Chapter 4

Results

This retrospective study was conducted in Chiang Mai and Lamphun area during 2004-2006. The objectives of the study were to determine the status and identify risk factors of Foot and Mouth Disease (FMD) in pig and cattle farms. Questionnaires concerning farm management and risk factors of FMD were applied to pig and cattle farmers in the study area. Geographic data such as road, river, provinces, districts and sub-districts boundaries, position of live animal markets and slaughter houses including position of pig and cattle farms were also collected to create maps of pig and cattle farms and FMD outbreak points in the study area. The results are showed in the following.

4.1 The General information

Geographical information of the study area: This study area consists of 23 districts (Amphoe) in 2 provinces (17 districts in Chiang Mai province and 5 districts in Lamphun province). The study area bordering Myanmar and Chiang Rai province in the north, Maehongson province in the west, Lampang province in the east and Tak province in the south. The geographical characteristics of the study area have less flatland surrounded with mountains. The land had been used for rice paddy field and rotated crops. There are 4 main roads connect with area outside the mountain, consist of Chiang Mai-Chiang Rai route, Chiang Mai-Fang route, Chiang-Lampang

route and Chiang Mai-Hod route. Ping River is the main river that flow through center of this area.

Pig farms located all over the study area and found densely in the center especially in San Patong district. Most of pig farms were established on flat land, a few were found on the mountain (Figure 4.1). Cattle farms were distributed the same as the pig farms. San Kamphang district has the highest number of cattle farms (Figure 4.2). The cattle farms were found densely around the dairy cow co-operation such as San Kamphang district, Mae-On district and San Sai district.

Number and size of farms: There were 3,936 pig farms and 12,495 cattle farms in the study area. Cattle farms and pig farms were divided in 4 classes according DLD standard farm practice as showed in table 4.1. Most of the farm types in this area were cattle or swamp buffalo farm. San Patong district had the highest number of pig farmers, which were 771 pig farmers. San Kamphang district had the highest number of cattle farms, which were 1,353 cattle farmers. This was showed in table 4.2.

Table 4.1 The criteria of farm size dividing

Size of farm	Number of animals (Head)	
	Pig	Cattle
Individual	Less than 50	Less than 5
Small	50 - 499	50 - 19
Medium	500 - 4999	20 - 99
Large	More than 5000	More than 100

Table 4.2 The number of pig and cattle farms in the study area divided by districts

and the percent of sample farms in each districts

Area	Pig farm			Cattle farm		
	No. of farms	Selected farms		No. of farms	Selected farms	
		Number	Percent		Number	Percent
Chiang Mai						
1. Mueang	6	6	100.00	137	40	29.2
2. Jom Thong	317	71	22.4	379	111	29.3
3.Chiang Doa	22	5	27.3	300	61	20.3
4. Doi Saket	177	38	21.5	1,097	304	27.7
5. Doi Tao	107	30	28.0	568	164	16.4
6. Proaw	316	44	13.9	1,280	203	15.9
7. Mae Tang	75	14	18.7	658	162	24.6
8. Mae Rim	94	22	23.4	413	122	29.3
9. Mae Wang	257	57	22.2	404	76	18.8
10. Saraphee	18	17	94.4	54	42	77.8
11.San Kamphang	221	54	24.4	1,353	357	26.4
12. San Sai	313	34	10.9	1,233	316	25.6
13. San Patong	771	154	19.9	710	187	26.3
14. Hang Dong	116	52	44.8	383	153	39.9
15. Hod	180	19	10.5	525	136	25.9
16. Mae-On	52	20	38.5	643	153	23.6
17. Doi Lor	298	76	25.5	362	46	12.7
Lamphun						
1. Mueang	181	74	40.9	576	314	54.5
2. Pa Sang	127	39	30.7	387	116	30.0
3. Mae Tha	18	7	38.9	166	76	45.7
4. Ban Hong	159	32	20.1	221	69	31.2
5. Ban Thi	53	18	34.0	508	214	42.1
6 Wiang Nong Long	58	16	27.6	138	42	30.4
Total	**3936**	**899**	**22.84**	**12495**	**3464**	**27.72**

Pig farms in Chiang Mai and Lamphun were distributed in the communities
which were inside flatland, especially in San Patong district of Chiang Mai province
(figure 4.1). The most density of pig farms closely located to the center of the study
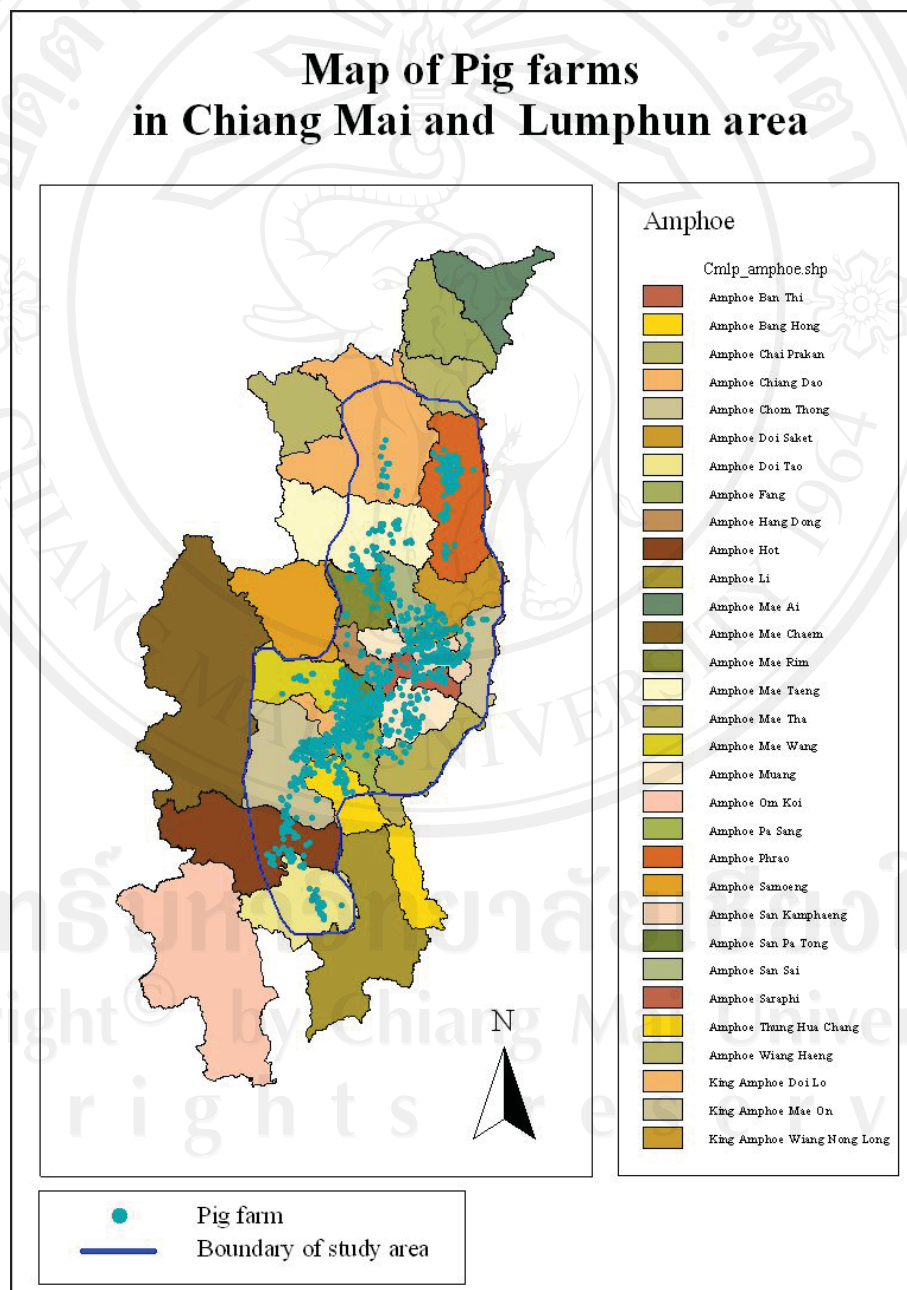area. In the rural areas like Doi tao had less density of pig farms.

Figure 4.1 Map of Pig farms in Chiang Mai and Lamphun area

About the cattle farms, their distribution was looked like the location of pig farms. The most cattle farms were located in the central part of the study area. This study area had cattle farms more than pig farms but their distribution was similarly (Figure 4.2).
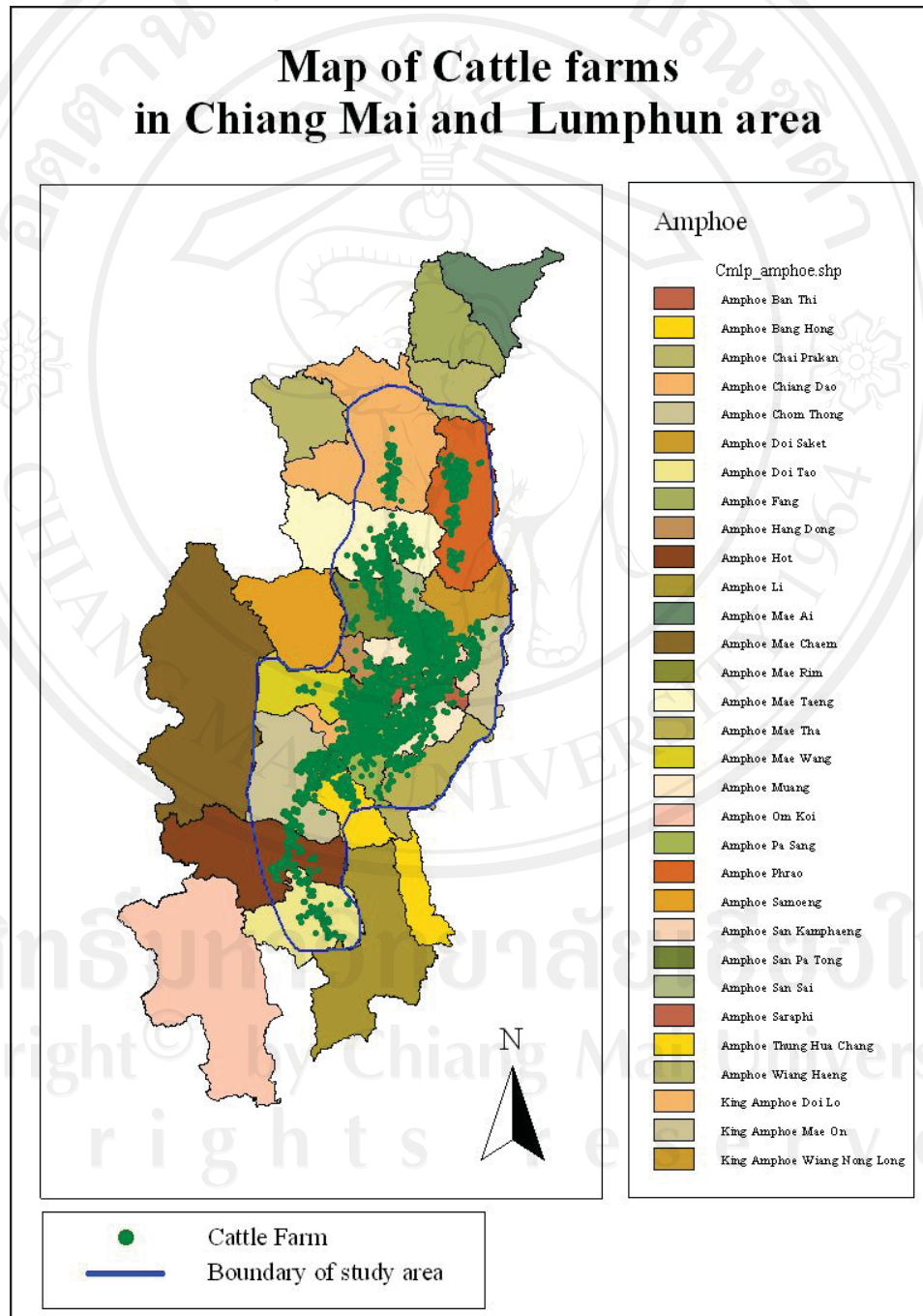

Figure 4.2 Map of Cattle farms in Chiang Mai and Lamphun area

The data from 899 pig farms and 3464 cattle farms were collected. The result showed that, 77.88 % of the pig farms were individual farm which less than 50 pigs per farm and 46.66% of cattle farms were small holder farms which less than 20 cattle in the farm, as showed in figure 4.3 and 4.4.
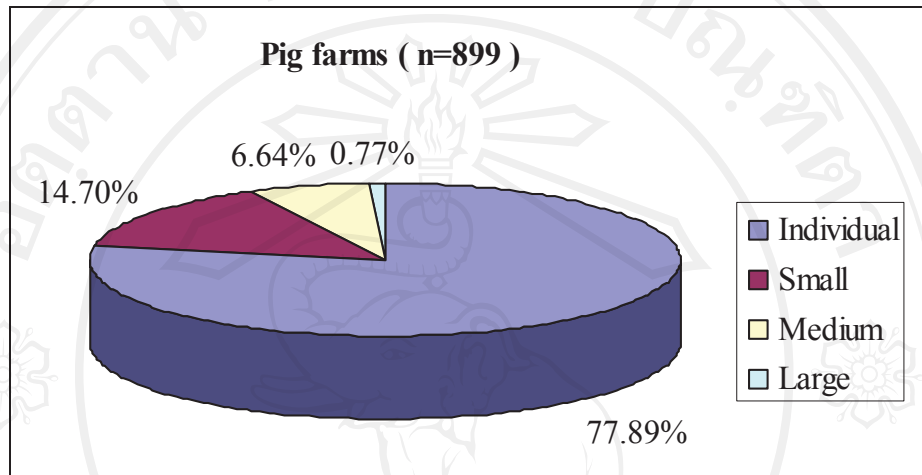

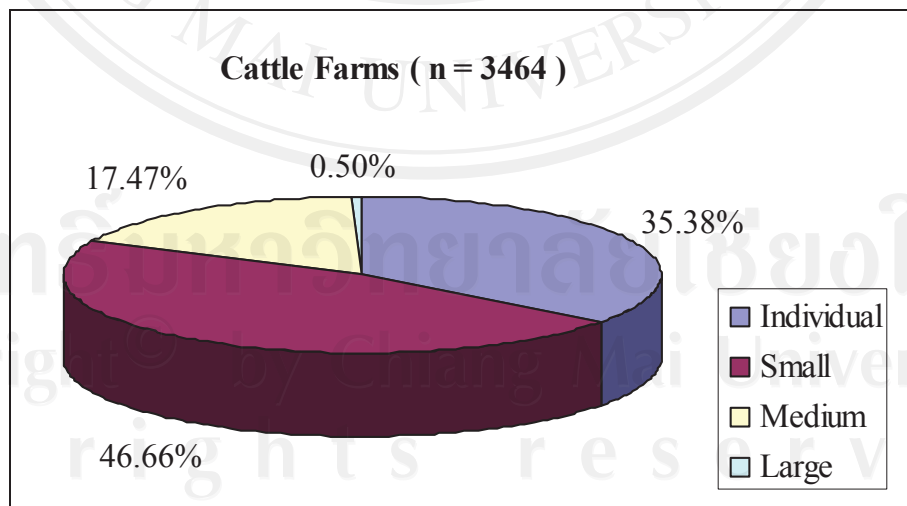**Figure 4.3** Percentage of pig farms in the study area dividing by farm size

Figure 4.4 Percentage of cattle farms in the study area dividing by farm size

Farm Management: Pig farms in Chiang Mai and Lamphun provinces had varied farm management upon size of farms. There were 50.15 % finisher pig farms, 33.34 % intensive pig farms, and only 16.42 % breeder farms. A total of 77.65 % of the farms was one-site. A total of 43.27 % of the farms used all-in all-out management system from nursery to finisher, while 46.12% had continuous management. A total of 96.32 % of pig houses were opened house and only 35.82% did not raise more than 2 type of pig in one house (Table 4.3).

Table 4.3 The character and pattern of pig farm management in the study area

Pig farm management	No. of farm	Percent
Farm type		
Intensive	301	33.43
Breeder	148	16.42
Finisher	451	50.15
Farm pattern		
One-site	698	77.65
Two-site	60	6.64
Three-site	83	9.19
No data	59	6.52
Housing type		
Closed	29	3.26
Opened	866	96.32
Mixed	4	0.41
Management system Between nursery to finishing pig		
All-in all-out	389	43.27
Continuous	415	46.12
Both	95	10.61
Separate housing by pig type	322	35.82

In Feeding and water management, 77.18% of the farms bought commercial feed from the supplier. Most of them used tab water as water resource. About 34% used aquifer as water supply, but only 20.63 % treated water before use (Table 4.4).

Table 4.4 Feed and water management in pig farms in the study area

Pig farm management	No. of farm	Percent
Feed		
In house	46	5.10
Bought	694	77.18
In house and bought	159	17.72
Water source		
Tab water	476	52.9
Aquifer	307	34.1
River or canal	58	6.5
Swamp	44	4.9
More than 1 source	24	2.7
Treated water before use	185	20.63

About biosecurity in the farm, 68.82% of pig farms had fence for located production area. But most of studied farms (93.24 %) did not decontaminate vehicle and people before farm entry. Furthermore 43.44% allowed the pig trucks park inside the farm. They prevented their pigs from the diseases with decontaminated the visitors' footwear in front of the pig house only 8.42%. More than half of pig farmers used disinfectant to clean the cages and left 5 days before add new batch. Only 11.08% had quarantine house, which separated from other houses more than 25 meters (Table 4.5)

Table 4.5 Biosecurity management in pig farms in the study area

Pig farm management	No. of farm	Percent
Have fence surrounding production area	619	68.82
Method of vehicle disinfectant		
Disinfectant pond	20	2.19
Spray house	3	0.3
Spray machine	38	4.27
Non	838	93.24
Method of personal disinfectant		
Bathroom	18	2.02
Wash basin	45	5.04
More than 1 method	5	0.59
Non	830	92.35
Has wash basin in every house	76	8.42
Leave 5 days between batch	643	71.55
Used disinfectant during empty period	467	51.99
Pig truck parks		
In front of farm	455	50.56
in farm	391	43.44
Quarantine house separate from other houses more than 25 meters	100	11.08

About waste management, 66.69% of the farmers destroyed death pigs by burying. Up to 90 % of the farms air dry pig feces (Table 4.6).

Table 4.6 Waste management in pig farms in the study area

Pig farm management	No. of farm	Percent
Carcass management		
Buried	600	66.69
Burnt	14	1.6
Sold	12	1.36
Non	261	29.05
More than 1 method	12	1.3
Feces management		
Treat pond	83	9.19
Other (dry by air or waste)	816	90.81

Only 4.15% of the farmers called for veterinary service, the rest of them treated sick animal by owners or care givers. Most of farmers had other job to do and less than 50% had main income from pig farm (Table 4.7).

Table 4.7 Other information in pig farms in the study area

Pig farm management	No. of farm	Percent
Person who treat sick animal		
Veterinarian	37	4.15
Other	862	95.85
Has other job except pig farm	709	78.84
Most income from pig farm	443	49.26

In the cattle farm, Most of the farms raised cattle on public pasture (81.90 %), and shared pasture with other farm or other villages. Moreover, their shared public water source with neighbouring villages. The main water source was public river or canal (33.60%) others used tab water, swamp and aquifer. Only 9.70% fed the concentrate to their cattle. 23.79% supplied the mineral supplement block to the cattle, while 0.40% shared the mineral block with other farm (Table 4.8).

Table 4.8 Feed and water management of cattle farm in the study area

Cattle farm management	No. of farm	Percent
Pasture		
Own	350	10.10
Public	2837	81.90
Other	114	3.29
More than 1 source	163	4.71
Shared pasture with other farm/villages	1174	33.89
Main water source		
Artesian well	495	14.29
Tab water	509	14.69
River or canal	1164	33.60
Swamp	468	13.51
More than 1 source	828	23.90
Shared water source with other farm/villages	1178	34.01
Feed concentrate	336	9.70
Mineral supplement	824	23.79
Share mineral with other farm	14	0.40

About biosecurity, over 95%of the farms did not decontaminate vehicles and visitors before entry. Only 2.20 % of the farms had disinfectant basin in front of cattle barns. A few of the study farms, imported feces into farm and their animal contacted with other animal (Table 4.9).

Table 4.9 Biosecurity management of cattle farm in the study area

Cattle farm management	No. of farm	Percent
Method of vehicle disinfectant		
Disinfectant pond	17	0.49
Spray house	31	0.89
Spray machine	97	2.80
Non	3319	95.81
Method of personal disinfectant		
Bathroom	3	0.09
Wash basin	94	2.71
Other	7	0.20
More than 1 method	3	0.09
Non	3353	96.80
Has wash basin in every house	76	2.19
Farm's animal contact with other animal	59	1.70
Import feces into farm	31	0.89

The farmers, up to 80.60% of cattle farmers, had other job apart from cattle farm such as longan orchard owner and 61.81% had main income from the cattle farm. Some farmers (20.00%) regularly add new stock every month with the average of 2 cattle per farm. Furthermore, the cattle frequently were artificial inseminate by animal volunteers (Table 4.10).

Table 4.10 Other information of cattle farm in the study area

Cattle farm management	No. of farm	Percent
Add new stock	693	20.01
Has other job except cattle farm	2792	80.60
Most income from cattle farm	2141	61.81
Artificial inseminator		
DLD Officer	246	7.10
Veterinarian	52	1.50
Owner	703	20.29
Other	2387	68.91
More than 1 group	73	2.11

4.2 History of FMD outbreak

The prevalence of FMD in the study area: Selected pig and cattle farms were collected data concerning history of FMD outbreak during 2003-2004 with questionnaires. The results were showed that 10 of 899 selected pig farms or 1.11% had FMD outbreaks in previous year. It was few prevalence of FMD in pig farm in the study area. But in the cattle farms were found 514 of 3464 selected farms or 14.84% had FMD outbreaks in previous year. Table 4.11 was showed detail of history of FMD outbreaks in each district.

Table 4.11 Number and percent of FMD outbreak farms in each district in this study

Area	Pig farms			Cattle Farms		
	No.	Outbreak farms		No.	Outbreak farms	
		Number	Percent		Number	Percent
Chiang Mai						
1. Mueang	6	-	-	40	10	25
2. Jom Thong	71	1	1.4	111	20	18
3.Chiang Doa	5	-	-	61	5	8.2
4. Doi Saket	38	-	-	304	23	7.6
5. Doi Tao	30	-	-	164	72	43.9
6. Proaw	44	1	2.3	203	12	5.9
7. Mae Tang	14	-	-	162	6	3.7
8. Mae Rim	22	1	4.5	122	2	1.6
9. Mae Wang	57	1	1.8	76	8	10.5
10. Saraphee	17	-	-	42	5	11.9
11.San Kamphang	54	-	-	357	45	12.6
12. San Sai	34	2	5.9	316	20	6.3
13. San Patong	154	-	-	187	23	12.3
14. Hang Dong	52	1	-	153	20	13.1
15. Hod	19	-	-	136	43	31.6
16. Mae-On	20	-	-	153	13	8.5
17. Doi Lor	76	1	1.3	46	2	4.3
Lamphun						
1. Mueang	74	-	-	314	109	34.7
2. Pa Sang	39	-	-	116	14	12.1
3. Mae Tha	7	-	-	76	13	17.1
4. Ban Hong	32	-	-	69	6	8.7
5. Ban Thi	18	2	11.1	214	39	18.2
6 Wiang Nong Long	16	-	-	42	4	9.5
Total	**899**	**10**	**1.11**	**3464**	**514**	**14.84**

In Chiang Mai province had 8 FMD outbreaks in pig farms in 7 districts including Jom Thong, Proaw, Mae Rim, Mae Wang, San Sai, Hang Dong and Doi Lor. In Lamphun province had 2 FMD outbreaks in pig farms in Ban Thi districts. The FMD outbreaks in cattle were found in every district in the study area and were found more than in pig farms. In Chiang Mai province had 329 FMD outbreaks in cattle farms and Doi Toa districts had the most prevalence of FMD. In Lamphun province had 185 FMD outbreaks in cattle farms and Mueang districts had the most prevalence of FMD.

The pig farms with FMD outbreak in 2004-2006 were found in 10 pig farms (figure 4.5). The central area was found more than half. This area is high density of pig farms. When compare with location of pig farms, the map (figure 4.6) shows FMD outbreak farms were identified only in the high density of pig farms area.
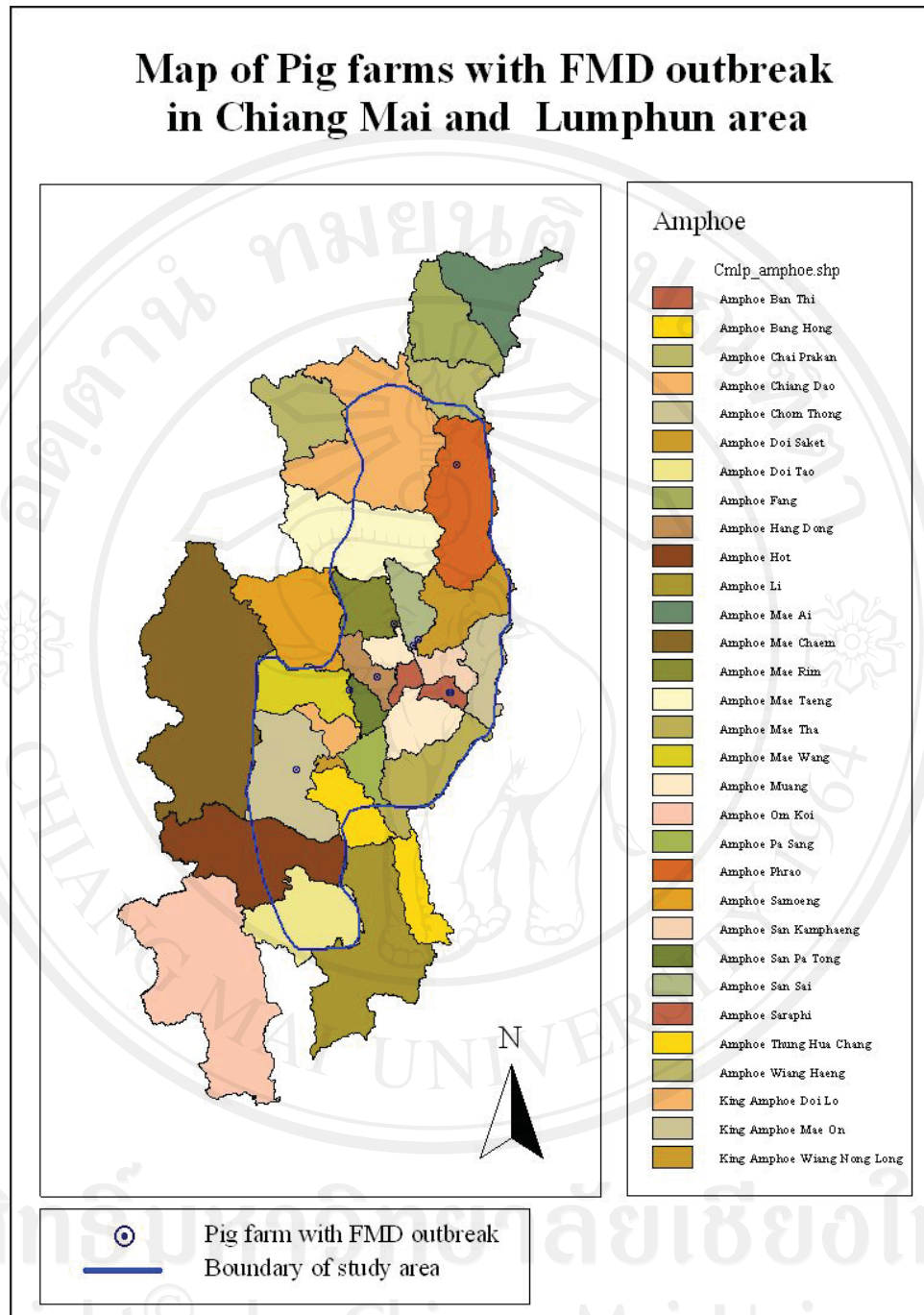
Figure 4.5 Map of Pig farms with FMD outbreak in previous year in Chiang Mai and
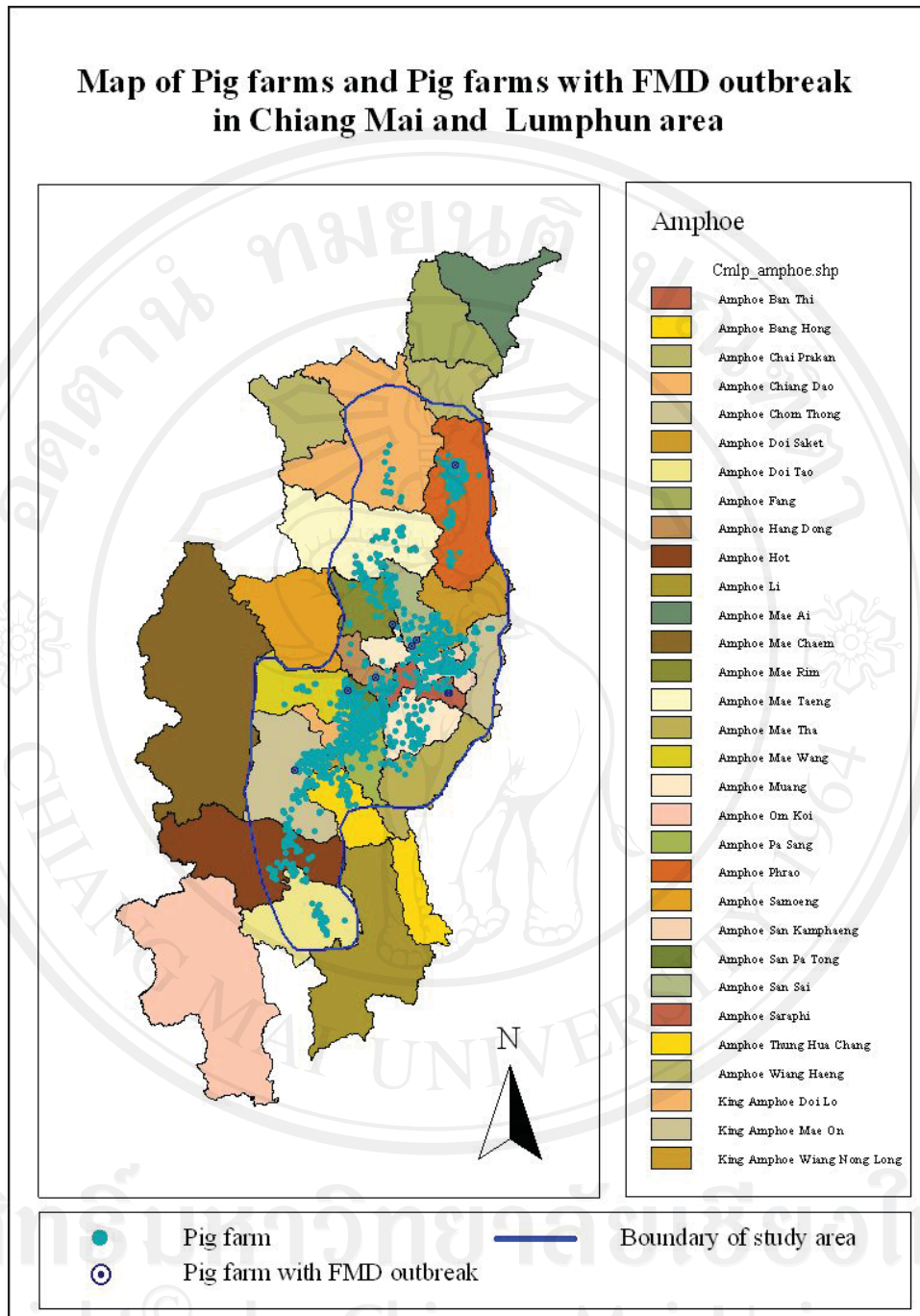
Lamphun area

Figure 4.6 Map of Pig farms and Pig farms with FMD outbreak in previous year in

Chiang Mai and Lamphun area

The cattle farms with FMD outbreak in 2004-2006 were found more than pig farms with FMD outbreak several times. The total of 514 FMD outbreaks were found in cattle farms (figure 4.7). Mostly were found in high density of cattle farms area (figure 4.8). This is similar to characteristic of FMD outbreak in pig farms.

Figure 4.7 Map of Cattle farms with FMD outbreak in previous year in Chiang Mai and Lamphun area

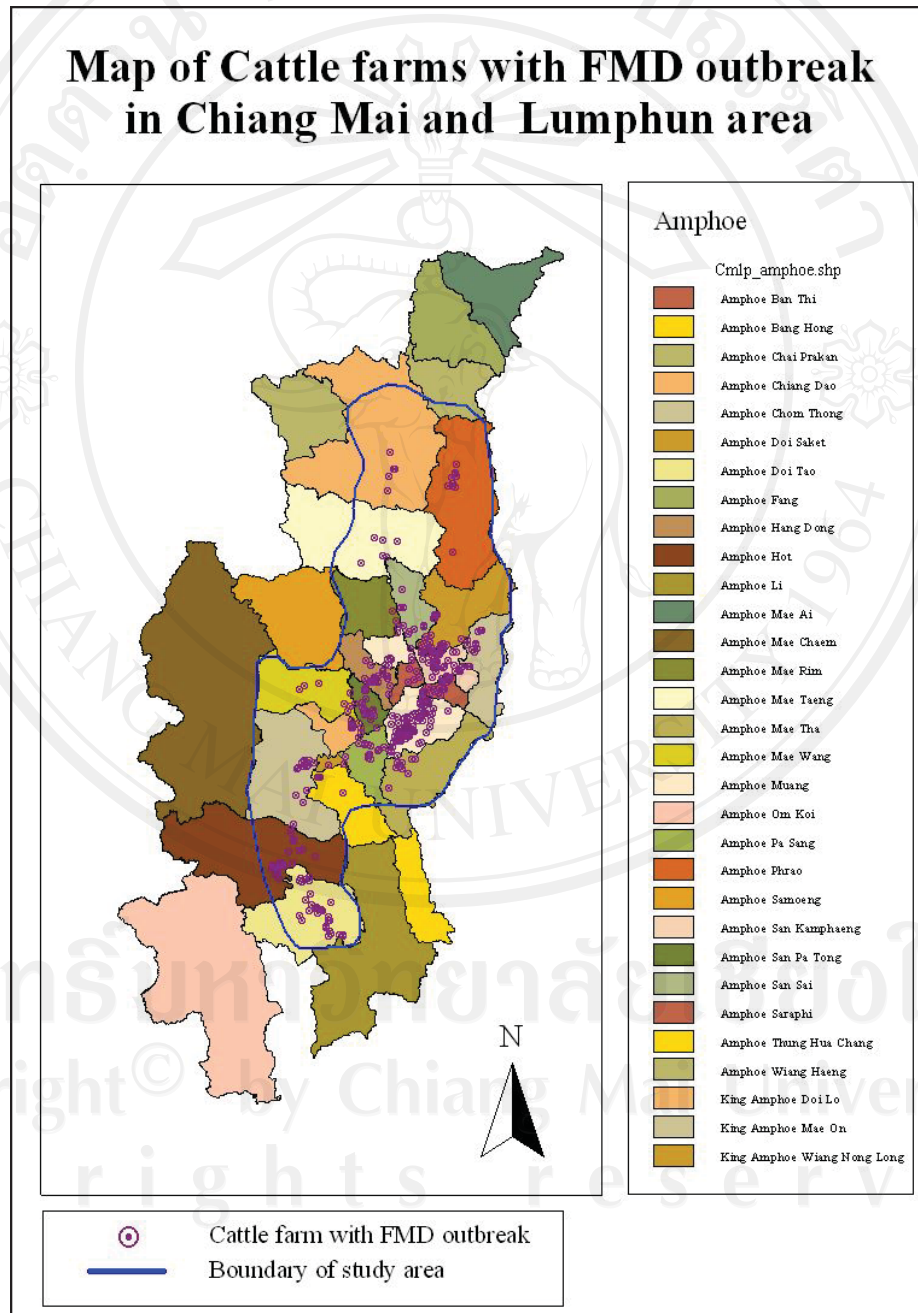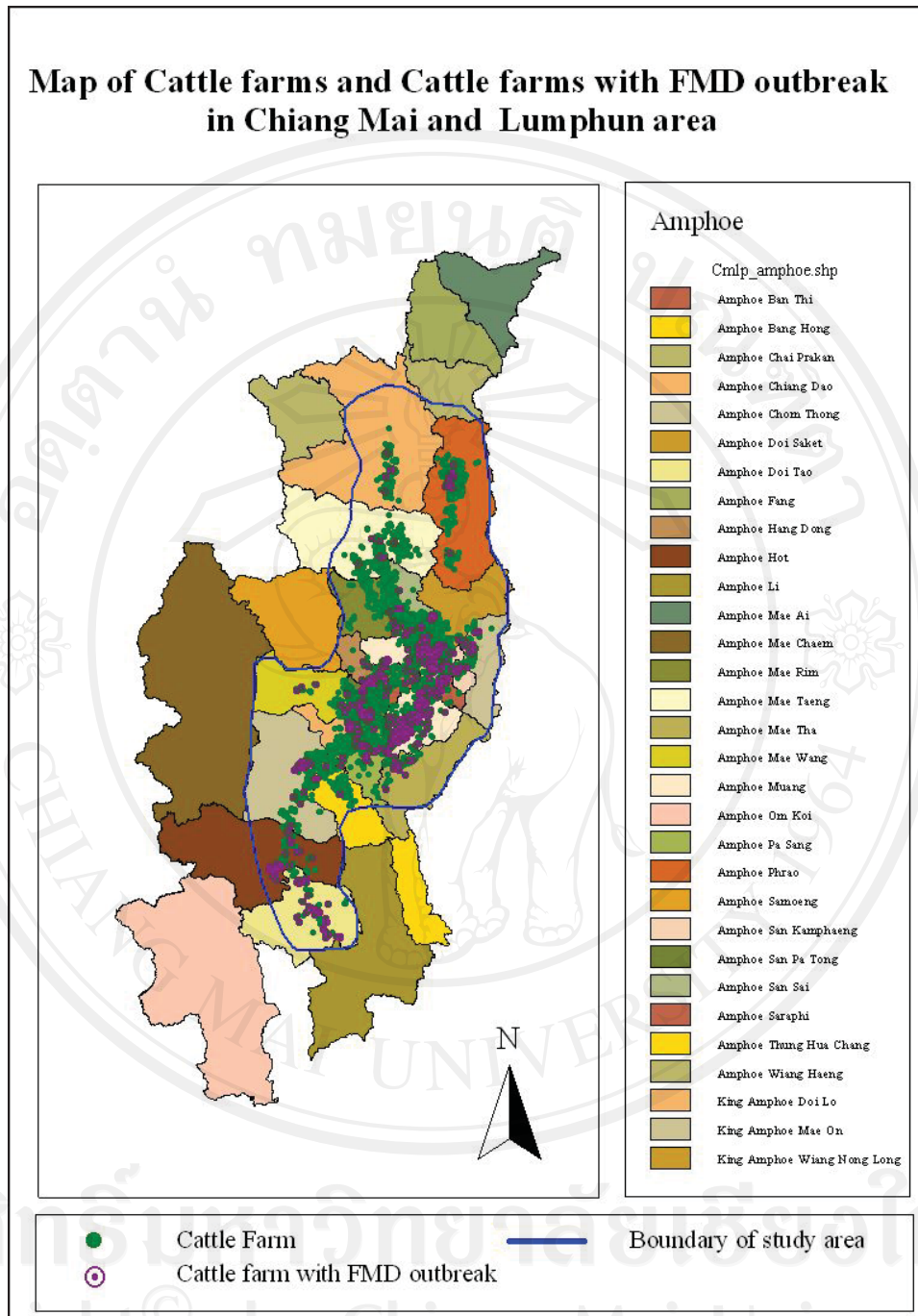**Figure 4.8** Map of Cattle farms and Cattle farms with FMD outbreak in previous year

in Chiang Mai and Lamphun area

In this study was collected information concerning practices of farmer during farm had FMD outbreak. The result showed that, pig farmers had sold healthy or recovery animals. The cattle farmer more than 66% had informed DLD officers. The most of pig and cattle farmers (3 cases and 33 cases, respectively) had sold sick animal when they found it. This may be the cause of FMD spread in the area.

Table 4.12 Number and percent of pig and cattle farm management during FMD outbreak

Management	Pig farms (n=10)		Cattle Farms (n= 514)	
	Number	Percent	Number	Percent
During outbreak				
Informed DLD officer	2	20.0	343	66.8
Called for veterinarian service	3	30.0	299	58.1
Sold healthy animal	2	20.0	18	3.5
Sold recovery animal	3	30.0	93	18.0
Did not move animal	3	30.0	133	25.8
Management of sick animal				
Sold	3	30.0	25	4.9
Butcher	1	10.0	8	1.6
Slaughtered and give away	1	10.0	8	1.5
Slaughtered and sold	2	20.0	6	1.2
Bury	4	40.0	22	4.3
Burn	0	0.0	5	1.0
Other	1	10.0	5	1.0

The FMD prevention and control practices: The FMD prevention have many method, the important one is vaccine strategies. Only 15.23% of pig farms used FMD vaccine, but around 78% of cattle farms used FMD vaccine. In Thailand have FMD vaccine from several sources such as Bureau of Veterinary Biologic of DLD or private company. The most of pig and cattle farmers had used trivalent vaccine that produced by DLD. The vaccinator in pig farms are owners but in cattle farms the

vaccinators are other person such as live stock volunteer or neighboring farmer. The most pig farmers kept their vaccine in refrigerator but the most vaccine in cattle farms were kept in ice box. The vaccinator and vaccine storage are factor that can affect the immunologic response. The details of information are showed in table 4.13.

Table 4.13 Number and percent of pig and cattle farm divided by vaccination

Vaccine information	Pig farms (n = 137)		Cattle Farms (n = 2702)	
	Number	Percent	Number	Percent
Type of FMD Vaccine				
Monovalent	35	25.3	378	14.0
Trivalent	73	53.3	1513	56.0
Other	2	1.17	8	0.3
Producer				
DLD	90	65.4	1878	69.5
Private company	21	15.2	24	0.9
Vaacinator				
DLD officer	13	9.3	457	16.9
Veterinarian	10	7.0	122	4.5
Farm owner	65	47.1	178	6.6
Other	24	17.5	1148	42.5
Vaccine storage				
Refrigerator	65	47.5	740	27.4
Ice box	41	29.6	1156	42.8
Other	4	3.1	8	0.3

When neighboring farms had FMD outbreak, the most pig and cattle farmers did not add new stock. But the almost 50% of farmers did not have special strategies. They still practice their farm management as same as normal situation (Table 4.14).

Table 4.14 Number and percent of pig and cattle farm management when neighboring

farm has outbreak

Management when neighboring farm has outbreak	Pig farms (n = 38)		Cattle Farms (n = 759)	
	Number	**Percent**	**Number**	**Percent**
Vaccination	12	31.58	232	30.56
Did not add new stock	18	47.37	296	38.99
Did not contact with outbreak farm	12	31.58	166	21.87
Did not allow visitor	10	26.32	97	12.78
No special strategies	18	47.37	262	34.52
Other	1	2.63	60	7.9

4.3 Risk factors of FMD outbreak in the farms

This study had collected the information concerning possible risk factors of FMD outbreaks in pig and cattle farms such as farm management, disease control and prevention, vehicle and personal movement control, distance from neighboring farm, livestock market, slaughter house and etc. Fisher's exact test was used for univariable analysis of risk factor and significant level of 0.2 was used to select the variables. The result showed that farm sized, farm had FMD vaccination program, farm did not add new stock, did not allow visitor, feed source, housing type, feces management, method of personal disinfectant, farm has wash basin in every house and farmer has other job except pig farm were important factors that statistical significant associated with FMD outbreak in pig farms.

Table 4.15 Number and percent of pig farms divided by expected risk factors that related with FMD outbreak

Risk factors	History of FMD outbreak				P-value
	FMD outbreak farms (n=10)		Non outbreak farms (n=84)		
	No.	Percent	No.	Percent	
Farm type					0.7831
Intensive	5	50.00	32	38.10	
Breeder	1	10.00	14	16.67	
Finisher	5	50.00	38	45.24	
Farm pattern					0.4908
One-site	5	50.00	56	66.67	
Two-site	4	40.00	16	19.05	
Three-site	1	10.00	4	4.76	
No data	1	10.00	8	9.52	
Farm size					<0.0001
Individual	5	50.00	65	77.38	
Small	0	0.00	15	17.86	
Medium	5	50.00	4	4.76	
Large	1	10.00	0	0.00	
Had FMD vaccination program	6	60.00	18	21.43	0.0446
Management when neighboring farm has outbreak (n=5)	2	20.00	3	3.57	0.1860
Vaccination	1	50.00	3	100.0	0.9531
Did not add new stock	2	100.0	2	66.7	0.0978
Did not contact with outbreak farm	1	50.00	2	66.7	0.7796
Did not allow visitor	2	100.0	0	0.00	0.0046
No special strategies	0	0.00	2	66.7	1.0000
Management system Between nursery to finishing pig					0.2853
All-in all-out	6	60.00	28	33.33	
Continuous	5	50.00	48	57.14	
Other	0	0.00	8	9.52	
Feed source					0.0507
In house	1	10.00	4	4.76	
Bought	6	60.00	71	84.52	
In house and bought	3	30.00	9	10.71	
Water source					0.5980
Tab water	4	40.00	49	58.33	
Artesian well	4	40.00	26	30.95	
River or canal	1	10.00	6	7.14	
Swamp	1	10.00	4	4.76	
Treated water before use	4	40.00	15	17	0.2974

Risk factors	FMD outbreak farms (n=10)		Non outbreak farms (n=84)		P-value
	No.	Percent	No.	Percent	
Housing type					0.0097
Closed	1	10.00	2	2.38	
Opened	9	90.00	82	97.62	
Mixed	1	10.00	0	0.00	
Separate housing by pig type	5	50.00	34	40.48	1.0000
Has fence surrounding production area	8	80.00	56	66.67	0.9512
Carcass management					0.1537
Buried	4	40.00	46	54.76	
Other (Burnt, sold)	6	60.00	37	44.05	
More than 1 method	1	10.00	1	1.19	
Feces management					0.0257
Treat pond	4	40.00	7	78.33	
Other (dry by air or waste)	7	70.00	77	91.67	
Leave 5 days between batch	8	80.00	66	78.57	0.9578
Used disinfectant during empty period	7	70.00	50	59.52	1.0000
Clear job description	5	50.00	39	46.43	1.0000
Pig truck parks					0.2000
In front of farm	2	20.00	22	26.19	
in farm	9	90.00	62	73.81	
Method of vehicle disinfectant					0.1284
Disinfectant pond	1	10.00	3	3.57	
Spray house	0	0.00	1	1.19	
Spray machine	3	30.00	6	7.14	
Non	7	70.00	74	88.10	
Method of personal disinfectant					0.0320
Bathroom	1	10.00	6	7.14	
Wash basin	2	20.00	2	2.38	
More than 1 method	1	10.00	0	0.00	
Non	7	70.00	76	90.48	
Has wash basin in every house	5	50.00	13	15.48	0.0481
Quarantine house separate from other houses more than 25 meters	4	40.00	18	21.43	0.4690
Person who treat sick animal					0.0534
Veterinarian	3	30.00	10	11.90	
Other	8	80.00	74	88.10	
Has other job except pig farm	5	50.00	67	79.78	0.0337
Most income from pig farm	9	90.00	44	52.38	0.1271

The numeric data such as distance from market, livestock market, slaughter house, feed mills, main road, water source, pasture, nearest farm, number of vehicle or person who came in farm, volume of production and etc. were analyze of risk factor with the Mann–Whitney U test and significant level of 0.2 was used to select the variable. The factors including distance from water source, number of finisher pig, number of vehicle used inside farm, number of vehicle come in and get out of farm, number of visitor who came in farm within 1 month and number of village within 5 kilometers were important factors that statistical significant associated with FMD outbreak in pig farms (Table 4.16).

Table 4.16 Median of expected risk factors that related with FMD outbreak in pig farm

Risk factors	History of FMD outbreak		P-value
	FMD outbreak farms (n=10)	Non outbreak farms (n=84)	
	Median	Median	
Distance from reference Point (km.)			
Market	3.000	2.000	0.8294
Livestock market	5.000	9.000	0.3255
Slaughter house	4.000	2.500	0.4215
AI station	3.000	7.000	0.2567
Feed mills	0.500	1.000	0.6866
Main road	3.000	1.650	0.2836
Water source	1.000	0.100	0.0578
Pasture	0.350	0.100	0.3391
Nearest farm	0.010	0.100	0.3832
Number of culling pig (Head)	2.500	3.000	0.7658
Number of finisher pig (Head)	400.000	9.000	0.0022
Number of weaning pig (head)	8.500	10.000	0.5748
Distance from nearest outbreak farm (km)	2.000	2.000	0.8587
Number of new stock import to herd (head)	14.000	6.000	0.3272
Number of farm/village which	1.500	2.000	0.7853

Risk factors	History of FMD outbreak		P-value
	FMD outbreak farms (n=10)	Non outbreak farms (n=84)	
	Median	Median	
shared water resource			
Number of vehicle used inside farm			
Motorcycle	2.000	1.000	0.0705
Truck	1.000	1.000	0.2616
Other	6.000	1.000	0.0302
Total	2.000	2.000	0.3004
Number of vehicle come in and get out of farm			
Feed truck	1.000	1.000	<0.0001
Pig truck	1.000	1.000	0.4525
Other	2.000	1.000	0.0770
Total	2.000	2.000	0.0146
Number of visitor who came in farm within 1 month			
DLD officer	2.500	1.000	0.0203
Salesman	3.000	2.000	0.1650
Merchant	2.000	2.000	0.5795
Other	-	1.000	-
Total	2.500	2.000	0.4633
Proportion of vaccinated pig in farm	80.000	100.000	0.0769
Number of village within 5 km.	4.000	4.000	0.0005
Number of farm which same merchant bought pigs	5.500	1.000	0.1442
Number of slaughter house which merchant sold pigs	1.500	1.000	0.1986

After finding out statistical significant variables analysis by using Fisher's exact test and Mann–Whitney U test. All significant variables were analyzed by the Logistic regression to find out risk factors and protective factors associated with FMD outbreak in pig farms. The results showed that, a treated sick pig by non-veterinarian was the important risk factor. Diseased farms were 13.76 times more likely to have other person than veterinarian treated their animals compared to non-diseased farms. Another significant risk factor was the number of feed truck that came into farm. The

significant FMD protective factors were had method for personal disinfectant, recognition of FMD outbreak in neighboring farm, pig truck was park in front of farm and the proportion of vaccinated pig in farm. Especially the visitor decontamination before coming into the farm, non-diseased farms were 47.6 times more likely to applied personal disinfectant compared to the diseased farms (Table 4.17).

Table 4.17 Risk factors which FMD outbreak in pig farms in the study area

Variable	Estimated regression coefficient	Estimated SE	Wald χ^2	*P*-value	Estimated odds ratio	95% CI for odds ratio	
Intercept	28.3877	14.6087	3.7761	0.0520	-	-	
Treated sick pigs by other person	2.6220	1.0622	6.0928	0.0136	13.763	1.716	110.386
Number of feed truck	0.6496	0.1889	11.8223	0.0006	1.915	1.322	2.773
Had method for personal disinfectant	-4.8491	2.1159	5.2522	0.0219	1/125.00	<1/1000	1/2.02
Recognition of FMD outbreak in neighboring farm	-4.3365	1.7924	5.8533	0.0155	1/76.92	<1/1000	1/2.28
Pig trucks park in front of farm	-2.7641	1.3972	3.9140	0.0479	1/15.87	1/250	1/1.03
Proportion of vaccinated pig in farm	-1.5102	0.6916	4.7686	0.0290	1/4.52	1/17.54	1/1.17

Same as in the pig farm, the information concerning possible risk factors of FMD outbreaks in cattle farms were collected, then Fisher's exact test and Mann–Whitney U test with significant level of 0.2 were used to select the variable. Finally, these variables were analyzed by the multivariate logistic regression. The results showed that farm size, the management when neighboring farm had outbreak, farm shared water source and pasture with other farm/villages, farm did not add new stock, the owner had other job except cattle farm, brought feces into farm, farm shared mineral with other farm and farm had wash basin in every house were related factors of FMD occurrence in cattle farms (Table 4.18).

Table 4.18 Number and percent of cattle farms divided by expected risk factors that related with FMD outbreak

Risk factors	History of FMD outbreak				P-value
	FMD outbreak farms (n = 514)		Non outbreak farms (n =2950)		
	No.	Percent	No.	Percent	
Farm size					0.000
Individual	83	16.1	956	32.4	
Small	269	52.3	1602	54.3	
Medium	156	30.4	384	13	
Large	6	1.2	9	0.3	
Management when neighboring farm has outbreak	197	38.4	264	8.95	<0.0001
Vaccination	272	52.9	726	24.6	<0.0001
Did not add new stock	187	36.4	1307	44.3	<0.0001
Did not contact with outbreak farm	70	13.6	814	27.6	0.0156
Did not allow visitor	50	9.7	454	15.4	0.0030
No special strategies	225	43.7	1015	34.4	<0.0001
Other	54	10.6	543	18.4	<0.0001
Shared water source with other farm/villages	242	47.12	955	32.38	<0.0001
Shared pasture with other farm/villages	249	48.45	949	32.17	<0.0001
Add new stock	137	26.59	567	19.21	<0.0001
Has other job except cattle farm	392	76.22	2395	81.18	0.0024

| Risk factors | History of FMD outbreak | | | | P-value |
| | FMD outbreak farms (n = 514) | | Non outbreak farms (n =2950) | | |
	No.	Percent	No.	Percent	
Most income from cattle farm	326	63.52	1817	61.59	0.3513
Farm's animal contact with other animal	5	1.03	52	1.76	0.2201
Import feces into farm	9	1.77	25	0.84	0.0315
Artificial inseminator					0.5106
DLD officer	41	7.89	207	7.03	
Veterinarian	5	1.03	45	1.54	
Owner	113	22.01	594	20.15	
Other	344	66.91	2041	69.2	
More than 1 group	11	2.07	61	2.08	
Pasture					0.6023
Own	48	9.31	302	10.23	
Public	21	3.99	94	3.18	
Other	423	82.27	2415	81.86	
More than 1 source	23	4.43	140	4.74	
Feed concentrate	55	10.64	282	9.56	0.4106
Mineral supplement	128	24.82	699	23.7	0.5512
Share mineral with other farm	4	0.74	9	0.32	0.0954
Main water source					<0.0001
Artesian well	76	14.77	421	14.28	
Tab water	72	14.03	435	14.76	
River or canal	137	26.59	1016	34.45	
Swamp	74	14.48	395	13.4	
More than 1 source	155	30.13	682	23.11	
Method of vehicle disinfectant					0.4055
Disinfectant pond	5	0.89	13	0.43	
Spray house	5	1.03	27	0.91	
Spray machine	13	2.51	83	2.82	
Non	491	95.57	2827	95.84	
Method of personal disinfectant					0.2975
Bathroom	0	0	4	0.14	
Wash basin	17	3.4	76	2.58	
Other	2	0.3	7	0.23	
More than 1 method	2	0.3	3	0.09	
Non	493	96.01	2860	96.95	
Has wash basin in every house	22	4.28	59	1.99	0.0002

The numeric data such as distance from market, livestock market, slaughter house, feed mills, main road, water source, pasture, nearest farm, number of vehicle

or person who came in farm, volume of production and etc. were analyzed of risk factor with Mann–Whitney *U* test and significant level of 0.2 was used to select the variable. The factors including distance from farm to AI station and pasture, number of cattle Distance from nearest outbreak farm, number of month in a year that share pasture with other farm/villages, number of new animal that add into the herd, number of village within 5 kilometers, number of motorcycle that used inside farm, number of visitor within 1 month and number of farm/village which shared water were related factors that statistical significant associated with FMD outbreak in cattle farms (Table 4.19).

Table 4.19 Median of expected risk factors that related with FMD outbreak in cattle farm

Risk factors	History of FMD outbreak		P-value
	FMD outbreak farms (n=514)	Non outbreak farms (n=2950)	
	Median	Median	
Distance from reference Point (km.)			
Market	2.000	2.000	0.1121
Livestock market	8.000	8.000	0.1901
Slaughter house	3.000	2.650	0.3365
AI station	4.000	5.000	0.0003
Milk collection center	5.000	4.500	0.6581
Feed mills	1.750	2.000	0.4244
Main road	1.000	1.000	0.6503
Water source	0.200	0.200	0.4011
Pasture	0.500	0.500	0.0951
Nearest farm	0.100	0.100	0.4831
Number of houses			
Cow	1.000	1.000	0.0014
Buffalo	1.000	1.000	0.3846
Goat	-	1.000	-
Sheep	-	1.000	-
Milk volume per day	90.000	75.000	0.0304
Distance from nearest outbreak	0.500	2.000	<0.0001

Risk factors	History of FMD outbreak		P-value
	FMD outbreak farms (n=514)	Non outbreak farms (n=2950)	
	Median	Median	
farm (km)			
Number of month in a year that share pasture with other farm/villages	12.000	12.000	0.0113
Number of new animal that add into the herd	2.000	2.000	0.0429
How often DLD officer visit farm within 1 month	1.000	1.000	0.1081
How often salesman came to visit farm within 1 month	2.000	2.000	0.8031
Number of village within 5 kms	4.000	4.000	0.0117
Number of vehicle used inside farm			
Motorcycle	1.000	1.000	0.0117
Car	1.000	1.000	0.3137
Truck	1.000	1.000	0.1305
Other	1.000	1.000	0.6125
Total	2.000	2.000	0.3300
Number of visitor within 1 month			
DLD officer	1.000	1.000	0.3118
Salesman	2.000	2.000	0.0029
Merchant	2.000	2.000	0.5947
Other	1.500	2.000	<0.0001
Total	3.000	2.000	0.5464
Number of new animal that add into the herd in 1 month	3.000	2.000	<0.0001
Number of animal			
Cow	12.000	6.000	<0.0001
Buffalo	6.000	5.000	<0.0001
Goat	15.500	15.000	0.2819
Sheep	-	26.000	-
Other	12.000	6.000	-
Number of farm/village which shared water resource	2.000	2.000	<0.0001
Proportion of vaccinated cattle in farm	100.000	100.000	0.0877

Multivariable logistic regression analysis results showed three significant risk factors and two protective factors associated with the occurrence of FMD in cattle farms as been shown in table 4.20. The risk factors of FMD outbreak in cattle farms

including using public pasture, number of cattle in farm, and number of new replacement. The protective factors of FMD outbreak in cattle farms were the recognition of FMD outbreak of neighboring farm and having disinfectant pool.

Table 4.20 Risk factors of FMD outbreak in cattle farms in the study area

Variable	Estimated regression coefficient	Estimated SE	Wald χ^2	*P*-value	Estimated odds ratio	95% CI for odds ratio	
Intercept	-0.0591	1.6492	0.0013	0.9714	-	-	-
Using public pasture	0.5016	0.1994	6.3313	0.0119	1.651	1.117	2.441
Number of cattle in farm	0.3340	0.0459	52.8303	<.0001	1.396	1.276	1.528
Number of new replacement	0.1087	0.0412	6.9506	0.0084	1.115	1.028	1.209
Recognition of FMD outbreak in neighboring farm	-1.3649	0.1306	109.2303	<.0001	1/3.92	1/5.05	1/3.03
Having disinfectant pool	-0.8266	0.2670	9.5852	0.0020	1/2.28	1/3.86	1/1.36