigs
1	764 010	93 973	14 389	42 486	566 053
2	261 626	161 483	2 161	4 623	1 316 131
3	1 490 829	2 205 586	3 651	1 516	1 015 975
4	965 903	1 587 092	876	750	578 258
5	734 068	330 374	8 411	1 821	838 308
6	1 144 431	202 601	14 234	25 866	677 218
7	986 584	54 634	10 327	51 985	2 444 618
8	248 322	64 152	22 941	1 987	406 913
9	523 169	28 376	82 211	45 195	349 929
Total	7 118 942	4 728 271	159 201	176 229	8 193 403

Source: Division of Planning and Statistics, Department of Livestock Development

Stock Movements

Although most of the borders are natural boundaries such as mountain ranges, rivers and coast lines, there are some passes which offer relatively free movement of livestock. FMD in cattle has been prevalent in provinces along the border, such as Chiang Rai, which is probably due to smuggling of animals across the border.

As mentioned previously, raising livestock is not the main occupation in the south. However, a number of livestock are needed in the south for local consumption and the south is therefore a tempting place for livestock traders as the prices tend to be much higher. As a result, the direction of animal transportation within Thailand are mostly from the north and northeast to the south. Region 1 and 7 which are the central part of Thailand are the transit points for animals gathering before going south.

Owing to the economic growth, road networks in Thailand have been extended further to almost all villages making the transportation more convenient. This change promotes the spread of several diseases and is one of the difficulties in controlling FMD.

Control/Eradication Strategies

Control measures for FMD have been implemented since 1956 based on the *Animal Epidemic Act 1956*. The Foot-and-Mouth Disease Center was established for diagnostic purposes in 1956 at Pak Chong, Nakhon Ratchasima Province. In 1960 the FMD Vaccine Production Center was built at Nongsari, Pak Chong. FMD diagnosis is also carried out at the Northern Veterinary Research and Diagnostic Center (NVRDC) at Hang Chat in Lampang Province.

Five main activities of the FMD control strategy currently used are:

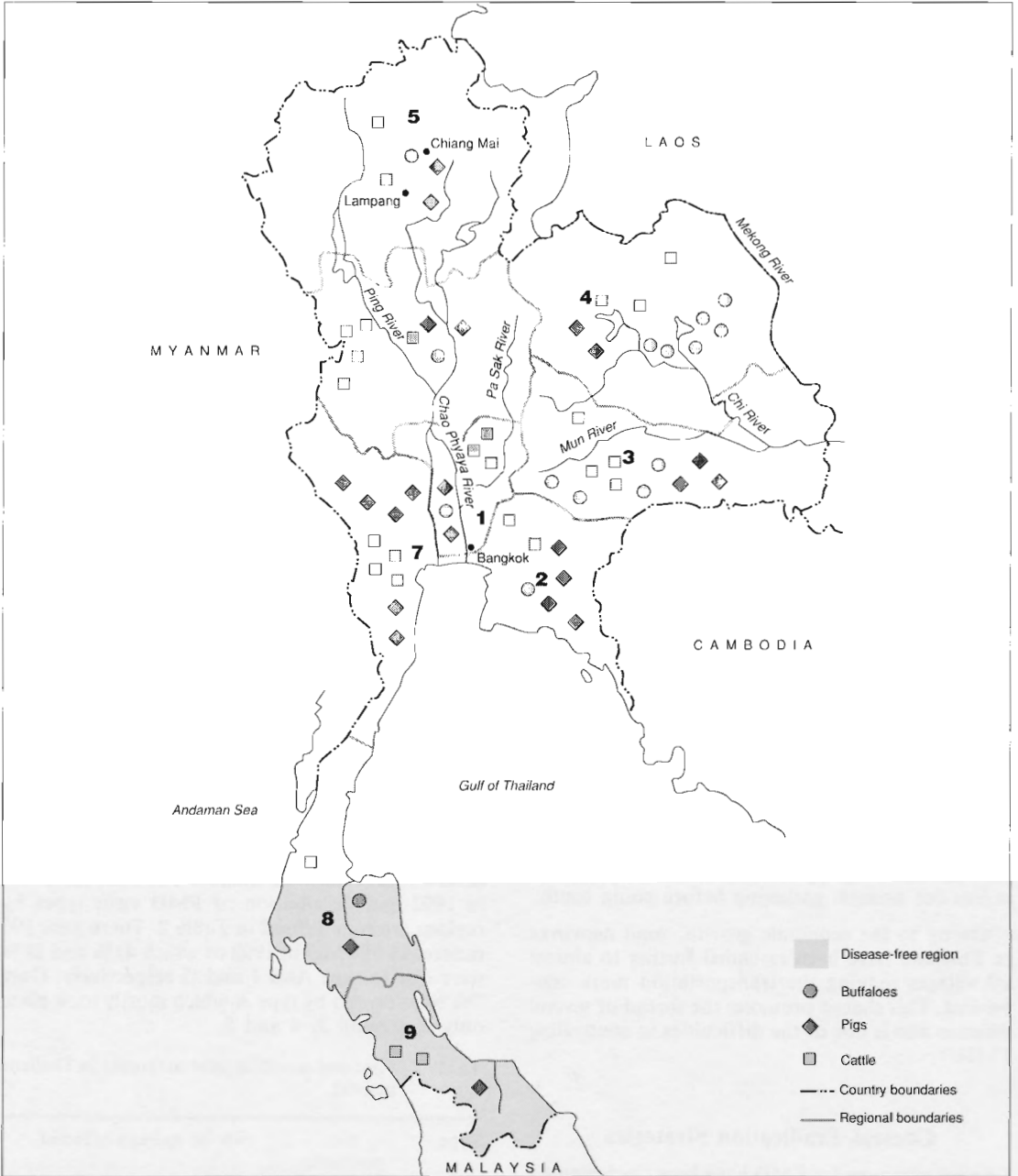
- mass vaccination program;
- FMD information system;
- control of animal movement;
- stamping out; and
- public relations with the goal of eradicating FMD from Thailand by the year 2000.

Recently a new vaccine factory has been established at Pak Chong to produce enough trivalent FMD vaccines for the mass vaccination program. In addition, new diagnostic techniques have been introduced to increase the efficiency of FMD diagnosis. The Foot-and-Mouth Disease Information Center was established at the Division of Disease Control, for the collection and analysis of FMD outbreak data. According to this information centre the number of FMD outbreaks in 1992 and distribution of FMD virus types by regions are summarised in Table 2. There were 196 outbreaks of FMD in 1992 of which 45% and 28% were due to type Asia 1 and O respectively. Only 7% were caused by type A which mostly took place only in Region 3, 4 and 5.

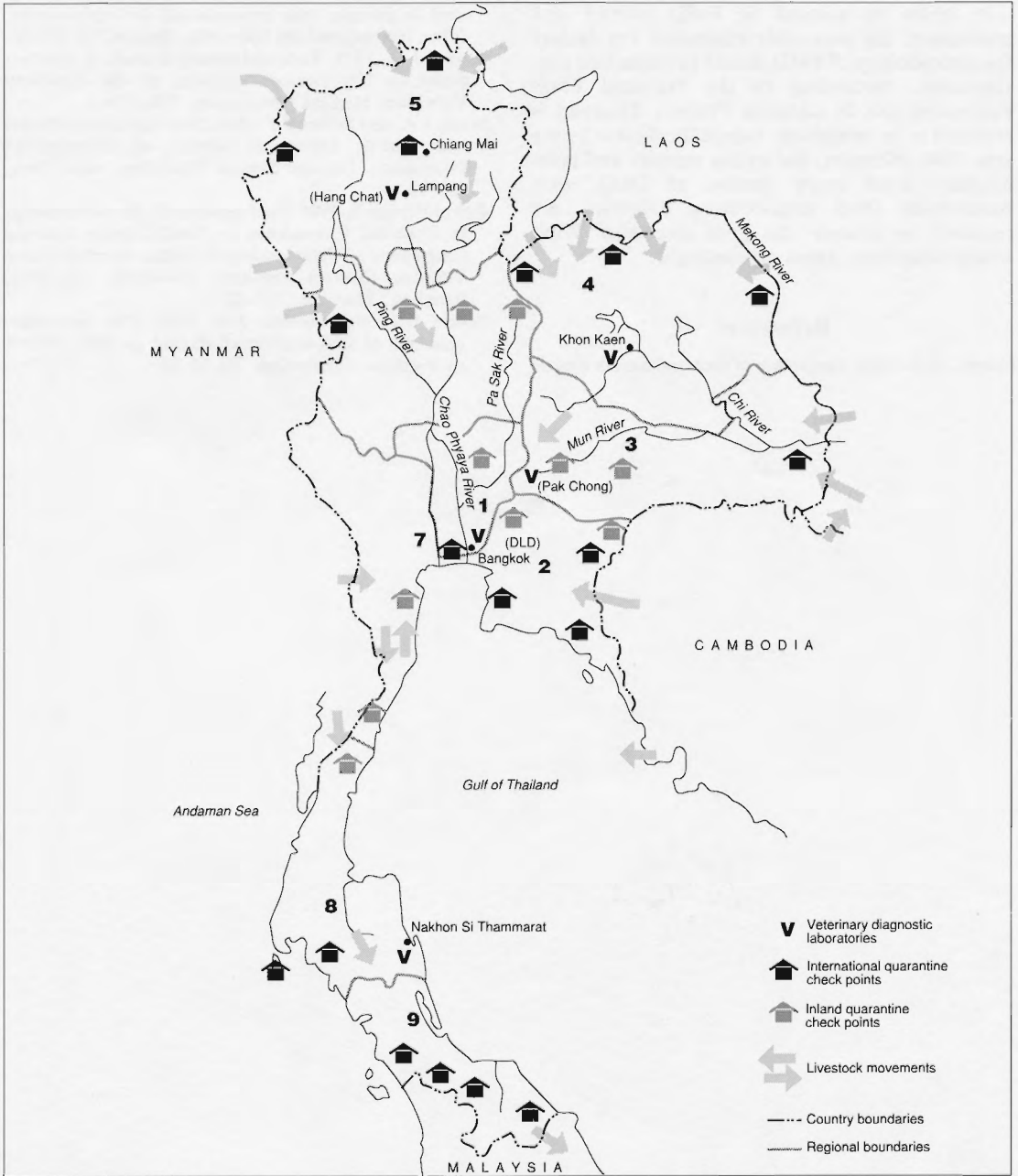
Table 2. Foot-and-mouth disease outbreaks in Thailand in 1992.

Type	No. outbreaks	No. of animals affected		
		Cattle	Buffaloes	Pigs
O	54	16 599	7 044	185 685
A	14	5 527	1 476	—
Asia 1	89	30 340	9 854	21 676
Unknown ^a	39	31 207	4 369	25 491

^a Old lesions; virus difficult to isolate or sample was too small
Source: FMD Information Center, Division of Disease Control, Department of Livestock Development



Map 1. Main livestock areas and FMD disease-free regions in Thailand.



Map 2. FMD outbreaks, facilities and livestock movement patterns in Thailand.

In order to succeed in FMD control and eradication, the previously mentioned key factors for epidemiology of FMD should be taken into consideration. According to the National FMD Prevention and Eradication Project, Thailand is expected to be completely free of the disease by the year 2000. However, the strong support and commitment from every section of DLD, with cooperation from neighbouring countries, are required to achieve the goal (see also Wipit Chairisongkram, these proceedings).

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Vietnam

Nguyen Xuan Phuc*

VIETNAM has experienced a decreasing number of outbreaks of foot-and-mouth disease (FMD) and of infected animals in recent years. In 1975 the disease was very common in the south with 60 outbreaks and 17 300 animals infected. From 1978-83 about 500 000 doses of FMD vaccine (types A, O and C) were imported into Vietnam every year from the former Soviet Union without charge. Vaccination campaigns were launched by the Department of Veterinary Services, with the aim of controlling the old outbreaks, at key points along the main routes of animal movement and in areas along the border between Cambodia and Vietnam. As a result the number of outbreaks was considerably reduced with only a few outbreaks of the disease recorded every year in villages along the border provinces such as Tay Ninh, An Giang and Thuan Hai.

In 1969 samples were sent to the World Reference Laboratory, Pirbright, United Kingdom for typing and the results showed serotype O. In 1984 samples were typed by Merieux Company and type O virus was also identified. In 1990 the Laboratory of the Centre for Veterinary Diagnosis, Ho Chi Minh City checked samples collected from the outbreak in Thuan Hai Province. Serotype O was again found, but in 1992 serotype Asia 1 was also detected from samples of another outbreak. Cattle and buffaloes are both equally susceptible to the disease and pigs and goats are sometimes also infected.

The source of infection has been reported as coming from Cambodia. In general, outbreaks start in villages located along the border and then spread to other villages inland. The morbidity is extremely high covering all herds of animals in an area within several days. The mortality is low, however, except in young animals.

FMD causes great economic losses to farmers, including cost of treatment, feeding animals during the sickness and reductions in draught power. Slaughterhouses in the infected area have been closed up until now.

The policy of the Department of Animal Health for controlling FMD in Vietnam includes:

- improvement of the disease-reporting system so that new cases of the disease are reported as soon as possible;
- ring vaccination;
- isolation and treatment of sick animals; and
- strict control of animal movement.

A National FMD Control and Eradication program has been set up. However, assistance from international organisations is required in areas such as funding, disease information, organisation of ring vaccination, setting up of check points to control animal movement, provision of equipment and facilities for laboratory typing.

* Department of Agriculture, Ministry of Agriculture and Food Industry, Hanoi, Vietnam.

COUNTRY LIVESTOCK AND FMD EPIDEMIOLOGY STATISTICS

Vietnam: 3 provinces

LIVESTOCK STATISTICS

Animals per owner: Estimated averages — 4-5 beef cattle; 2-3 dairy cattle; 1-2 working cattle; 1-4 buffaloes; 2-5 pigs; 10-15 sheep/goats

Type	Number (million)	Draft use %	Meat use %	Milk production %
Cattle	3.1	40	50	10
Buffaloes	2.8	68	31	1
Pigs	12.5	na	na	na
Sheep and goats	0.3	na	na	na

International stock movement: see map

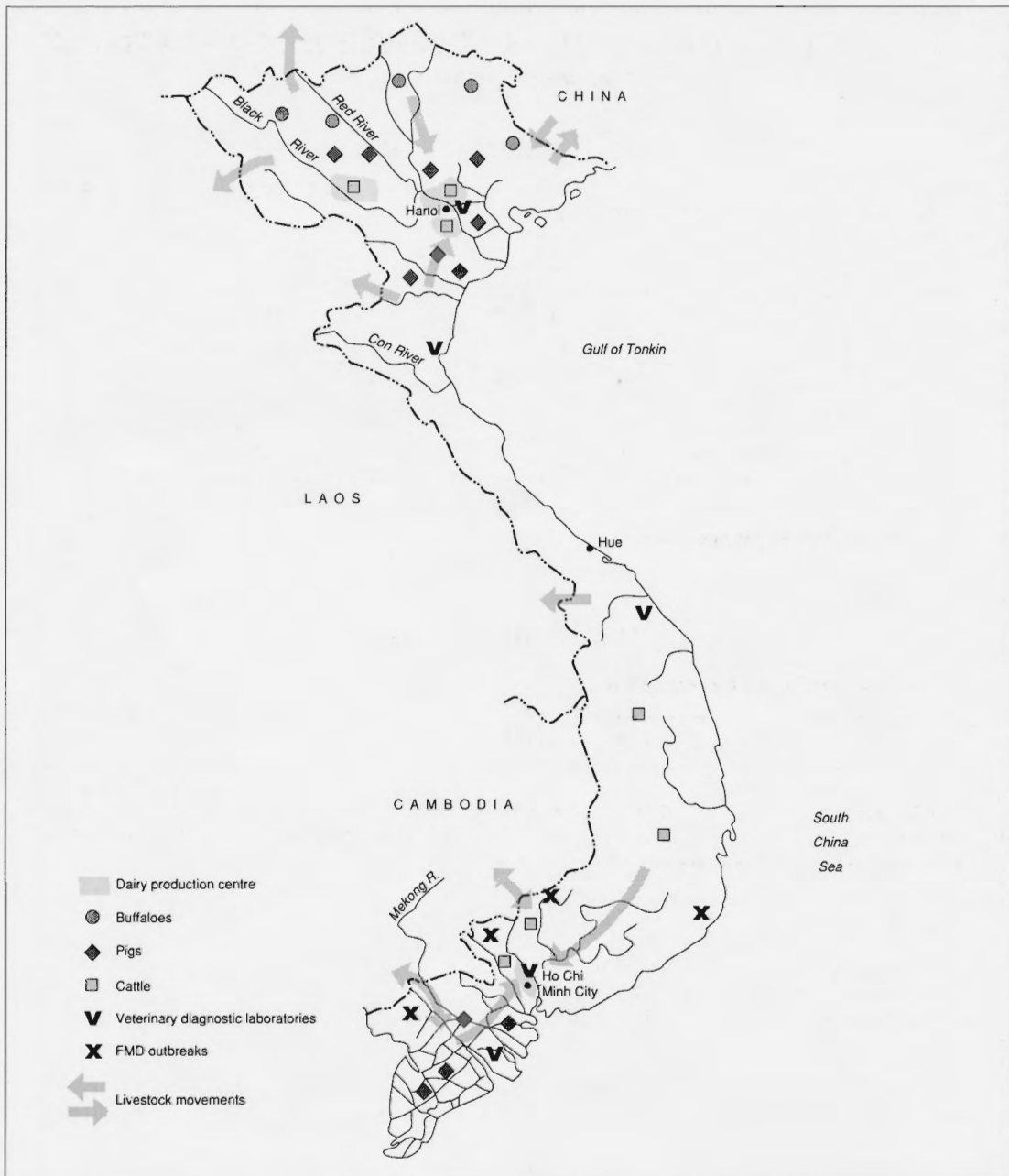
FMD EPIDEMIOLOGY

Disease outbreaks and vaccinations

	1988	1989	1990	1991	1992	1993
Serotypes recorded	O	O	O	O	Asia 1	Asia 1
Species involved	C,B,P,G	C,B,P,G	C,B,P,G	C,B,P,G	C,B,P,G	C,B,P,G
Vaccine use	polyvalent	polyvalent	polyvalent	polyvalent	polyvalent	polyvalent

Vaccine

Vaccine supply: Imported
Cost per dose (\$US): 1.2 (1992)
Vaccine strategy: ring vaccination



Map 1. Main livestock areas, FMD outbreaks, facilities and livestock movement patterns in Vietnam.

RECOMMENDATIONS

The final session of the workshop consisted of group discussions and formulation by the conference participants of recommendations for an improved control program for foot-and-mouth disease in Southeast Asia. The recommendations cover the following aspects of FMD control:

- economic and extension activities;
- vaccination program;
- laboratory diagnosis to support a national and regional FMD control program;
- epidemiological and data management for control and eradication; and
- strategies and regulations for regional and national FMD control.

Recommendations of Foot-and-Mouth Disease Workshop

Recommendations on economic and extension activities

Economic activities

1. Benefits and costs from FMD control and eradication vary from area to area of each country according to differences in agricultural and livestock production systems. Assessments should therefore be based on aggregation of valued effects obtained from representative villages and farms in each area or region.
2. Assessments of loss should include the loss of draft animal power, milk, abortion, infertility and mortality, as well as the treatment costs. Such assessments can be made with partial budgets on models which can show cumulative losses in productivity and income over time. Totals can be expected to vary over time according to species and farming systems involved and the epidemiological characteristics of the FMD outbreak.
3. Costs of additional measures to be borne by villages and farmers should be calculated on the same series of representative units. That is, the costs associated with isolation facilities, handling, disinfection and compensation, if appropriate, should be included.
4. Social issues such as the value of animals as a reserve capital or as an indication of status should be estimated and included in a control and eradication campaign, particularly for the poorer smallholders and landless of the community.
5. The aggregate potential benefits can be obtained for each disease control area by using epidemiological evidence to estimate numbers of villages and farms expected to be infected in the operational area with and without selected combinations of control and eradication measures. Anticipated trends in the herd and flock characteristics have to be considered.

6. Potential costs can be summed for each control area on the basis of total farms and animals that have to receive attention. Grouped veterinary costs such as quarantine, vaccine storage, etc. have to be added for each area.
7. Social benefit-cost analyses should be used to:
 - adjust individual item values by 'shadow pricing' to reflect the national interest in such factors as export potential, rural employment and development policies;
 - adjust for the cumulative benefits and costs by 'discounting' according to national practice to reflect the changing value of money over time from the national perspective;
 - allow for public health and nutritional benefits; and
 - the most appropriate method of expressing results should be utilised, such as economic rate of return as well as benefit-cost ratios.

Extension activities

1. Extension activities are essential for a successful completion of strategies.
2. Extension strategies should:
 - be based on human, social and animal welfare as well as economic return to the community and nation; and
 - use all available resources including the media, police, and existing rural and administrative structures.
3. Communications of process and problems, at both the national and village level, of progress and resolution of problems is essential, as benefits from FMD eradication will exceed costs to the nation and farmer in the long term.

Recommendations for a successful vaccination program

1. A safe and potent vaccine with at least 3 PD₅₀ (protective dose for 50% of animals) per dose should be used in order to protect animals against FMD viruses which are circulating in the area.

Primary inactivates should be mandatory and have a shelf-life of at least one year when stored correctly. FMD vaccines must include only those serotypes recorded in the region.

2. Primary immunisation should consist of two vaccinations one month apart at a minimum age of six months. Vaccination campaigns should only be planned in areas where a high proportion of animals can be realistically vaccinated. A minimum level of 75% of animals vaccinated is desirable.
3. Neighbouring countries should coordinate vaccination campaigns in zones adjacent to national borders.
4. The development of a regional vaccine bank should be encouraged under the authority of a regional FMD coordination unit. Active surveillance of vaccine efficiency should be encouraged.

- A vaccine failure should be thoroughly investigated with the assistance of a neutral body.
5. The advantage of better adjuvants such as oil should be studied. The possibility of a combined FMD/haemorrhagic septicaemia vaccine should be examined. Future funding of vaccine production and purchases should be discussed at the regional level in conjunction with international organisations.

It was noted that there was strong endorsement of the second meeting of the Office International des Épizooties/Food and Agriculture Organization (OIE/FAO) Co-ordinating Group for Control of FMD in Southeast Asia which stressed the need of a successful vaccine control and eradication program.

Recommendations for laboratory diagnosis to support a national and regional FMD control program

1. National and regional laboratories must be disease secure and operate according to OIE/FAO guidelines.
2. Government authorities should establish a contingency fund to pay for transport of samples to the regional, national and World Reference Laboratory.
3. Research should be undertaken to improve and standardise virus infection-associated (VIA) antibody detection to differentiate infected from vaccinated animals.
4. National laboratories should be encouraged and assisted to develop a tissue culture capability for the isolation of FMD virus.
5. It would be desirable for the regional laboratory to be able to analyse FMD strains by molecular techniques.
6. The essential components of a national diagnostic laboratory are:
 - ability to diagnose FMD and serotype by ELISA techniques;
 - capacity to detect and quantify antibody to FMD virus for evaluation of vaccine, serosurveillance and animal import/export testing by ELISA;
7. The essential components of a regional FMD laboratory are:
 - ability to train field staff in safe sample collection and transport of specimens; and
 - facility to rapidly communicate results to the national central veterinary authority in the country.
7. The essential components of a regional FMD laboratory are:
 - ability to type FMD virus by ELISA techniques;
 - capacity to test and quantify antibody to FMD virus by ELISA tests;
 - tissue culture capacity to isolate FMD viruses;
 - ability to antigenically characterise FMD virus strains for vaccine production;
 - capability to produce and supply diagnostic reagents to national FMD laboratories;
 - ability to undertake external quality assurance assessments of diagnosis at the national level;
 - facilities to collect and hold reference strains of FMD virus from countries in the region;
 - ability to diagnose exotic strains of FMD virus to the region by use of inactivated reagents; and
 - to conduct training programs for national laboratories.

Recommendations for the epidemiological and data management for FMD control and eradication

1. It is essential to determine the basic needs, framework of data collection and analysis on a national scale relevant to national and regional strategies. Data collected needs to be in a standardised form for both national and regional analysis, particularly data sheets and computer files.
2. Information needs to be exchanged with the agreement of the appropriate authorities directly among the FMD epidemiologists in each country.

3. FMD vaccination needs to be monitored to ensure correct protection and coverage levels and for serological monitoring for effectiveness. Forward and backward tracing from outbreaks needs to be determined, as well as location, name of owner, geocode, dates of first and subsequent case, number of animals at risk, species, livestock movements and suspected source of infection. Specimens submitted to the national and regional laboratories should have the following information: collection date, identification and address of animals, results of any testing and description of specimen or origin of isolate.
4. Economic implications need to be evaluated by analysis of sub-samples of outbreaks and examining the direct and indirect losses plus costs of control measures.
5. Coordination of epidemiological investigations needs to reflect national and international requirements. Regional epidemiological studies need to be coordinated by a central regional coordination unit. While cooperation and collaboration on regional FMD control does occur, a mechanism or process is required to harness national goodwill for the overall benefit of the region.

Recommendations on the strategies and regulations for regional and national FMD control

1. National governments should have an agreed policy on information flow, decision making and implementation of FMD control strategies. Each country and/or province should have an animal disease control law or regulation which is practicable and includes FMD. It may be necessary to review or amend existing laws or regulations. All should include obligatory FMD reporting.
2. In the early stage of a control program, animal registration may not be necessary. As control programs become more successful, governments should be encouraged to develop practical animal registration procedures. Abattoirs must be licensed and ante- and post-mortem inspection at abattoirs should be compulsory to avoid dissemination of infectious material. Animal health authorities, veterinarians and livestock officers need to have authority to inspect livestock products and markets.
3. Vaccination programs should be phased in and as soon as possible compulsory vaccination should be offered free of charge to farmers. Vaccinated animals should be individually identified and recorded following vaccination. Owners should be provided with health/vaccination certificates for livestock movement.
4. A compulsory quarantine zone must be implemented immediately around a FMD outbreak. The OIE recommendation of a quarantine zone of 10 km radius is supported.
5. The final stages of an eradication campaign will require a stamping out policy, which will require a legal basis for compensation. This will require careful consideration and agreement by all involved and the allocation of funds for compensation. To conclude the campaign when stamping out is practised, regulations for safe disposal of infected animals and disinfection will be necessary.

International perspective

1. There is a need to establish a regional reference laboratory and a regional coordination unit for FMD in Southeast Asia.
2. As the host country of the proposed regional reference laboratory, Thailand should make legal and biological security arrangements to accept FMD samples from the Southeast Asian region. Agreement should be negotiated by the member countries regarding submission of samples to a regional reference laboratory.
3. Bilateral and multilateral regulations should be encouraged to legalise the movement of livestock and livestock products, and for rapid exchange of disease control information.
4. Veterinary services and national diagnostic capabilities need to be strengthened and reliable standardised FMD surveillance and disease reporting systems developed on a national and regional basis. Implementation of mass vaccination programs with free vaccination should be an early aim, followed up by monitoring and evaluation of vaccine effectiveness.
5. Additional control methods for specific FMD outbreaks should be designed and implemented with a move towards effective livestock movement control, particularly around focal national and zonal outbreaks.
6. There is a need for an integrated and coordinated approach by governments, the private sector and communities within countries with the development of FMD eradication strategies including elimination of animals in final focuses with full compensation for owners.

Participants

Australia

Dr John Copland
Research Project Co-ordinator
ACIAR
3rd Floor, Drake Centre
10 Moore Street
Canberra ACT 2601

Dr K Murray
CSIRO
Aust Animal Health Lab
PO Bag 24
Geelong
Vic 3220

Mr Neil Tweddle
Head of Foreign Disease Unit
Livestock and Pastoral Division
GPO Box 858
ACT 2601

Dr H Westbury
CSIRO
Aust Animal Health Lab
PO Bag 24
Geelong
Vic 3220

Dr Janet Salisbury
Communications ACIAR
3rd Floor Drake Centre
10 Moore Street
Canberra ACT 2601

Dr Bill Geering
Director Animal & Plant Health
Branch
Bureau of Resource Sciences
DPIE
PO Box E11
Queen Victoria Terrace
ACT 2600

Dr L Gleeson
CSIRO
Aust Animal Health Lab
PO Bag 24
Geelong
Vic 3220

Dr C Tisdell
Department of Economics
Uni of Queensland
St Lucia
Qld 4067

Dr C Baldock
Animal Research Institute
Locked Mail Bag No.4
Moorooka QLD 4105

Dr Pramod Sharma
University of Queensland
St. Lucia
Qld. 4072

Dr S Harrison
Department of Economics
Uni of Queensland
St Lucia Qld 4067

Austria

Dr Martyn Jeggo
Animal Health and Production Unit
Joint FAO/IAEA Division
FAO
Wagramerstrasse 5
PO Box 100
A-1400 Vienna, Austria

Bangladesh

Dr Nazir Ahmed
Director Livestock Services
Krishi Khamar Sarak
Dhaka
Bangladesh

Dr A.F.M. Rafiqul Hasan
Principal Scientific Officer
Foot and Mouth Disease
Livestock Research Institute
Mohakhali
Dhaka
Bangladesh

France

Dr Lombard
Rhone Merieux
28 Avenue Tony Barnier
BP 7133
08348 Lyon CEOEX 07
France

Cambodia

Mr Som Soon
Deputy Director of Animal Health
and Production
Ministry of Agriculture
c/- Ms K Bourke
Australian Embassy
Phnom Penh
Cambodia

Mr Son Siveth
Head of Diagnostic Lab
Ministry of Agriculture
c/- Ms K Bourke
Australian Embassy
Phnom Penh
Cambodia

Mr Kong Reatrey
Chief of Animal Health
Pursat Province
c/- Ms K Bourke
Australia Embassy
Phnom Penh
Cambodia

Dean Sam Saron
c/-Ms K Bourke
Australian Embassy
Phnom Penh
Cambodia

Dr Sen Sovann
Church World Service
CWS-Cambodia
GPO Box 2420
Bangkok 10501
Thailand

Dr C Bartels
Church World Service
CWS-Cambodia
GPO Box 2420
Bangkok 10501
Thailand

Dr Son Saan
AFSC/Cambodia
C/- INDOSWISS
GPO Box 2420
Bangkok 10501
Thailand

M Lee Bun Kun
Church World Service
CWS-Cambodia
GPO Box 2420
Bangkok 10501
Thailand

Mr Nget Sotheara
Church World Service
CWS-Cambodia
GPO Box 2420
Bangkok 10501
Thailand

Ms Kate O'Sullivan
Church World Service
CWS-Cambodia
GPO Box 2420
Bangkok 10501
Thailand

Dr M Maclean
AFSC/Cambodia
C/- Indoswiss
GPO Box 2420
Bangkok 10501
Thailand

India

Dr V A Srinivasan
Deputy General Manager
Indian Immunologicals
Rakshapuram
Gachibowli
Hyderabad 50013
India

Dr G K Sharma

Scientist 3
Animal Disease Research Laboratory
National Dairy Development Board
Anand 388 001 Gujarat
India

Dr A K Mukhopadhyay

Project Coordinator
Modular Laboratory Building
Indian Veterinary Research Institute
Izatnagar 243122
Bareilly (U.P.)
India

Dr C Natarajan

Joint Director, Cum Officer in
Charge
Indian Veterinary Research Institute
Campus

Indonesia**Dr H Setyaningsih**

Laboratory Scientist
Pusat Veterinarian Farma
JI Raya Jend A. Yani 65-70
Surabaya 60231 Kotak Pos W03
Indonesia

Mr Ron Rakiman

ACIAR Country Manager
Australian Embassy
JI Rasuna Said Kav 15-16
Kuningan
Jakarta
Selatan, Indonesia

Dr M Malole

Co-ordinator FMD Team
Faculty of Veterinary Medicine
Institute of Pertanian Bogor
JI Taman Kencana No.1
Bogor Jawa Barat
Indonesia

Japan**Dr Y. Ozawa**

OIE Regional Representative
East 311, 11-1-1 Minamiaoyama
Minato-Ku
Tokyo 107
Japan

Malaysia**Dr Gan Chee Hiong**

Director
Veterinary Research Institute
Ipoh
Malaysia

Dr Muhammad Safaruddin Dawan

Veterinary Officer
Diagnosis and Epidemiology
Kuala Lumpur
Malaysia

Pakistan**Dr Saeed Akhtar**

Senior Scientific Officer
(Epidemiology)
Animal Sciences Institute
National Agricultural Research
Centre
Park Road, Islamabad 4550
Pakistan

Peru**Mrs Ana Maria Espinoza**

Instituto Nacional de Salud
Centro de Produccion de Insumos
Capac Yupanqui 1400
Lima 11
Peru

Philippines**Yvonne G. Vinas**

Chief of Regulatory Division
Department of Agriculture
Region IV, Quezon City
Metro Manila
Philippines

Dr Bemis Mondia

Chief of Veterinary Quarantine
Services
Department of Agriculture
Region X, Cagayan de Oro City
Philippines

Sri Lanka**Dr Susima Kodituwakku**

Head Virology Division
Veterinary Research Institute
Gannoruwa
Peradeniya
Sri Lanka

Dr S S Balachandran

Dept of Animal Production and
Health
Getambe
Paradeniya
Sri Lanka

Thailand**Mr John McCarthy**

Australian Ambassador
Austalian Embassy
37 South Sathorn Road
Bangkok 10120
Thailand

Dr Pornchai Chamnanpood

Chief
Epidemiology Section
Northern Regional Veterinary
Research and Diagnostic Center
Hang Chat, Lampang, 52190
Thailand

Dr Sasaki

Regional Animal Health Officer
FAO Regional Office
Phra Atit Road
Bangkok 10200
Thailand

Assoc. Prof. Dr Maliwan Choontanom

Department of Pathology,
Microbiology Unit
Faculty of Veterinary Medicine
Kasetsart University
Bangkok 10900
Thailand

Dr Wipit Chairisengkram

Deputy Director
Department of Livestock
Development
Phyathai Road
Bangkok 10400
Thailand

Dr Ab Kongthon

Senior Veterinary Expert on Biologics
Division of Biologics
Department of Livestock
Development
Phyathai Road
Bangkok 10400
Thailand

Dr Banhong Apiwatanakorn

Immunology Section
NAHPI
Kaset Klang, Bang Khen
Bangkok 10900
Thailand

Dr Wantanee Hanyanun

Division of Disease Control
Department of Livestock
Development
Phyathai Road
Bangkok 10400
Thailand

Prof. Dr. Cherdchai Rattanasetankul

Dean
Faculty of Veterinary Medicine
Khon Kaen University
Khon Kaen 40001
Thailand

Dr Inthira Kramomthong

Bacteriology Section
NAHPI
Kaset Klang, Bang Khen
Bangkok 10900
Thailand

Dr Siltham Wara-asawapati

Chief
Epidemiology Section
NE Regional Veterinary Research
and Diagnostic Center
Tha Pra, Khon Kaen 40260
Thailand

Dr Yodyot Meephuuech
FMD Information Center
Department of Livestock
Development
Phyathai Road
Bangkok 10400
Thailand

Dr Namba
Research Section FMD Centre
Pak Chong
Nakornratchasima 30130
Thailand

Dr Kumagai
JICA Team Leader
National Animal & Production
Institute
Kasetsart University
Bang Khaen
Bangkok 10900
Thailand

Ms Chiraporn Sunpakit
ACIAR Manager
Australian Embassy
37 South Sathorn Road
Bangkok 10120
Thailand

**Assoc. Prof. Dr Songkam
Leungthongkam**
Dean
Faculty of Veterinary Science
Chulalongkorn University
Henri Dunont Road
Bangkok 10330
Thailand

Dr Ubol Srisomboon
Director Division of Veterinary
Research
Department of Livestock
Development
Phyathai Road
Bangkok 10400
Thailand

Dr Sunejitt Kongthon
Director Veterinary Biologics
Control Center
Division of Veterinary Biologics
Pak Chong Nakornratchasima 30330
Thailand

Dr Somchai Srihakim
Director
NE Regional Veterinary Research
and Diagnostic Center
Tha Pra, Khon Kaen 40260
Thailand

Dr Chaowana Mekamol (retired)
Department of Livestock
Development
Phyathai Road
Bangkok 10400
Thailand

Dr Wipit Chairisongkram
Deputy Director General
Department of Livestock
Development
Phyathai Road
Bangkok 10400
Thailand

Dr Nimit Triwanatham
Director
Southern Regional Research and
Diagnostic Center
Tung Song, Nakorn Srithammarat
80110
Thailand

Dr Rapeepong Wongdee
Director
Division of Disease Control
Department of Livestock
Development
Phyathai Road
Bangkok 10400
Thailand

Dr Prateep Pemayothin
Chief
Epidemiology Section
NAHPI
Kaset Klang, Bang Khen
Bangkok 10900
Thailand

Dr Aree Supcharoen
Virology Section
NAHPI
Kaset Klang, Bang Khen
Bangkok 10900
Thailand

Dr Sanong Srinanthapan
Chief
Epidemiology Section
Southern Regional Veterinary
Research and Diagnostic Center
Tung Song, Nakorn Srithammarat
80110
Thailand

Dr Somachai Kamolsiripichaiporn
Division of Veterinary Biologics
Pak Chong, Nakornratchasima
30330 Thailand

Dr Buddhachard Srisopar
Chief
Virology Section
NE Regional Veterinary Research
and Diagnostic Center
Tha Pra, Khon Kaen 40260
Thailand

Dr Chanpen Chamnanpood
Chief Virology Section
Northern Regional Veterinary
Research and Diagnostic Center
Hang Chat, Lampang 52190
Thailand

Dr Nopporn Saratapan
Chairman
Working Committee of National
Livestock Information Center
NAHPI
Kaset Klang, Bang Khen
Bangkok 10900
Thailand

Dr Wilai Linchongsongkrot
Division of Veterinary Biologics
Pak Chong, Nakornratchasima
30330 Thailand

Dr Pinai Musikul
Division of Disease Control
Department of Livestock
Development
Phyathai Road
Bangkok 10400
Thailand

Dr Laddawan Rattananakorn
Division of Disease Control
Department of Livestock
Development
Phyathai Road
Bangkok 10400
Thailand

Dr Wimolporn Thitisak
International Coordination
Department of Livestock
Development
Phyathai Road
Bangkok 10400
Thailand

Dr Sawat Srisithyanon
Director
2nd Regional Livestock Office
Chacherngsao 24000
Thailand

Dr Suchinta Tangchaitrong
Director
3rd Regional Livestock Office
Nakornratchasima 30000
Thailand

Dr Udom Bhodi
Director
4th Regional Livestock Office
Udonthani 41000
Thailand

Dr Kamol Awaiwanon
Director
5th Regional Livestock Office
Chiengmai 50000
Thailand

Dr Supachai Samutrapaoraya
Director
6th Regional Livestock Office
Pittsanulok 65000
Thailand

Dr Wises Prasert

Director
8th Regional Livestock Office
Surat Thani 84000
Thailand

Dr Samor Tawe-wigarn

9th Regional Livestock Office
Songkla 90000
Thailand

Dr Phothawat Ratanachot

Chief
Chiangmai Provincial Livestock
Office
Chiangmai 50000
Thailand

Dr Weerawong Komomena

Chief
Lampang Provincial Livestock Office
Lampang 52000
Thailand

Dr Prawat Ratanapumma

Chief
Mae Hong Sorn Provincial Livestock
Office
Mae Hong Sorn 58000
Thailand

Dr Sakchai Sribunsue

Chief
Chiengrai Provincial Livestock Office
Chiengrai 57000
Thailand

Dr Prawat Prapapanya

Chief
Lamphuni Provincial
Livestock Office
Lamphun 51000
Thailand

Dr Nisit Tangtrakarnpong

Chief
Pittsanulok Provincial Livestock
Office
Pittsanulok 65000
Thailand

Dr Chan Petch-aksorn

Chief
Nakorn Sawan Provincial Livestock
Office
Nakorn Sawan 60000
Thailand

Dr Ittipol Chaichanapoonpol

Chief
Parasitology Section
Northern Regional Veterinary
Research and Diagnostic Center
Hang Chat, Lampang 52190
Thailand

Dr Chaiwat Withurakool

Northern Veterinary Research &
Diagnostic Center

Hangchat

Lampang 52190
Thailand

Dr Pensri Teerawat

Northern Veterinary Research &
Diagnostic Center
Hangchat
Lampang 52190
Thailand

Dr Narongchai Nakarangkul

Northern Veterinary Research &
Diagnostic Center
Hangchat
Lampang 52190
Thailand

Dr Arun Numtoom

Northern Veterinary Research &
Diagnostic Center
Hangchat
Lampang 52190
Thailand

Dr Somkid Teeapatimakorn

Northern Veterinary Research &
Diagnostic Center
Hangchat
Lampang 52190
Thailand

Dr Sutas Taimtanom

Northern Veterinary Research &
Diagnostic Center
Hangchat
Lampang 52190
Thailand

Dr Ekkart Klung-awut

Northern Veterinary Research &
Diagnostic Center
Hangchat
Lampang 52190
Thailand

Dr Watcharapol Chotiyaputta

Disease Control Division
Department of Livestock
Development
Bangkok 10400
Thailand

Dr Yodyot Meephuch

Disease Control Division
Department of Livestock
Development
Bangkok 10400
Thailand

United Kingdom**Dr Peter Ellis**

VEERU
Department of Agriculture
Earley Gate
PO Box 236
Reading RG6 2AT
United Kingdom

Dr Alex Donaldson

Institute for Animal Health
Pirbright Laboratory
Ash Road, Pirbright
Working GU 24 ONF
United Kingdom

Union of Myanmar**Dr Aye Thein**

Staff Veterinary Officer
Myanmar Livestock Breeding and
Veterinary Department
Insein, Yangon
Union of Myanmar

Vientiane**Dr Saly Sihlath**

Deputy Director General Technical
Section of DLV
C/- Ian Millar
AIDAB First Secretary
Australian Embassy
Vientiane

Dr Singkham Phonvisay

Director General of DLV
C/- Ian Miller
AIDAB First Secretary
Australian Embassy
PO Box 292
Vientiane

Dr Sounthone Vongthilath

Department of Livestock and
Veterinary
Vientiane Laos
C/- Ian Millar
AIDAB First Secretary
Australian Embassy
Vientiane

Dr Sommay Mekhagnomdara

Director of Technical Division of
Veterinary of DLV
C/- Ian Millar
AIDAB First Secretary
Australian Embassy
Vientiane

Vietnam**Dr Bui Quy Huy**

Chief of Bureau for Epidemiology
Staff Member of National FMD
Control Program
Department of Animal Health
Ministry of Agriculture and Food
Industry
Phuonngmai Dongdo
Hanoi Vietnam

Dr Nguyen Xuan Phuc

Department of Animal Health
Ministry of Agriculture and Food
Phuonngmai Dongdo
Hanoi Vietnam

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