LIMITATIONS IN THE APPLICATION OF CONTROL MEASURES DURING THE FIRST AVIAN INFLUENZA OUTBREAKS IN THAILAND

SOMPISS JULLABUTRADEE

MASTER OF SCIENCE

IN VETERINARY PUBLIC HEALTH

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ABSTRACT

By way of structured interviews carried out from December 2004 to April 2005 information was collected on-the-spot to validate kinds, sequence and timing of control measures against Avian Influenza (AI) during the first outbreak wave in Thailand, official declaration dates for that period start at 23 January 2004. The investigation covered 20 of the 42 outbreak provinces, one index (outbreak) farm within each province and 9 farms surrounding each index farm in a 5 km radius. A total of 21 index farms and 191 surrounding farms, 16 village chiefs and 19 provincial veterinary officers were interviewed at their locations on their recall or records of the chain of control measures executed and their dates after the first suspicion of an AI outbreak.

Strong suspicions of massive and area-wide AI outbreak much earlier than the first official declaration date, 23rd January 2004, were reported by all intervieweegroups. These outbreaks were not acknowledged and responded to by central authorities. After AI was suspected, the measures specified in the official control policy included a veterinary visit, samples to be sent to a laboratory, the notification for depopulation, the depopulation and cleaning and disinfection. Disease control authorities failed to respond to and correct unduly delays in the execution of individual of these control measures. From the interviews delays in the confirmation of outbreaks with an average of 30 days were noted. Only 42% of the provinces did declare outbreaks within an average of 7 days starting from the suspicion of disease. For the index farms

the average time period spent between reporting and depopulation was 6 days, and 3 days for the 191 surrounding farms. Cleaning was delayed on average up to 11 days in surrounding farms, of which 60% kept backyard chicken, but took only 1.5 days on index farms. While measures were generally carried out timely in commercial broiler farms, less attention for individual measures was paid to layer and particularly backyard chicken farms. Depopulation was carried out by all index farms, in contrast, only 82% of the surrounding farms did depopulate their birds and on another 30% of farms depopulation was carried out only incompletely. Not all study farms also cleaned and disinfected their premises: 95% of the index farms did so but only 67% of the surrounding farms, disinfections in non-broiler farms took up to 12 days. did so The restocking guidelines of the Thai authority were not followed by 25% of the backyard farmers. While individual bio-security measures of commercial broiler farms statistically did reduce the risk of AI infection, the complete package of bio-security measures did not spare these farms from also experiencing AI outbreaks.

ชื่อเรื่องวิทยานิพนธ์	ข้อจำกัดในการใช้มาตรการควบคุมโรคในระยะแรกที่เกิดการระบาดของโรคไข้หวัดนก ในประเทศไทย
ผู้เขียน	นางสาวสมพิศ จุลลาบุตรดี
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บทคัดย่อ

จากการสัมภาษณ์เก็บข้อมูลในพื้นที่ระหว่างเดือนธันวาคม 2546 ถึงเมษายน 2547 เพื่อค้นหาวิธีการปฏิบัติ ลำดับ และเวลาในการควบคุมโรคไข้หวัดนก ระหว่างการระบาดครั้งแรกในประเทศไทยซึ่งมีรายงานการระบาดอย่างเป็นทางการครั้งแรกเมื่อวันที่ 23 มกราคม 2547 ในการศึกษาครั้งนี้ได้ทำการสุ่มสำรวจทั้งหมด 20 จังหวัด จาก 42 จังหวัด ที่เกิดการระบาด โดยในแต่ละจังหวัดได้ทำการสัมภาษณ์ฟาร์มที่เกิดโรคระบาดจำนวน 1 ฟาร์ม และฟาร์มในรัศมี 5 กิโลเมตร อีกเป็นจำนวน 9 ฟาร์ม รวมสัมภาษณ์ฟาร์มที่เกิดโรคระบาด 21 ฟาร์ม และฟาร์มข้างเคียง 191 ฟาร์ม นอกจากนั้นได้ทำการสัมภาษณ์ผู้ใหญ่บ้านจาก 16 หมู่บ้าน และสัตวแพทย์ประจำจังหวัดอีก 19 คน เพื่อเก็บข้อมูลกระบวนการ และเวลาในการควบคุมโรค

จากข้อมูลที่ได้จากการสัมภาษณ์ คาดว่าอาจมีการระบาดของโรคไข้หวัดนก ก่อนการรายงานอย่างเป็นทางการครั้งแรก ซึ่งในขณะนั้นหน่วยงานที่รับผิดชอบยังไม่ให้ความสนใจและตอบสนองมากนัก ขั้นตอนการปฏิบัติเริ่มจากเมื่อหน่วยงานที่รับผิดชอบได้รับรายงานสงสัยการเกิดโรคไข้หวัดนกระบาด สัตวแพทย์ได้เข้าไปตรวจสอบและทำการเก็บตัวอย่างจากฟาร์มเพื่อส่งตรวจยืนยันผลทางห้องปฏิบัติการ จากนั้นได้เข้าทำลายสัตว์ปีก และทำความสะอาดฆ่าเชื้อเป็นอันดับสุดท้าย นอกจากนั้นยังพบว่าหน่วยงานที่รับผิดชอบมีความล่าช้า และไม่สามารถตอบสนองเพื่อเข้าควบคุมโรคได้อย่างทันท่วงที โดยพบว่ามีความล่าช้าในการยืนยันผลอย่างเป็นทางการถึง 30 วันจากวันที่เริ่มสงสัย จากจังหวัดตัวอย่างทั้งหมด มีเพียง 42 เปอร์เซ็นต์ เท่านั้นที่สามารถยืนยันโรคอย่างเป็นทางการได้ ภายใน 7 วัน และจากข้อมูลที่ได้ จากฟาร์มที่เกิดโรคพบว่า ช่วงเวลาระหว่างการรายงานถึงการทำลายสัตว์เป็นระยะเวลาโดยเฉลี่ย 6 วัน และจากฟาร์มรอบข้างเป็นระยะเวลา 3 วัน และพบความล่าช้าในการเข้าทำการฆ่าเชื้อของฟาร์มรอบข้างซึ่ง 60 เปอร์เซ็นต์เป็นไก่พื้นบ้าน หลัง

จากทำลายสัตว์แล้วนานถึง 11 วัน ขณะที่ฟาร์มที่เกิดโรคระบาดใช้เวลาเพียง 1.5 วัน ขณะที่มาตรการโดยทั่วไปถูกนำไปใช้ควบคุมโรคอย่างรวดเร็วในฟาร์มไก่เนื้อ แต่ในฟาร์มไก่ไข่และโดยเฉพาะในไก่พื้นเมืองได้รับความใส่ใจน้อยกว่า พบว่ามีการทำลายสัตว์ปีกในทุกฟาร์มที่เกิดโรค ในทางตรงกันข้ามมีเพียง 82 เปอร์เซ็นต์ ของฟาร์มในบริเวณข้างเคียงทำลายสัตว์ปีก และในจำนวนนี้ 30 เปอร์เซ็นต์ไม่ได้ทำลายสัตว์ทั้งหมด พบว่า 95 เปอร์เซ็นต์ ของฟาร์มที่เกิด โรคระบาด และ 67 เปอร์เซนต์ของฟาร์มข้างเคียงที่ได้ทำความสะอาดและฆ่าเชื้อ เล้าแต่พบว่าฟาร์มที่ไม่ใช่ฟาร์มไก่เนื้อใช้ระยะเวลาถึง 12 วันระหว่างการทำลายและการฆ่าเชื้อเล้ามีฟาร์มไก่พื้นบ้านเพียง 25 เปอร์เซนต์เท่านั้นที่ทำตามข้อปฏิบัติสำหรับการเริ่มนำสัตว์เข้าเลี้ยงใหม่ จากการศึกษานี้สรุปได้ว่าถึงแม้ฟาร์มไก่เนื้อซึ่งมีระบบในการควบคุมและป้องกันโรคอย่างเข้มงวด ก็ยังไม่สามารถหลีกเลี่ยงจากการเกิดของโรคไข้หวัดนก

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ABBREVIATIONS

AGID	Agar gel immuno-diffusion
AGPT	Agar gel precipitation Test
AI	Avian Influenza
B.C.	British Columbia
C&D	Cleaning and disinfection
CDC	Centers for Disease Control and Prevention
CEO	Chief Executive Officers of the province
CFIA	Canadian Food Inspection Agency
CI	Confidence interval
DIVA	Differentiation of infected from vaccinated animals
DLD	Department of Livestock Development, Thailand
ELISA	Enzyme-linked immunosorbent assay
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographic Information Systems
HA	Haemagglutination
HI	Haemagglutination inhibition

HPAI	Highly pathogenic avian influenza
HPNAI	Highly pathogenic notified avian influenza
Index farm	Reported case by DLD
Max	Maximum
Min	Minimum
OIE	World Organization for Animal Health (Office International des Épizooties)
PCR	Polymerase chain reaction
PPE	Personal protective equipment
RT-PCR	Reverse transcriptase polymerase chain reaction
RRT-PCR	Real-time reverse transcriptase polymerase chain reaction
SARS	Severe acute respiratory syndrome
Surrounding farm	Farm within a 5 km radius from index farm
UK	United Kingdom
US	United State
USA	United States of America
WHO	World Health Organization

1. INTRODUCTION AND OBJECTIVES

With each outbreak of Avian Influenza (AI) around the world, more knowledge has been gained about the disease, its origins and its consequences. From this knowledge, countries will be able to prevent the infection more effectively and control or eradicate the disease.

From 1955 to 2003, 20 outbreaks of different HPAI viruses were recorded, 3 of which (Scotland, 1959, England, 1979, Hong-Kong, 1997) were caused by H5N1. The first AI outbreaks within the East Asian countries spread very quickly from one area to another. In 2004, H5N1 virus suddenly caused multiple AI outbreaks in South Korea, Japan, China, Cambodia, Vietnam, Thailand, Laos, Indonesia, Hong-Kong and Malaysia.

The fact that all continents potentially can experience HPAI outbreaks, calls for a response system, which countries should have in place and that immediately goes into action once a risk of infection is detected. This response system starts with continuing surveillance in order to detect early signs of possible infection follow by prompt investigation of any suspicion after rapid reporting to the authorities. Immediate visits by veterinarians should be carried out, samples should be collected and sent for laboratory analysis. Laboratories must have the capabilities for rapid diagnosis and if samples are found positive, immediate corrective action must be initiated. The affected farm must immediately be depopulated in a humane and efficient manner, followed by adequate cleaning and disinfection. Concurrently, surrounding high-risk farms must be made subject to recommended restrictions (control of movement, strict bio-security, quarantine, and awareness education).

Speed is essential because as the sooner the official intervention takes place, the fewer the number of birds that will have to be destroyed. Veterinary lines of command and action consequently must be alerted and trained for that event. Many of the above control measures did exist on paper but were not carried out in the field timely and efficiently, particularly in the initial stages of the outbreaks, where elimination of the disease upon quick and decisive action was still a viable option.

These omissions have led to a situation that has caused significant economic and social damage to Thailand which was the world's fourth largest poultry exporting country before the outbreak, having a modern livestock industry with high levels of infrastructure standards, especially in the broiler sector.

In 2003 the total population of all poultry species of 210 million birds was housed in 31,000 farms. The broiler industry represented about 110 million of these birds and layers, backyard chicken and ducks totalled the other 100 million birds.

Before the AI outbreaks, the production of broiler chicken was about 22 million birds a week at an average weight of 2 kilograms per bird, resulting in about 2.3 million metric tons (MT) of live birds processed per annum. In 2003, Thailand exported 370,000 MT of raw poultry meat and 162,000 MT of cooked product (Thai customs data, 2003). It was estimated that about a further 3 million birds a week were sold as whole birds on the domestic market, thus, 80 to 85% of all birds slaughtered were used to produce parts for export. This indicates how important the international trade was to the Thai broiler industry. Before AI, the per capita consumption of broiler meat in Thailand was estimated to be about 13 kg per annum (USDA Foreign Agricultural Service, 2003).

Broiler production was almost exclusively carried out by 13 integrated companies, these companies with the AI outbreaks had to significantly reduce the number of people employed in their plants and also to reduce the number of contract farmers.

Operations of 100 million table egg layers, ducks and native chicken was carried out by thousands of smaller farms, it was on these farms that AI has caused large social consequences, as poultry keeping for the farms was their only means of making a livelihood.

The direct cost of cleaning up and payment of compensation was about 90 million USD, but total cost of AI to the broiler meat exporters and the domestic table egg industry was estimated at 400 million USD by FAO in 2004b. As production levels are still significantly lower than before, a figure closer to 600 million USD would be a more accurate estimate. The continuing fragile situation of the Thai export sector is demonstrated by a newspaper article of July 25th, 2005, which reported that the Japanese authorities would ban all poultry imports including cooked products from Thailand if vaccination would take place.

Given the scale of consequences, both economic and social, of the AI outbreaks it was deemed necessary to identify those activities of AI disease control that did not function efficiently in the earliest outbreaks in Thailand. Identification of omissions and shortcomings are expected to help to introduce improvements.

As can be deducted from Table 1, 48% (20/42) of the provinces and 11% (21/190) of the outbreak farms during the first outbreak wave were investigated. Additionally, a total of 180 surrounding farms were investigated.

Table 1.1: Study units: date of AI declaration, province, no. index farm and its species and no. surrounding farms and their species

Official date of declaration	Province No.	Index farms			Surrounding farms		
		Type	Number	Open/ closed	Type	Farm No.	Open/closed (o, c)
26.01.2004	1	Layer chicken	850	Open	Broiler chicken	1	C
					Broiler chicken	2	C
					Broiler duck	3	O
					Backyard chicken	4	O
					Backyard chicken	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
					Backyard chicken	10	O
26.01.2004	2	Layer chicken	100,000	Open	Backyard chicken	1	O
					Backyard chicken	2	O
					Backyard chicken	3	O
					Backyard chicken	4	O
					Backyard chicken	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O

Official date of declaration	Province No.	Index farms			Surrounding farms		
		Type	Number	Open/ closed	Type	Farm No.	Open/closed (o, c)
26.01.2004	3	Layer chicken	12,000	Close	Layer chicken	1	O
					Layer chicken	2	O
					Layer chicken	3	O
					Backyard chicken	4	O
					Backyard chicken	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
26.01.2004	4	Layer chicken	10,000	Open	Layer chicken	1	C
		Broiler chicken	15,000	Close	Layer chicken	2	O
					Broiler chicken	3	C
					Broiler chicken	4	C
					Broiler chicken	5	C
					Broiler chicken	6	C
					Broiler chicken	7	C
					Broiler chicken	8	C
					Mix type chicken	9	O
					Backyard chicken	10	O
27.01.2004	5	Broiler chicken	10,000	Close	Broiler chicken	1	C
					Broiler chicken	2	C
					Broiler chicken	3	C
					Broiler chicken	4	C
					Broiler chicken	5	C
					Broiler chicken	6	C
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
26.01.2004	6	Layer chicken	1,100	Open	Layer duck	1	O
					Broiler chicken	2	O
					Backyard chicken	3	O
					Backyard chicken	4	O
					Backyard chicken	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
					Backyard chicken	10	O
26.01.2004	7	Layer chicken	5,100	Open	Layer chicken	1	O
					Layer chicken	2	C
					Layer chicken	3	C
					Layer chicken	4	C
					Layer chicken	5	C
					Layer chicken	6	C
					Layer chicken	7	C
					Layer chicken	8	C
					Backyard chicken	9	O
28.01.2004	8	Broiler chicken	13,000	Close	Broiler chicken	1	C
					Broiler duck+backyard	2	O
					Broiler duck+backyard	3	O
					Broiler duck+backyard	4	O
					Backyard chicken	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
					Backyard chicken	10	O

Official date of declaration	Province No.	Index farms			Surrounding farms		
		Type	Number	Open/ closed	Type	Farm No.	Open/closed (o, c)
27.01.2004	9	Backyard chicken	238	Open	Layer duck+backyard	1	O
					Layer duck+backyard	2	O
					Broiler goose+backyard	3	O
					Backyard chicken	4	O
					Backyard chicken	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
28.01.2004	10	Goose + backyard	10,000	Open	Broiler chicken	1	O
					Broiler chicken	2	C
					Broiler chicken	3	O
					Broiler chicken	4	C
					Broiler chicken	5	C
4.02.2004	11	Backyard chicken	400	Open	Layer duck	1	O
					Layer duck+backyard	2	O
					Layer duck	3	O
					Layer duck	4	O
					Broiler duck+backyard	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
					Backyard chicken	10	O
28.01.2004	12	Layer chicken	30,000	Open	Layer duck	1	O
					Layer duck	2	O
					Layer duck	3	O
					Broiler duck	4	O
					Mix type goose	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
					Backyard chicken	10	O
27.01.2004	13	Quail	5,000	Close	Backyard chicken	1	O
					Backyard chicken	2	O
					Backyard chicken	3	O
					Backyard chicken	4	O
					Backyard chicken	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
27.01.2004	14	Layer chicken	2,300	Close	Layer duck	1	O
					Backyard chicken	2	O
					Backyard chicken	3	O
					Backyard chicken	4	O
					Backyard chicken	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
					Backyard chicken	10	O

Official date of declaration	Province No.	Index farms			Surrounding farms		
		Type	Number	Open/ closed	Type	Farm No.	Open/closed (o, c)
28.01.2004	15				Layer chicken	1	C
					Layer chicken	2	C
					Broiler chicken	3	C
					Broiler chicken	4	C
					Broiler chicken	5	C
					Broiler chicken	6	C
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
					Backyard chicken	10	O
					Backyard chicken	11	O
					Backyard chicken	12	O
					Backyard chicken	13	O
					Backyard chicken	14	O
28.01.2004	16	Backyard chicken	100	Open	Mix type chicken+backyard	1	O
		Backyard chicken	5	Open	Backyard chicken	2	O
					Backyard chicken	3	O
					Backyard chicken	4	O
					Backyard chicken	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
29.01.2004	17	Layer duck	300	Open	Layer duck+backyard	1	O
					Broiler chicken	2	C
					Backyard chicken	3	O
					Backyard chicken	4	O
					Backyard chicken	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
					Backyard chicken	10	O
24.01.2004	18	Quail + backyard	80,510	Close	Layer chicken	1	C
					Layer chicken	2	C
					Layer duck+backyard	3	O
					Layer duck+backyard	4	O
					Mix type chicken	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
					Backyard chicken	10	O
					Backyard chicken	11	O
					Backyard chicken	12	O
30.01.2004	19	Backyard chicken	800	Open	Mix type chicken	1	C
					Mix type duck	2	O
					Backyard chicken	3	O
					Backyard chicken	4	O
					Backyard chicken	5	O
					Backyard chicken	6	O
					Backyard chicken	7	O
					Backyard chicken	8	O
					Backyard chicken	9	O
					Fancy bird+native	10	O
23.01.2004	20	Layer chicken	4,000	Open	Broiler chicken	1	C
					Broiler chicken	2	C
					Broiler chicken	3	C
					Broiler chicken	4	C
					Broiler chicken	5	C
					Broiler chicken	6	C
					Broiler chicken	7	C
					Broiler chicken	8	C

The objectives of this study were to document the types of actions at each stage of the cascade of control measures taken and their timings, after AI was first suspected on farms in Thailand. The descriptive parts of the study involved investigation and cross-checking of results of interviews of outbreak (index) farm owners, of representatives of the village(s) where the farm was located, of owners of farms surrounding the index farm and of provincial veterinary personnel. Data were gathered by means of structured questionnaires for interviews of above actors at their place of residence or work. The final questionnaire was used after being field-tested during the first provincial interviews. The findings from the field will be compared to the outbreak control procedures and regulations set out by the main relevant authority, the Department of Livestock Development (DLD) of Thailand. Results subsequently will be compared and interpreted by types of farms and finally with currently available information from other countries that have experienced AI outbreaks in the recent past. The conclusions of this study will include recommendations as to future actions that should be taken by Thailand.

2. LITERATURE REVIEW

Until 1981 Avian Influenza (AI) in its pathogenic form was known by a variety of names including fowl plague and fowl pest. In that year the term highly pathogenic avian influenza (HPAI) was adopted to officially define the highly virulent form of AI. Since that date HPAI has appeared in every continent and in all species of poultry. Even countries with high reputations for high bio-security standards and exceptional geographic barriers as Australia and Chile have had outbreaks.

Once an infection has occurred in a country it is becoming apparent that it is increasingly difficult to avoid re-incidence at a later date. Australia had five HPAI outbreaks from 1976 to 1997 and Italy four outbreaks from 1997 to date (Horimoto, 2001, Capua and Alexander, 2004).

2.1 AI definition

Highly pathogenic Avian Influenza (HPAI) is a list A disease of the OIE and, as such, must be reported immediately (within 24 hours) in accordance with international protocols by any government in whose country the disease occurs. It is important to use a clear definition, Avian Influenza in its notifiable form (NAI) is defined by the OIE as an infection of poultry caused by any influenza A virus of the H5 or H7 subtypes.

Highly pathogenic notifiable avian influenza (HPNAI) viruses have an intravenous pathogenicity index (IVPI) in 6-week old chickens greater than 1.2 or, as an alternative, cause at least 75% mortality in 4 to 8-week-old chickens infected intravenously. H5 and H7 viruses which do not have an IVPI of greater than 1.2 or cause less than 75% mortality in an intravenous lethality test should be sequenced to determine whether multiple basic amino-acids are present at the cleavage site of the haemagglutinin molecule (HAO). If the amino acid motif is similar to that observed for other HPNAI isolates, the isolate being tested should be considered as HPNAI (Chapter 2.7.12 of the 2005 OIE Terrestrial Animal Health Code-2005d).

In the EU, a similar definition was adopted in Directive 92/40/EEC (European Union, 1992) although in this case the IVPI test was used as method of assessing virulence. For the purposes of confirmation of AI as disease and implementing the control measures in the Directive, the following definition applies: ‘an infection of poultry caused by an influenza A virus that has an intravenous pathogenicity index in 6-week old chickens >1.2 or any infection with influenza A viruses of H5 or H7 subtypes for which nucleotide sequencing has demonstrated the presence of multiple basic amino-acids at the cleavage site of the haemagglutinin.

2.2 Importance

2.2.1 Thailand production aspects and international trade

Thailand is divided into four main regions, the Central region which includes the Bangkok area, the Northern, the North-eastern and the Southern regions. Most poultry farms are highly concentrated in a few provinces in the central, eastern and western regions around Bangkok.

Poultry population show the numbers birds other than broilers. The data indicate that the Thai poultry sector is not as homogenous as conventionally conceived. The spatial distribution of the poultry population is expected to undergo further geographic shifts in response to changes in economic and market opportunities.

With the recent trends in expansion of areas of poultry production, the mix of small and large farms in the same areas will remain, unless the integrators continue their movement away from the current concentration regions. The incentive to do so may have been heightened by the havoc that the spread of AI brought on the Thai broiler industry in general, and to the export market for Thai chicken meat in particular (Costales, 2004).

The broiler meat industry is made up of western breeds and of backyard breeds. Most of the western breeds (Aviagen, Cobb and Hubbard) are multiplied by 13 large integrators who have their own facilities and are raised by contract farmers who are strictly controlled by the integrators. At the time of the AI outbreak on January 23, 2004, there were about 100 million broiler birds housed and the majority of these birds were in company-owned farms with good bio-security and high quality facilities. It is estimated that about 5 million of these birds were culled and nearly all of these were culled because they were situated in an exclusion zone. In the preliminary report on HPAI in 2004, considering that broilers represented 11.9% of all poultry, it can be seen that broilers were proportionally less affected than all other species (Appendix E).

The "backyard" or colored chickens are mainly grown in small holdings in the north and northeast of Thailand and are sold in the domestic market. It was demonstrated that 70% of households in the rural community – in the vicinity of Jomtong district, Chiangmai province, raised backyard chickens for family consumption (Paopong, 2005). Also, the study of the national income indicated that 8 million Thais earn less than one US dollar per day (FAO/OIE/WHO, 2005).

Egg laying production is nearly totally destined for domestic consumption and is split between large industrial groups and small farmers.

The duck industry can also be separated into two sectors, integrated operations destined for processing for local consumption and for export and the other herded after the rice harvest to clean the fields for lost grain, included mix ducks herded with chicken and other animals years round on the small farms (FAO, 2005). There are two companies with good facilities that dominate the processing sector while many small farmers occupy the other sectors.

2.2.2 Commercial and international trade consequences

There was an immediate worldwide ban on imports of Thai poultry made and all shipments were returned to Thailand after January 1, 2004. Domestic consumption plummeted to levels of below 60% of pre-outbreak levels. The industry initiated a campaign to promote the safety of chicken but as this campaign was concentrated on the cooked product, consumer's perceptions rather were increased that raw chicken meat was dangerous to handle. Domestically it is estimated that consumption has only partially recovered to 10 kg per person, still over 20% below levels at time of outbreak.

Exports of cooked products were resumed in April 2004 and many companies have invested heavily in new facilities (Thai custom data, 2005) and now Thailand becomes the worlds' largest exporter of these products. However, although impressive, efforts are only sufficient to sustain the production of about just over 50% of pre-AI levels. The chief executives of two of the major exporters are forecasting that in 2006 exports of cooked product will reach 350,000 MT and this will bring live bird production back up to 70% of pre-AI production. Unless market conditions radically change in the only two importing countries, Japan and EU, it is though unlikely that this target will be surpassed in the foreseeable future.

The egg industry was particularly hard hit, with nearly 50% of the flocks being culled, most of which were from small farmers (Avian Influenza Control Operating Center, DLD, 2004a). This resulted in a significant increase in egg prices at retail level.

The duck industry is undergoing a large transformation. The practice of raising ducks in rice paddies has decreased substantially and there is an increase in companies looking to enter this market segment on a safer industrialized basis, the same as in the chicken broiler sector.

For the first and second wave of outbreak control measures (cleaning and disinfection, surveillance, movement control, improvement of public awareness), 12.5 million USD and million 26 USD respectively were spent. A further estimated 49 million USD were spent for compensation. Also, about 400 million USD were indirectly spent restructuring the poultry production sector after the first and second wave of outbreaks (FAO, 2004a).

2.2.3 Long-term future of Thai poultry industry

Even though the eradication of AI is difficult and complex (Laddomada, 2004). Thailand has a significant cost advantage compared to EU and Japanese producers and processors. However, the market for cooked products is limited by issues of logistics, as is the ability to constantly develop new products to compete on supermarket shelves or in the food service industry. Although industry representative have recently issued optimistic forecasts, the maximum volume realistically achievable in the coming three years will be only about 350,000 MT per annum (50% up on today's level). Unless Thailand can resume shipments of raw meat production, the country will not return to pre-outbreak levels.

2.2.4 Public health

Human populations all over the world are continuously affected by epidemic waves of influenza due to human virus strains. By far the worst influenza pandemic was the one beginning in 1918. It has been estimated that 20 to 40 million people died (European Commission, 2000) due to this 'Spanish' flu. The virus can contaminate eggs and poultry meat, even when the meat is dressed, frozen and commercially packed. The virus can survive in frozen carcasses for up to 3 weeks (WHO, 2004). Newly emerging virus combinations as a result of mixes of human Influenza viruses and HPAI of avian origin, possibly originating by routes over swine as "mixing vessels" pose the greatest threat. Human cases by HPAI viruses with the recent AI outbreaks occurred in largest numbers in Vietnam (82), Thailand (17) and Cambodia (4). Exposure to poultry through direct contact is considered a risk factor, whilst human-to-human transmission of strains of avian origin has never been demonstrated. In recent years three different subtypes of Avian Influenza virus were involved in human cases.

2.3 General Medicine

AI virus can be inactivated by heating to 56°C in 3 hours or, 60°C in 30 minutes, by acid pH, oxidizing agents, sodium dodecyl sulphate, lipid solvents, b-propiolactone, detergents, halogenated compounds (chlorine and iodine), quaternary comonium salts, synthetic phenols, alkalis, formaldehyde and glutaraldehyde, and other products. The virus can also survive in a viable form for long periods in tissues, faeces and water (FAO, 2001).

Species affected since the start of the outbreaks (2003) in Asia were layers, ducks, chicken, quail, muscovy ducks, crows, pheasants, tiger, goose, turkeys, storks, the Little Cormorant, Asian Openbilsl, Scaly-breasted Munia, Red Turtle-Doves, Black Drongo, pigeons, guinea fowls and wild birds such as Peregrine falcons, broilers, pigeons, black swans, fighting cocks and ostriches (FAOAIDE news, 2005). All H and N subtypes were isolated in all species (Fenner *et al*., 1987). Infected poultry initially may show only mild signs of disease but subsequent economic losses are high due to high mortality, production drop and cost of vast stamping-out and control measures.

Pigs are the most frequent interspecies transmitters of influenza A compared to other mammals and currently H1N1 and H3N2 have been detected in swine (Castrucci *et al*., 1993). There also was found an outbreak of the AI subtype H5N1 in tigers in the zoo in Thailand (Keawchareon *et al*., 2004).

2.4 Diagnostic methods

For AI, a confirmed diagnosis of the Avian Influenza subtype is required. Firstly, samples were taken to carry out a screening test such as PCR (offering same day results) or haemagglutinating activity or immunodiffusion test (which took 4-7 days), followed by a confirmation test (HI-test and AGPT-test), which required 2-10 additional days.

Isolation in chicken embryos has recently been replaced, under certain circumstances, by reverse-transcription polymerase chain reaction: RT-PCR takes about one day for preliminary result (Cattoli *et al*., 2004).

Serological tests: As all influenza A viruses have antigenically similar nucleocapsid and matrix antigens, agar gel immunodiffusion tests are used to detect antibodies to these antigens. Enzyme-linked immunosorbent assays have been used to detect antibodies to influenza A type specific antigens (OIE, 2005d, Chapter 2.7.12. Avian Influenza). Haemagglutination inhibition tests have also been employed in routine diagnostic serology, but this technique may miss some particular infections because the haemagglutinin is subtype-specific.

Alternatively, newly isolated virus may be examined by haemagglutination and neuraminidase inhibition tests against a battery of polyclonal antisera to a wide range of strains covering all the subtypes. A commercial rapid diagnostic test kit (Directigen® Flu A test) provides a diagnosis within 30 minutes (CDC, 2004, OIE, 2005d) and is used in the US together with AGID, which can detect antibody in serum (24 hours for positives and 48 hours for negatives) and later virus isolated by 3 to 5 days.

The common factor in all recent outbreaks (especially when they happened for the first time) is the excessive length of time that elapsed between the first manifestations and the actual diagnosis. The Animal Disease Surveillance Unit in Canada (CFIA Report: 2004) was critical of the average 7 days time period from disease detection to flock euthanasia and carcass disposal. The desired target was defined as 24 to 48 hours (Power, 2005). In order to achieve this, a highly coordinated, emergency response programme has to be in place. Changing the case definition to include flocks, which were positive to the screening test (PCR), without having the benefit of subtype-confirmation results at hand, permits more rapid disease response actions (Power, 2005).

2.5 Epidemiology

2.5.1 AI transmission

Potential sources of transmission are identified as following (Power, 2005):

a) Through poultry manure/litter - The greatest threat of spread of AI viruses is mainly by mechanical transfer of infective faeces, in which virus may be present at high concentrations and may survive for considerable periods (Utterback, 1984).

b) Through water - Evidence exists that AI virus may remain infective in lake water up to 4 days at 22^{o}C and over 30 days at 0^{o}C (Webster *et al.*, 1978), virus infectivity was retained up to 207 days at 17^{o}C and 102 days at 28^{o}C from an initial concentration of 10^6 $TCID_{50}$/ml (Stallknecht *et al.*, 1990).

c) Through human activity - In several specific occasions strong evidence exists that implicated movements of caretakers, farm owners and staff, trucks and drivers moving birds or delivering food in the spread of the virus both on to and through a farm (Wells, 1963; Homme *et al.*, 1970; Halvorson *et al.*, 1980; Alexander and Spackman, 1981; Glass *et al.*, 1981).

Once infected flocks become virus factories they can shed significant amounts of live virus into their environments. Although the proportion of each of the above sources has not yet been determined, key means of transmission are considered to be through high-risk activities, involving people and equipment and through dust emissions (Power, 2005).

As in Asia several poultry species are often present in crowded live poultry markets for long periods, this practice adds a high potential for the spreading of the disease through this part of the chain (Halvorson, 2002).

2.5.2 Emergence of novel strains and pandemic threat

Three prerequisites exist for a human pandemic, of which in the case of AI two have already been met: 1) emergence of a new influenza virus to which the human population has little or no immunity and against which there is no effective vaccine, and 2) ability of the virus to replicate in human beings and cause disease. As yet, there is no convincing evidence of the third prerequisite–efficient human-to-human transmission (Buxton Bridges *et al*., 2000), although no confirmed reports have emerged, it is believed that the longer the presence and the greater the spread in poultry, the more likely it is that HPAI virus will emerge (Alexander, 2003).

Currently, there would not be enough vaccines available for such a pandemic to protect a large human population, it could take 8 months from the onset of an epidemic that sufficient vaccine is available (Stephenson *et al*., 2005).

2.5.3 Reservoirs

AI virus was found in far greater amount in waterfowl than in other birds, wild and domesticated, which are the major natural reservoir of the viruses (Ministro da Saude Humberto Costa, 2004, Stallknecht, 1998). Data from the 3-year study by Hinshaw *et al.* (1980) on ducks congregating on lakes in Alberta, Canada, prior to their southern migration showed that influenza virus isolation rates from juvenile ducks might exceed 60%. Another reservoir is live poultry markets, which have mostly ceased in most large cities forever but still are a phenomenon in some areas (Halvorson *et al*., 2002).

2.5.4 Seasonal pattern

It is speculated that seasonal infection in migratory waterfowl may also be related to seasonal influenza infections in other species, including humans (Halvorson *et al*., 1985). It is significant that many of the outbreaks in most countries occurred in turkey flocks situated on the migratory routes of waterfowl. Even in Minnesota, USA, where outbreaks in turkey occur almost annually, there exists considerable variation in virus sub-types. This together with the seasonal relationship of outbreaks (such as increased prevalence of HPAI in Thailand in September 2004 (Chaitaweesub, 2005)) suggests that influenza epizootics are the result of new primary introductions each year.

2.5.5 Risk factors

Although waterfowl and other wild birds appear to be responsible, even though indirectly, for most influenza introductions to domestic poultry, other possibilities should not be ruled out. For example, H1N1 virus may pass readily between pigs, humans and turkeys and the introduction of viruses of this subtype to turkey flocks from infected pigs is well documented (OIE, 2003). It was also found that areas with higher proportions of ducks in rice paddle fields, associated with the practice year-round rice production, are related to a higher potential number of outbreaks (Chaitaweesub *et al*., 2005).

Similarly, poultry may be less likely to become infected with AI viruses if kept indoors but strong pressures exist to rear them on range and for some species, e.g. ostriches, this is a necessity (Lang, 1982).

Use of surface drinking water and the presence of lakes that attracted waterfowl close to the farms were associated with the HPAI outbreaks in Australia (Westbury, 1998). On what was the index farm in the catastrophic outbreaks in Pennsylvania in 1983/4, the farmer had created an artificial pond to keep ducks and attract wild waterfowl (Webster and Kawaoka, 1988).

2.6 AI Prevention, control and eradication

2.6.1 AI control constraints and challenges

The constraints and challenges indicated for HPAI control (FAO, 2004a) are as following: Inadequate veterinary services are a major weakness; Bio-security measures are difficult to implement; More epidemiological expertise is needed; Inadequate disease information systems; Domestic ducks are an important H5N1 reservoir; Disease has become endemic in several countries; Wildlife reservoirs are a source of HPAI infection; Failure to base disease control planning on socio-economic impact assessment; Weak linkages with public sector; Sustainable long-term regional coordination is badly needed; Financial resources remain inadequate. Due to these ongoing constraints, countries will have to prepare for further outbreaks, which can occur (almost) everywhere.

2.6.2 Contingency plan

From 1997 onwards an increasing number of cases is documented where the virus has moved from birds to humans. Deaths have occurred in various countries in Asia as well as in the Netherlands. This has led to the involvement of public health authorities when outbreaks occur and the participation of these authorities in the drawing up of contingency plans (Australian Veterinary Emergency Plan, 2004) and of well preparedness.

Disease control contingency plans should contain the details of management structure, disease control strategies and operational procedures, which animal welfare consideration should be addressed (OIE, 2005b).

2.6.3 Legislation and measures to be taken after an outbreak occurs

It is not possible to prescribe a universal valid approach that suits each country and which requires a long-term management response. The main measures to prevent, control and eradicate HPAI though include timely destruction of infected and at-risk poultry in combination with cleaning and disinfection and proper disposal of carcasses and infective material (Sims *et al.*, 2003). At the same time surveillance must be closely integrated with control strategies (Dolberg, 2005).

Hence a depopulation or stamping-out policy is the preferred method of control for HPAI with the objective of returning a country to a disease free status in the shortest possible time. This becomes particularly critical to countries with large export markets (Breytenbach, 2005).

Once an outbreak is identified, measures should be undertaken in accordance with detailed recommendations made by the FAO and OIE (FAO, 2001; FAO 2004b; OIE, 2005b). Additional to measures at the outbreak farm, containment measures have to be applied in protection zones where HPAI infected or potentially infected poultry are identified. The rationale for this protection zone strategy is to immediately contain the geographic spread of HPAI. Thus, it entails stamping out of all infected and potentially infected poultry flocks and restricting entry onto and exit from these farms and locations by people, materials, equipment, vehicles (cars, trucks, bicycles, etc.), and animals (livestock, pets, and vermins).

2.6.3.1 Quarantine measures applied in surveillance zones

Areas immediately surrounding protection zones are declared as surveillance zones. These zones are subject to quarantine measures even though no reports of HPAI infection in poultry exist within these zones. Strict bio-security measures are implemented within and between establishments to assure that poultry and birds are kept isolated from other birds and animals, and strict movement restrictions (e.g. from farms to markets) are in place (OIE, 2005c).

2.6.3.2 Culling

Culling inside the protection zones must be diligently performed, considering the risk of infection to poultry in adjacent apparently HPAI-free areas and the potential for H5N1 transmission to people. Culling must be done as close as possible to the centre of infection, for example, within the affected farm. Moist disinfection of the house or container surfaces, poultry litter and debris can help reduce the spread of virus during and after the culling process. Under all circumstances, the culling procedure should be as humane as possible, without compromising human safety (carbon dioxide saturation is the method of choice for destroying poultry species when large numbers are involved) under the responsible official veterinarian (OIE, 2005b).

The subsequent prompt and effective disposal of culled birds and contaminated materials that cannot be effectively disinfected (e.g. feeds, litter and eggs) is essential. Although it is best to bury poultry and contaminated materials at the affected area or farm, this may not always be possible because of the local well-water table level or other environmental conditions.

2.6.3.3 Decontamination and disinfection

Strict adherence to decontamination and disinfection procedures is essential to the control of HPAI infection in affected areas (FAO, 2001). Decontamination involves thorough cleaning and disinfection of the infected site to remove all contaminated material and sources of virus. Individuals should be trained to conduct the procedures.

2.6.3.4 Vaccination

In some HPAI outbreaks, stamping out attempts alone may be unsuccessful (Halvorson, 1998). Even though immunization with an inactivated vaccine was found to be able to reduce the susceptibility of the poultry population and be the second line of defence for AI (Halvorson *et al.*, 1987, Beard, 1981; 1992), no consensus still exists as to the general use of vaccination.

Few countries propose using vaccine to aid in the control of HPAI, in some of these countries export markets though are not an issue and a slow systematic programme of vaccination and controlled marketing might be used as a mean to eradicate HPAI. In a country such as Thailand where the broiler industry is export dependant, vaccination presently would probably lead to the exclusion from the EU market. However, the recent EU commission directive in this respect does not necessarily help an exporting country as it still addresses individual countries by a "case-by-case" clause.

2.6.3.5 Communication

An important component of any contingency plan are the lines of communication. Various lines of communication exist, at the minimum a readily available centralized telephone number must exist so that a farmer who has a suspicion of a problem can immediately inform a central organ. Then this central organ must set in motion measures to notify any outbreak and at the same time must put surveillance into effect to comply with OIE recommendations (OIE, 2005a). There must also be in place an effective process to deal with media and public questions.

2.6.3.6 Surveillance

The presence of influenza viruses in wild birds creates difficulties for a country to declare itself free from Avian Influenza. However this fact does not excuse the complete absence of permanent surveillance programmes in most places, principally due to costs.

Therefore, as the impact of epidemiology of NAI differs widely in different regions (contacts of poultry with wild birds, different bio-security levels, production systems and the co-mingling of different susceptible species, including domestic water fowl), it is impossible to provide specific surveillance guidelines for all situations.

Ongoing both active and passive surveillance, designated by inputs from competent professionals with experience in this field, should be conducted though and cover all susceptible poultry species by both serological and virological tests (OIE, 2005a; CFIA, 2005).

2.7 Thailand AI control

The Department of Livestock Development (DLD) of the Ministry of Agriculture and Cooperatives is directly responsible for the animal health services and the promotion of animal products in Thailand. This authority's structure contains nine regional livestock offices, 76 provincial livestock offices, and four Regional Diagnostic Centres (Poapongsakorn *et al*., 2003).

The Division of Veterinary Epidemiology, Office of Animal Disease Control, at DLD acts as a main reference and extension service centre for epidemiology in Thailand. The provincial livestock offices have considerably more autonomy in decision making since the decentralization of authority from the regional office, although financial constraints with needs for fund raising for essential extension services still exist for them (Poapongsakorn *et al*., 2003).

The National Institution of Animal Health (NIAH) is another government office that provides training programmes and serves as a reference laboratory to notify diagnosis. It collaborates with other organizations in conducting investigations and surveillance of major animal diseases. There exist another 8 laboratories located in separate parts of the country in order to increase the availability of services for the livestock farmers. The portal of the disease surveillance reporting system is arranged as in Appendix I.

In 2001, DLD had a staff of 510 veterinarians, 1,642 para-veterinary trainees, 319 animal husbandry scientists and 573 animal husbandry assistants. Apart from permanent staff, the authority also trains key persons in villages to carry out routine vaccinations and to detect and notify any outbreaks of contagious disease (Poapongsakorn *et al*., 2003).

2.7.1 History of Avian Influenza in Thailand

Fowl plague is the epizootic disease named in the Animal Epidemic Act (1956). Later on, the disease name was changed to "Highly Pathogenic Avian Influenza". In

1973, H3- and H4-AI was detected in birds imported to the US from Thailand (Slemons *et al*., 1973). In 1984, a mild strain of AIV was isolated from pheasants by the relevant authority and was confirmed H6N9 (Tantaswadi *et al*., 1986). Laboratory surveillance was conducted from 1997 to 2002 without any positive result for AI by the AGID test and the HI-test employed (Chaisingh *et al*., 2003).

With the start of the first AI outbreak wave, sub-committees were set up after the weekly meeting held by the head of the National HPAI Committee (Avian Influenza Control Operating Centre, DLD, 2004b) in order to specifically work on the HPAI crisis, on technical and poultry raising strategies, and on public relations aspects. On the 29th September 2004 meeting, the Prime Minister assigned Provincial governors to be the Heads of the HPAI Control Taskforce which was given full power to recruit all relevant authorities, procure supplies and coordinate the HPAI issue in order to cope with the disease (Avian Influenza Control Operating Centre, DLD, 2004), also the disease surveillance networking system was reviewed (Appendix I).

2.7.2 Chronology of AI outbreaks in Thailand

With the first AI outbreaks, Thailand was one of the hardest hit countries in the region. In the mid of November, 2003, a disease outbreak occurred on one layer farm at Nong Bua district, Nakornsawan province but it was not thought to be AI. In January 2004 there was another disease outbreak on a layer farm in Bangplama district, Suphanburi province, in the central region of Thailand. This time the presence of AI was confirmed and Thailand promptly notified the OIE (Appendix C) and announced Suphanburi as the infectious disease control zone on January 23rd, 2004 (estimated date of primary infection was 19 January 2004 (OIE, 2004)).

On 30 January 2004, one week later, more outbreaks in another 32 provinces occurred and in a further 8 provinces at 6 February 2004 (Appendix C). Active surveillance was initiated (from 28 February to 5 March 2004) and resulted in the detection of one new outbreak. Some more outbreaks were detected later after 12 March 2004. The last outbreak of the first wave was at Chiangmai province (in the training farm of the faculty of Agriculture, Chiangmai University, on 25 May 2004

(OIE, 2004). Reports summarize a total of 190 AI outbreak declarations in 89 districts in 42 provinces from 23 January to 25 May 2004 (Avian Influenza Control Operating Centre, DLD, 2004). 8 humans, among them 7 children, infected from 12 cases, died.

2.7.3 Affected number of animals

(Avian Influenza Control Operating Centre, DLD, 2004)

In the 1st outbreak wave from 23rd January to 24th May 2004 cases reported were smallholder naive chicken (58.5%), commercial layers (12.4%), and broilers (11.9%), ducks (6.7%), quails (4.7%), turkeys (1.6%), geese (0.5%) and 3.4% of other animals such as ostriches, peacocks, domestic cats, tigers, leopards, white tiger and clouded leopard (Appendix E).

The 2nd outbreak wave lasted from 3rd July to 30th September 2004 with 288 suspected (all destroyed), 187 cases (index farms) were confirmed positive and 101 negative. There were 855,790 birds and 35,000 quail eggs in 38 provinces destroyed. Another two humans died and 1 person recovered from 3 confirmed and 1 probable cases. The crucial cause of the 2nd outbreak in Thailand was believed to be a residual virus that had eluded the intervention measure during the initial (1st) outbreak wave and was still circulating in some poultry population.

Investigations revealed that wild or migratory birds, human formites, backyard chickens, vehicles, traditional duck raising and residual virus in the area etc. attributed to the latter outbreaks.

2.7.4 Control measures employed

(Avian Influenza Control Operating Centre, DLD, 2004)

For Thailand, the country for the first time was exposed to country-covering outbreaks of AI. Thailand had a contingency plan (Appendix G) and it was carried out during the first outbreaks. Not all control methods though immediately were in place or effective, such as awareness of all farmers, communities, officers availability of culling-, cleaning and disinfection and investigation-teams, facilities, monitoring, surveillance (Appendix H), psychologists etc. for disease outbreak crisis management.

The whole series of processes and disease control measures (culling of all birds, disposal of carcasses and all animal products, cleaning and disinfection and allowance of at least 21 days before restocking (Animal Epidemics Act, 1956) though was employed in Thailand in accordance) with the Office International des Epizooties (OIE) Terrestrial Animal Health Code. National contingency plans for AI of other countries having experiences with the disease were also observed.

2.7.4.1 Legislation and outbreak response employed

(Avian Influenza Control Operating Centre, DLD, 2004)

Laboratory confirmation after first suspicion, veterinary visit with sample taking on farm and submission to one of the 9 references laboratories (Appendix F; Appendix H). A full protocol diagnosis method was employed, which took 6-10 days, as well as an emergency protocol, which took 1-4 days during the first outbreak. After the confirmation the following measures were employed;

a) Stamping-out promptly the infected holding and all surrounding farms in a 5 km radius

b) Disposal of poultry carcasses, their products, cleaning and disinfection of cages, housing, farm equipment and vehicles

c) Quarantine of the infected farms and 5 km radius surrounding farms (plus active surveillance)

d) Movement control (Veterinary inspectors in cooperation with local police or military taskforce and other authorities)

e) Compensation

(vaccination prohibited)

2.8 Timing of AI outbreak control measure recorded

Timing of control measures prescribed and employed during the outbreak in Thailand (Avian Influenza Control Operating Centre, DLD, (2004)) was:

- If an animal is sick or dies its owner shall inform the relevant authority or veterinarians within 12-24 hours.
- Permissible time between farmers information and veterinarian's farm visit, with sample taking is 48 hours and if not the farmer could bury their birds by the manure method.
- Permissible time between sample submission and laboratory confirmation is promptly.
- Permissible time between laboratory confirmation and declaration by DLD is 1 to10 days.
- Stamping out all susceptible poultry and their products from infected farms (index farm) including those contagious farms within a radius of 5 km (surrounding farm) by burning or burial within 1 day.
- Disinfection of poultry houses and equipment of both index and surrounding farms promptly after depopulation was completed.
- Quarantine of both index and surrounding farms unless authority permits otherwise.
- Movement control of the surrounding areas within a radius of 50 km from index premises without veterinary permission since declaration unless authority permits.
- Proclaim 5 km radius area and remain effective for 30 days or unless authority permits.
- Prohibit poultry products export during the 90 days after the last flock stamping-out. However, after a 30 days period some product could be used for local consumption.
- Conducted active surveillance by serum and cloacal swab collections from each village.

- Raising awareness of farmers, veterinary staffs and industry to understand the importance of sanitation.
- Ensuring no re-infection by the virus in the re-stocked farms.
- Compensation.
- Public education – bio-security.
- Re-stocking permitted only after 21 days plus (another 39 for closed houses or 69 days extra for open houses) after the last flock was stamped-out and the farm revised for its sanitation and environment meeting authority standards.

3. MATERIAL AND METHODS

3.1 Study area

The study was conducted in Thailand, which is geographically divided into 76 provinces.

3.2 Study design

Official and public domain reports of Thailand on AI to the OIE (OIE, 2004) and the summary report of DLD on first AI outbreaks (DLD, 2004) were used for study design. Reports to OIE contain information on the location of outbreak(s) (province, district), the number of outbreaks, the nature of diagnosis, date of initial detection, description of affected population, laboratory where diagnosis was confirmed, causal agent identified and control measures undertaken.

The DLD summary report lists the date of official declaration (by DLD), the date of suspicion (at which samples were taken by official veterinarians), the province, the district and the species.

3.3 Study population

42 provinces, which experienced the first chronology of avian influenza outbreaks in Thailand, from 23rd of January to 24th of May 2004, were the reference population (Appendix D). A random sample of 20 of the 42 provinces was selected, giving proportional weight to the geographic/administrative zone in which the province is located. The provincial veterinary officer of each province served as initial contact point and source of information on officially undertaken measures. Within each province, one outbreak (index) poultry farm and its holder was selected, visited and interviewed by the senior investigator without involvement of the provincial

veterinary officer. Surrounding poultry farms and their holders were equally selected within a radius of 5 km of the index farm using information of the index farm holder and/or the chief of the village where the index farm was located. Nine surrounding farms were targeted for each index farm.

3.4 Selection of index and surrounding farms

Selection was based on convenience (availability of the farm owners, distance, accessibility by road, etc.).

3.5 Data collection procedures

Province veterinary officers were contacted using telephone numbers given by the DLD 24 hours call centre in Bangkok and appointments were made with the officers.

Reason to use provincial veterinary officers as initial contacts and first interviewees were that they were the principal responsible authority during the outbreak, they kept records of the coordinates of the index farms and did record kinds and steps of control measures implemented. The reason to interview the index farms was to gather information on location how outbreak containment actually had been implemented in the field, additional to gathering information on farm environment, farming practices, and farmers' awareness of AI. Reason for interviewing village chiefs was that they administratively were the representatives of the provincial veterinary officers at village level and the first entry point of reporting outbreaks to them. Village chiefs further were mostly included in the stamping-out team and they further facilitated access of the investigator to farms. Reason for including surrounding farms was to compare control actions carried out on them additional to those carried out on the index farms.

Questionnaire pre-tests were carried out in the first 2 provinces' visits. The questionnaire subsequently was improved before being used throughout all interviews in order to gather necessity information at the different levels regarding the outbreak control measures implemented.

Questionnaires

Data were collected by means of structured questionnaires (Appendix A). With few exceptions, the senior investigator did administer the questionnaires herself.

Questionnaire data:

Data collected on the farm level were:

- farm location, type of operation (layers, broilers, mix), farm size, poultry species (chicken, ducks, pet birds, backyard chickens);
- bio-security practices (secure from all wild birds, rodents, feral and domestic animals and unauthorized visitors, cleaning and disinfection, personnel hygiene);
- number of poultry housed during the outbreak, suspicion date, diagnostic confirmation date;
- poultry disposal measures (burning, burial, contract pick-up and others);
- feed supplied (feed type, source and delivery);
- application of movement control, authority, key bodies involved and evidence found from farmers' interviews on movement control;
- legislation for movement control by the authority or awareness of farmers in assessment of poultry or their products' destination; restocking approaches, requirement for moving fighting cocks, poultry products, hatching eggs, table eggs, broilers for meat exports, ducks in rice paddies, source of poultry for restocking, advise from authority;
- restocking time (period) after the outbreak;
- steps implemented and time of each interval between control steps;
- compensation;
- evidence of surveillance;

- other important bodies involved;
- general public reaction, comments and other important information

Data from provincial veterinary offices on movement controls were used as reference of the country procedure, while respective data from farm holders were used to assess their awareness.

Supportive information on legislation, procedures and control measures implemented, chronology of control measures and management information was provided by DLD in Bangkok.

Time spent for each interview, especially with provincial veterinary officers was long, in some cases the interview lasted longer than 5 hours. The steps of the interviewing approach, which included 4 levels of interviewees, are graphically shown in Figure 1:

42 provinces with HPAI cases report

↓ random selection

20 provinces → **Provincial veterinary officers**

↓ convenience selection

21 Index farm → **Farm owners, village chiefs**

↓ convenience selection

20 x 9 surrounding farms within 5 km radius from index farms

Figure 1: Diagram summarizing interviewing approach, numbers and level of interviewees

3.6 Data management and analysis

Questionnaire data were transferred into a spreadsheet. The Epical 2000 programme was used to calculate mean times and their 95% confidence intervals (in days) which each of the control steps took to be implemented.

For each farm, the proportion of control steps undertaken was calculated.

Associations or differentiation between bio-security practices and farm characteristics' were analysed by using th4e EpiInfo 2002 programme by means of the chi-square test (uncorrected) and the Fisher's exact test at a p-value of 0.05. Equally, associations between movement control knowledge of farms and farm characteristics were analysed by the same tests.

4. RESULTS

4.1 Implementation of study approach

With few exceptions, interviews in numbers were carried out as planned. A total of 247 interviews rather than the planned 240 interviews were carried out. One of selected authorized provincial veterinary officers declined to be interviewed, as he did not feel comfortable, the data concerning the index farms in that province subsequently were gathered from the Sub-district health centre instead. Data on a selected duck index farm in rice paddies are missing due to the absence of the owner. A slightly larger number than planned of surrounding farms was interviewed.

Data were collected retrospectively, a period of about 12 months had passed between the outbreaks and the interviews. Many of the exact dates of actions had been forgotten, particularly by farmers. It consequently was decided to work backwards and forwards from the official notification date and the date of depopulation at farm.

Most of backyard farms did not have an available phone number to schedule a visit, the selection of studied farms subsequently had to be based on convenience and on possible access to farms. The selection of farms though was made by the senior investigator and not by the provincial veterinary officer.

No reports were said to be available on several initial outbreak control steps in four study provinces, because the outbreaks were said to be detected by active surveillance.

While acknowledging these few shortcomings in data collection, and using the robust analysis of the data, there is a high degree of confidence that these limitations in the interview process did not affect the findings and the final conclusions.

4.2 Study farms and interviewees

Table 4.1: Geographical location and number of interviews carried out

Region	Number of				
	Provinces	Official veterinarians	Village chiefs	Index farms	Surrounding farms
Central	10	9[e]	8	11[a]	90
Eastern	2	2	2	1[b]	26
Northern	3	3	2[d]	4[a]	26[c]
Northeastern	5	5	4[d]	5	49
Total	20	19	16	21	191

[a] Two selected index farms were located in the same outbreak area, one in a province in the central region, one in a province in the northern region
[b] One selected index farm was missing in one of the two provinces of eastern region, because it was a free range duck operation without owner
[c] One surrounding farm was missing from one province of northern region, because owner was not present at time of agreed visit
[d] Two village chiefs were not located in two of the selected outbreak areas (one in northern, one in northeastern region)
[e] One provincial veterinary officer refused interview

Forty eight percent (20/42) of the provinces having experienced the first episode of AI outbreaks (some provinces had repeated outbreaks) from 23 January to 24 May 2004 and 11% (21/191) of the officially reported index farms (DLD, 2004, Appendix D) were included in the study.

Table 4.2: Study farms differentiated by farm type

Farm type		Index farms		Surrounding farms	
		Number	%	Number	%
Chicken	Layer	9	42.9	17 113	8.9
	Backyard Broiler	5	23.8	33	59.2
		3	14.3		17.3
Ducks	Layer	1	4.8	7 2	3.7
	Broiler Mix-	-	-	1	1.0
	type	-			0.5
Quail	Quail	2	9.6	-	-
Mix	Broiler + backyard chicken Mix-	-	-	1 2	0.5
	+ backyard chicken Broiler	- -	-	1 1	1.0
	geese + backyard chicken	-	-	7	0.5
	Mix type chicken Layer	- -	-	4	0.5
	ducks + backyard chicken Broiler ducks	1	-	- 1	3.7
	+ backyard chicken	-	-		2.1
	Mix geese + backyard chicken		4.8		-
	Mix type geese		-		0.5
Fancy birds	Fancy birds	-	-	1	0.5
Total		**21**		**191**	

17 of the 21 index farms were farms keeping chicken, differentiated into layer chicken, broiler chicken and backyard (native) chicken. The remaining index study farms kept mixes of different poultry species. For surrounding farms, the majority of them also kept chicken (layers, backyard, broilers).

The proportions of index farms in each of the 3 chicken farm categories in 20 provinces experiencing the first AI wave are contained in Table 4.3.

Table 4.3: Proportions of study farms in poultry farm categories

Chicken category*		**No. of study index farms**	**Proportion index farms (%)**
No Layer chicken farmers	4,348	9	0.2
No Broiler chicken farmers	7,359	3	0.04
No Native chicken farmers	560,067	5	0.0009

Source: Provincial Livestock Office, Information and Statistics Group, Information Technology Center, Department of Livestock Development, 2003, Appendix B

Avian Influenza outbreaks occurred in all farm types. In this sample, the number of outbreaks in commercial farms (layer and broiler) was by far greater than the number of outbreaks in backyard (native) holdings.

4.3 Avian Influenza outbreaks and control steps taken

4.3.1 Division of AI control activities between different actors

Table 4.4 summarizes the cascade of control steps and the principal involvement of the different actors in the steps. Provincial authorities, particularly the veterinary authorities, were principally involved in each of the control steps, as were their representatives at the village level, the village chiefs. The farmer's role concentrates on those activities deal with direct containment activities on their farms. They, in contrast, are not part of several regulatory steps, particularly quarantine and movement control. Activities of public health officers essentially center on manual activities during an outbreak (depopulation, disposal, cleaning and disinfection) and further involve human health promotion activities. The role of the police is limited to quarantine and movement control measures.

The village chief or sub-district chief (Kamnan) had a cooperating role in each of control measures implemented to contain the outbreak (Table 4.4). From interviews on location, it is suggested that on 77.8% of the farms there was involvement from the relevant authority, 31.1% involvement from police officers, 17.2% involvement from public health officers and 40% involvement from the other authorities.

Table 4.4: Role and involvement of relevant agencies in AI disease containment at farms

Agencies	Suspicion report	Disease investigation	Sample sent to lab	Confirmation to Depopulate	Depopulation	Disposal	Quarantine	C&D	Movement control	Passive surveillance	Active surveillance	Human health promotion	Movement awareness promotion
Provincial: relevant authority/veterinary officer	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
Village chief/Sub-district governor	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Farmers – Index -Surrounding	✔ ✔		✔ ✔		✔ ✔	✔ ✔		✔ ✔		✔ ✔			
Public health officers		✔			✔	✔		✔		✔		✔	
Police							✔		✔				

4.3.2 Interview results: Suspicions of Avian Influenza prior to official declarations (23 January 2004)

Table 4.5: Numbers, kinds of interviewees and recall of AI suspicions prior to 23 January 2004.

	Nov. 2003	Dec. 2003	< 23 Jan. 2004	Total	Percent
Surrounding farms	2	17	8	27	**42.8**
Index farms	2	6	10	18	**28.6**
Village heads		1	2	3	**4.8**
Provincial veterinarians	4	4	7	15	**23.8**
Total	8	28	27		
Percent	**12.7**	**44.4**	**42.9**		

AI outbreaks were suspected much earlier than the first official declaration date, 23 January 2004. Table 4.5 indicates, that several actors did suspect AI already as from November 2003. Obviously these first outbreaks already did peak in December 2003 and in the month of January 2004, prior to 23rd. Close to 25 percent of these early outbreak suspicions were reported by veterinary personnel. It is likely that they did forward these suspicions to their central authority. Why immediate respective control activities were not undertaken remains unanswered.

4.3.3 Timing of AI control measures by provinces.

Table 4.6: Time spent to complete all controlling steps to contain the outbreak

Days spent	Frequency (number of province(s))	Cumulative frequency	Cumulative relative frequency (%)
1 day	1	1	6
2 to 3 days	4	5	28
4 to 7 days	4	9	50
> 7 days	9	18	100
Total	**18**	**18**	

Table 4.6 summarizes the speed by which the total of control steps were completed by the provinces. Only 50% of the provinces did complete all control measures within a week (7 days), the remaining provinces took much longer than 7 days.

Differentiating times used for different control steps and comparison of respective set targets gives the following picture (Table 4.7):

Table 4.7: Percents accomplishment of executing control measures (intervals (days) between control steps) as compared with national targets (interview results)

Control steps interval	National target*	% national target achieved	Exceeding target (%)
Farmer to village chief - village head to province veterinarian	12- 24 h	66.7	33.3
Village head to PVO - vet visit/ inspection	<48 h	88.2	11.8
Vet visit/inspection - sample collection/ submission	promptly	88.6	11.4
Sample collection/ submission - laboratory confirmation/ declaration	1 – 10 d	≤1d: 47 ≤ 2d: 65 ≤ 5d: 82 ≤7d: 100	
Laboratory confirmation/declaration – stamping out	1 d	81	19
Stamping out - disinfection	promptly	≤1d: 56 ≤ 3d: 73 ≤ 7d: 93	

* Avian Influenza Control Operating Centre, DLD, 2004

Interview results reveal that all control measures were carried out in all individual outbreaks but that the prescribed times to carry out each measure were often not kept. While individual provinces, through their province veterinary officers, reacted fast, often very fast, others took longer than prescribed. Very fast action often was taken by veterinarians in regards to sample taking, submission of samples for laboratory confirmation and stamping out after laboratory confirmation. Conversely, notification of the provincial veterinary personnel by affected farmers themselves or by their respective village chiefs, often was delayed. Particular notice deserve delays in disinfection after depopulation: only about a good half of farms were disinfected immediately, for others it took several days to do so. In the extreme, for individual farms it took up to 1 or even 2 months before disinfection was carried out.

4.3.4 Time spent to accomplish laboratory confirmation and depopulation

Fast submission of samples and in particular fast (and reliable) laboratory confirmation and, after declaration, depopulation with subsequent cleaning and disinfection are of central importance for successful AI control. As deficits in keeping up with national targets were noted for both areas in summary form before (Table 4.7), both areas were analysed in more detail.

4.3.4.1 Duration between suspicions to laboratory confirmation (or official declaration) of AI outbreak

Forty two percent of the outbreaks could be confirmed by the laboratories within 1 week, of these outbreaks, 21% (4/19) were detected by active surveillance. Delays longer than one week in laboratory confirmation, or official declaration, though occurred in about 58% of outbreaks (Table 4.8), the shortest and longest times spent between suspicion to laboratory confirmation or official declaration of outbreaks were 2 and 73 days, respectively.

Table 4.8: Duration (days) between suspicions to laboratory confirmation (or official declaration) in AI outbreaks; interviews of provincial veterinary personnel

Duration	Number of province(s)	Cumulative relative frequency (%)
0 day*	4	21
2 days	1	26
3 days	1	32
5 days	1	37
7 days	1	42
>1 wk to 2 wk	3	58
>2 wk to3 wk	1	63
>3 wk to 4 wk	0	63
>4wk to 8 wk	3	79
> 8 wk	4	100
Total	**19**	-

* declaration by surveillance

Recalls of provincial veterinary personnel on dates of first AI suspicions go back before the first officially declared outbreak date. The average time of 30.4 days, which passed from suspicions to laboratory confirmations in 19 study provinces, clearly indicates that early suspicions did exist in the provinces but were not followed up by, e.g. taking of samples and submission for laboratory analysis. The fact that about 37% of the provinces even register more than these about 4 weeks only supports that the AI outbreaks already had started occurring in large numbers already in November/December 2003, but were not given attention.

4.3.4.2 Time used for depopulation and subsequent disinfection

The vast majority, 81.1% of bird depopulation from study index and surrounding farms, was disposed of by burial and a further 11.1% by burning. Slightly more than

50% of the birds were disposed of at their farm, while nearly half of the birds (46.7%) first were transported from the farm to another site by contracted pick-up cars.

Depopulation was carried out on all of the selected index farms. However, there were four backyard farms (Table 4.9) that did not depopulate completely. For the surrounding farms, 82% (156/191) performed depopulation, but 57 backyard farms did not depopulate completely. Cleaning and disinfection was carried out on 95% (20/21) and 67% (127/191) of the index and surrounding farms respectively (Table 4.9).

Table 4.9: Completion of depopulation and cleaning/disinfection measures as planned

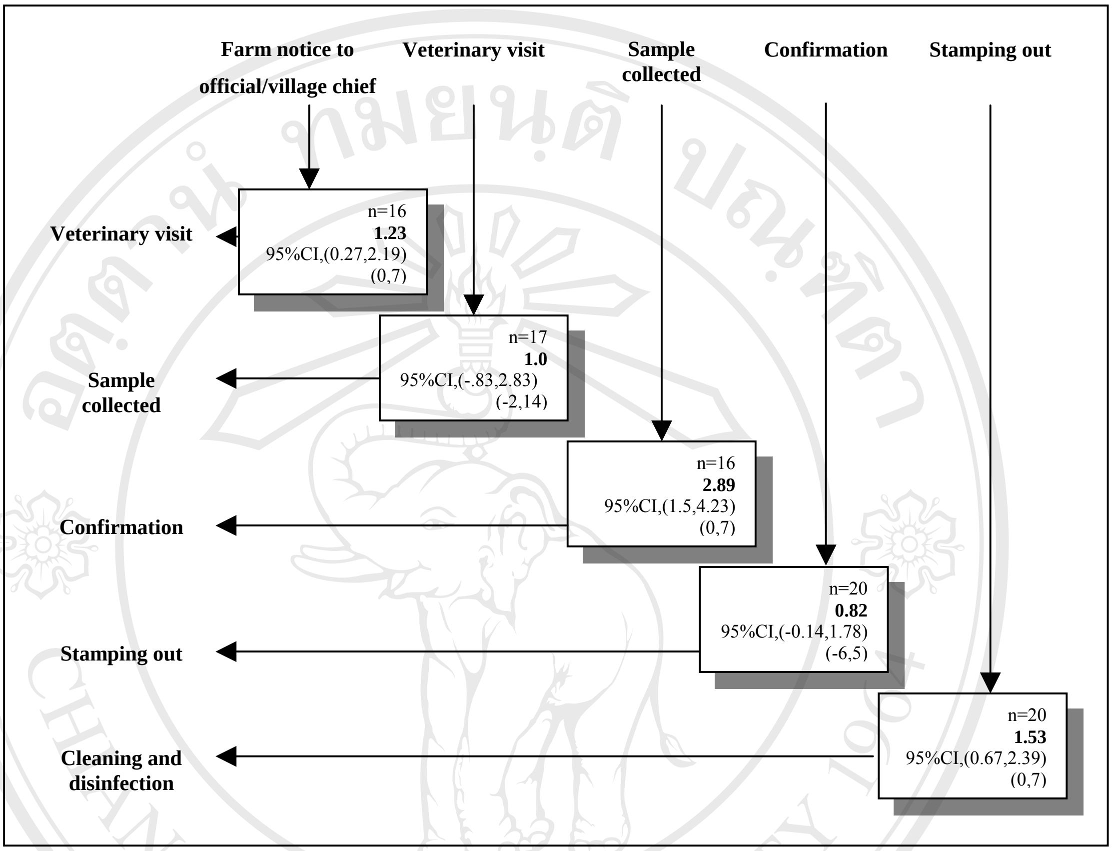
Control step	No .of farms action imposed /total no. of involving farms		% of completion	
	Index	Surrounding	Index	Surrounding
Depopulation	21/21	156/191	100 %	82 %
Cleaning & Disinfection	20/21	127/191	95 %	67 %

Because of their different nature in regards to AI and the timing of control measures applied on them, results were differentiated for index and surrounding farms.

4.3.5 Time intervals between each step of AI outbreak control in index farm

For index farms (Figure 2), it took on average 1.2 days from the farm informing the authority to the veterinary officer visit and 1 day between the visit of the veterinary officer and sample collection. Most time passed (2.9 days) between the sample collection and the confirmation step. Then, on average less than 1 day (0,.8 day) were used between confirmation and depopulation and 1.5 days from depopulation to cleaning and disinfection.

Figure 2: Mean time intervals (days) needed between each step of AI outbreak control in index farms



Remarks: n = number of farms
Value = mean time (days)
95% CI (-, -) = 95% confidence interval (lower limit, upper limit)
(-, -) = data range (minimum, maximum)

Differentiated for poultry type, for index layer chicken farms (Table 4.10), it on average took 2 days from farmer report to farm visit of the veterinarian and 2.3 days before samples were collected after the visit. Most time passed (2.4 days) between sample collections to receipt of notice to depopulate. Then on average it took 1.5 days between notice to depopulate and actual depopulation and average of 1.8 days were used from depopulation to cleaning and disinfection step.

For backyard index chicken farms different times were recorded. Compared to index layer farms, time between farmer report to the authority was shorter (0.7 days), and veterinarians immediately did visit the farms (0 days). Again most time (3.8 days) passed between sample collection and receipt of depopulation, but again average times from notice to depopulation and actual depopulation (1 day) and between depopulation and cleaning and disinfection (1 day) were shorter than on layer farms. Veterinarians in consequence did react and did carry out control measures must faster when AI outbreaks occurred on broiler farms than on layer farms. It has to be noted again that broiler farms are usually company led/contracted farms.

Table 4.10: Comparison of time spent on each step of outbreak containment between layer and backyard index farms.

Step – Step	Average days spent; (95% CI: lower, upper value); (minimum, maximum days)		
	All farms (n=21)	**Layer farms (n=9)**	**Backyard farms (n=6)**
Report -Vet visit [a]	**1.3**; (95%CI: 0.3,2.2); (0,7)	**2.0**; (95%CI:-0. 3, 4.3); (0,7)	**0.7**; (95%CI: -0.8,2.1); (0,2)
Vet visit - Sample collection [b]	**1.0**; (95%CI: -0.8,2.8); (-2,14)	**2.3**; (95%CI: -2.6,7.2); (-1,14)	**0**; (95%CI: 0,0); (0,0)
Sample collection -Confirmation [c]	**2.9**; (95%CI: 1.5,4.3); (0,7)	**2.4**; (95%CI: 1.5,3.3); (2,4)	**3.8**; (95%CI: -0.5,8.1); (0,7)
Confirmation-Stamping out [d]	**0.8**; (95%CI: -0.1,1.8); (-6,5)	**1.5**; (95%CI: 0.7,2.3); (0,3)	**1.0**; (95%CI: -1.1,3.1); (0,5)
Stamping out – Cleaning [e]	**1.5**; (95%CI: 0.7,2.4); (0,7)	**1.8**; (95%CI: 0.0,3.5); (0,7)	**1.0**; (95%CI: -1.2,3.2); (0,4)

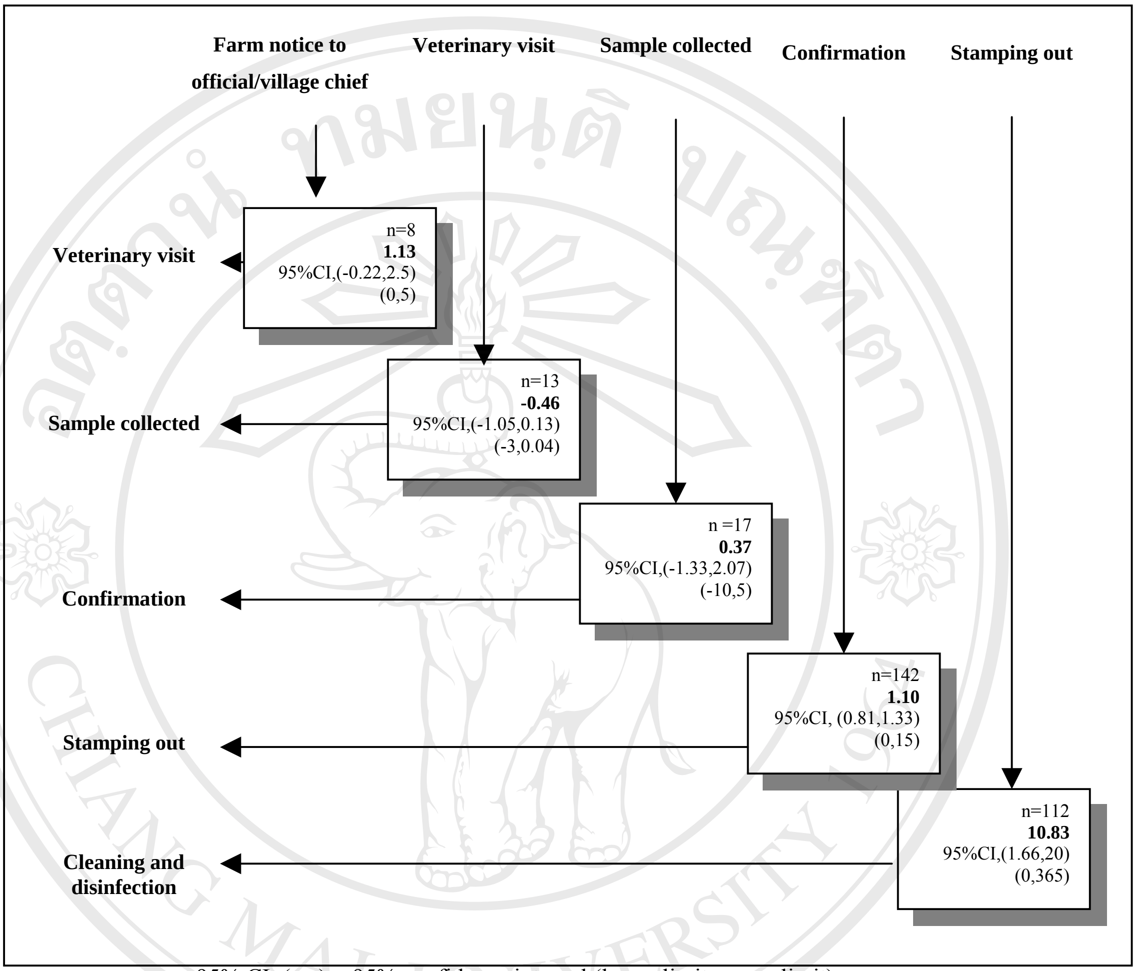
Remarks:

a = only 16 out of 21 index farms did report to the authority
b = only 17 out of 21 index farms had a veterinary visit and had samples sent to laboratory
c = only on 16 out of 21 index farms samples were collected to notify for depopulation
d = only 20 out of 21 index farms were notified to depopulate
e = only 20 out of 21 index farms carried out depopulation to cleaning and disinfections

4.3.6 Time intervals between each step of AI outbreak control in surrounding farms

For surrounding farms (Figure 3) most time passed (10.83 days) between depopulation to cleaning and disinfection step, whereas there were 0.37 days between the sample collection to confirmation step, 1.13 days between farm informing authority to veterinary officer visit, 1.1 days between confirmation to depopulation and sample was collected before (-0.46 day) visit of veterinary officer.

Figure 3: Mean time interval (days) between each step of AI outbreak control in surrounding farms



95% CI (-, -) = 95% confidence interval (lower limit, upper limit)
(-, -) = data range (minimum, maximum)

Compared to index farms, control measures generally took longer and again differences between layer and broiler farms are noticeable (Table 4.11). The time interval between sample collections to notice was longer (2.4 days) for surrounding broiler chicken farms than for layer and backyard farms. In contrast, longer time on average passed in surrounding layer chicken farms (2.8 days) between notices and depopulations than in backyard (0.7 day) broiler farms (1.1 days). Particular delays were noted before farms were cleaned and disinfected after depopulation. Again, this period was extremely long, on average, for surrounding layer and backyard chicken farms (9.1 days, 11.9 days) than for broiler farms (2.2 days). .

Table 4.11: Comparison of time spent at each step of outbreak containment between each type of chicken farms in surrounding farms

Step – Step	Average days spent; (95% CI lower, upper value); (minimum, maximum days)			
	All surrounding farms (n=191)	Layer farms (n=17)	Broiler farms (n=34)	Backyard farms (n=112)
Report -Vet visit [a]	1.1; (-0.2, 25); (0, 5)	1.8; (-1.6,3.5); (0, 5)	0.3; (-1.1, 1.8); (0, 1)	0; (0, 0); (0, 0)
Vet visit - Sample collection [b]	-0.5; (-1.1, 0.1); (-3, 0.0)	-0.8; (-3.1, 1.6); (-3, 0)	-0.3; (-1.2, 0.5); (-2, 0)	-1; (-2.5, 2.5); (-2, 0)
Sample collection -Confirmation [c]	0.4; (-1.3, 2.1); (-10, 5)	0; (0, 0); (0, 0)	2.4; (0.4, 4.5); (0.1, 5)	0.2; (0.0, 0.3); (0.1, 0.2)
Confirmation - Stamping out [d]	1.1; (0.8, 1.3); (0, 15)	2.8; (1.5, 4.1); (0, 7)	1.1; (0.6, 1.5); (0, 4)	0.7; (0.6, 0.8); (0, 3)
Stamping out - Cleaning [e]	10.9; (1.7, 20); (0, 365)	9.1; (0.4, 17.9); (0,60)	2.2; (1.3, 3.1); (0, 17)	11.9; (-0.1, 23.9); (0, 365)

Remarks:

a = only 8 out of 191 surrounding farms reported to the authority
b = only 13 out of 191 surrounding farms were veterinary visited and had samples sent to laboratory
c = only on 17 out of 191 surrounding farms samples were collected for notification for depopulation
d = only 142 out of 191 surrounding farms were notified about depopulation
e = only in 112 out of 191 surrounding farms depopulation to cleaning and disinfections carried out

4.4 Bio-security practices in poultry farm management during the outbreak period

Bio-security refers to protecting the health of animals by preventing the transmission of disease. Bio-security measures range from general common sense precautions to prevent disease from coming onto a farm and spreading there to specific measures to prevent a specific disease to do so.

On-location-investigations firstly noted that not all backyard farms as well as some layer farms were properly registered with the relevant authority.

In nearly all aspects of bio-security, except for securing against rodents and lack of footbaths, most of broiler chicken farms had good standards while the level on backyard chicken farms was very low. Just over half of the layer farms met the recommended standard (Table 4.12).

Table 4.12: Bio-security practices of layer, broiler and backyard chicken farms in all 212 study farms

Bio-security practice	% of farms which adopted the practice		
	Broiler	Layer	Backyard
Secured against bird	91.9%	53.8%	3.4%
Secured against rodents	75.7%	34.6%	3.4%
Secured against pets	97.3%	61.5%	4.3%
Cleaning between batches	97.3%	80.8%	4.3%
Outsider secured	97.3%	61.5%	2.6%
Having washing facility	97.3%	76.9%	9.4%
Having footbath	78.4%	46.2%	1.7%
Using protective clothing	91.9%	57.7%	1.7%

As indicated in Table 4.13, significant differences did exist between index and surrounding farms for bio-security in regards to cleaning between batches (p-value = 0.002, 95%CI), security against unauthorized persons (p-value=0.006, 95%CI) and washing facility available on farm (p-value=0.006, 95%CI). A higher number of index than surrounding farms had respective measures in place.

Table 4.13: Comparisons of bio-security practices in index and surrounding farms during AI outbreak period (23rd of January to 24th of May, 2004).

Bio-security practice	Level	Yes	No	Total	% Yes	P-Value
Secure against birds	Index	8	13	21	38.1	0.201
	Surrounding	48	143	191	25.1	
Secure against rodents	Index	4	17	21	19	1.0
	Surrounding	38	153	191	19.9	
Secure against pets	Index	9	12	21	42.9	0.133
	Surrounding	52	139	191	27.2	
Cleaning between batches	Index	13	8	21	61.9	0.002*
	Surrounding	54	137	191	28.3	
Secure against unauthorized personnel	Index	10	11	21	47.6	0.033*
	Surrounding	49	142	191	25.7	
Having washing facility	Index	13	8	21	61.9	0.006*
	Surrounding	61	130	191	31.9	
Having footbath	Index	7	14	21	33.3	0.323
	Surrounding	45	146	191	23.6	
Having protective cloth	Index	6	15	21	28.6	0.352
	Surrounding	38	153	191	19.9	

Remarks: * significant differences between index farms and surrounding farms

4.5 Feed transportation and feeding practices in poultry farms

Of the study poultry farms most used grain and rice as feed (65.8%), while pellets and mash were used by 30.1% and 4.1% respectively. These proportions are similar to the source of feed, with 32.8 % being supplied by feed milling companies. For the transport of feed, most transport, 60%, was done by either the feed mill truck or the farms own trucks (Table 4.14).

Table 4.14: Proportion of feed used by farms by type, source and means of transportation on index and surrounding farms for layer, broiler and backyard chicken farms.

Feed delivery	Type	Proportion
Feed type	Pellet	30.1%
	Mash	4.1%
	Grain or rice and it's debris	65.8%
Feed source	Feed mill company	32.8%
	Farm mix	10.6%
	From rice mill, farmer's rice field, remaining food from household	56.7%
Feed transport	Feed mill's truck	24.4%
	Farm's truck	36.1%
	Third party or no transport	39.4%

4.6 Acknowledgement of farmers regarding the enforcement of AI control measures

Most (88.9%) of the selected index and surrounding farm were aware that they were not allowed to move birds and 78.9% were aware that they could only move birds after authorization from the relevant authority. And within that (Table 4.15), except for knowledge about movement of poultry products and hatching eggs, there was a high level of awareness on the part of layer and broiler farm operators with respect to those items that related to them. And in nearly all items except for knowledge of fighting cock restrictions, the backyard farmer had very little awareness.

Table 4.15: Comparison of farmer's acknowledgement in index and surrounding farmers regarding AI control measures enforced by authority

AI control measure	No. acknowledged/no. of interviews(% awareness)		
	Layer	**Broiler**	**Backyard**
Security of farm environment	25/26 (96.2%)	32/37 (86.5%)	32/117 (27.4%)
Restocking permission	26/26 (100.0%)	32/37 (86.5%)	27/117 (23.1%)
Fighting cock movement control	20/26 (76.9%)	24/37 (64.9%)	83/117 (70.9%)
Poultry product movement control	7/26 (26.9%)	7/37 (18.9%)	16/117 (13.7%)
Hatching egg movement control	4/26 (15.4%)	6/37 (16.2%)	35/117 (29.9%)
Table egg movement control	17/26 (65.4%)	11/37 (29.7%)	19/117 (16.2%)
Poultry movement to slaughter for export	12/26 (46.2%)	33/37 (89.2%)	30/117 (25.6%)
Duck in the rice paddies, movement control			
- before AI outbreak	0/26 (0.0%)	0/37 (0.0%)	3/117 (2.6%)
- during AI outbreak	20/26 (76.9%)	26/37 (70.3%)	51/117 (43.6%)
Safe bird origin for restocking	19/26 (73.1%)	31/37 (83.8%)	19/117 (16.2%)

4.7 Compensation

There was evidence that all index farms were compensated, and nearly all 98.8% (160/162), of surrounding farms had proof of having received compensation also.

4.8 Surveillance

Evidence of surveillance during the first AI outbreak period: there was documentary evidence from interviews with the provincial veterinary officers that all (19) selected provinces carried out the surveillance during the outbreak. However it was found that only 40% (8/20) from selected surrounding farms interviewed, 30% (6/20) from selected index farmer interviewed, and 25% (5/20) from selected village chief interviewed were able to ratify this data.

Evidence of surveillance after the first AI outbreak period: again there was evidence from interviews with the provincial veterinary officer that all (19) selected provinces performed the surveillance after the outbreak, but only 70% (14/20) of selected surrounding farmers could corroborate this.

4.9 Re-stocking

All layer and broiler farms were depopulated and only one broiler farm restocked before the end of the 60 days period and most waited for more than 90 days. However most backyard farms either did not destroy all birds or repopulated before the recommended period of time had passed (Table 4.16).

Table 4.16: Comparison of restocking period in days after depopulation, from the first chronology of AI outbreak by selected farm level and farm type

Farm level	Farm type	Frequency (%)			
		Not completely depopulated*	Restocking period (days)		
			<60	60-90	>90
Index	Layer (n=3)	-	-	3 (100%)	-
	Broiler (n=3)	-	-	-	3 (100%)
	Backyard (n=5)	4 (80%)	-	1 (20%)	-
Surround	Layer (n=13)	-	-	5 (38%)	8 (61%)
	Broiler (n=30)	-	1 (3%)	7 (23%)	22 (73%)
	Backyard (n=78)	57 (73%)	7 (8%)	10 (12%)	4 (5%)
Total	132	61 (46%)	8 (6%)	26 (19%)	37 (28%)

Remark: * Be interpreted as no restocking period.

Not all birds in the selected backyard surrounding farms culled all their birds and some of the selected farms restocked with birds earlier than the national target standard (60 days for closed house farms and 90 days for the open house farms). And it was also found that not all backyard farms were properly registered with the relevant authority as well as some layer farms.

5. DISCUSSION AND CONCLUSION

5.1 Discussion

This investigation concentrated on the first wave of Avian Influenza (AI) outbreaks in Thailand. According to official reports this wave lasted from 23 January to 24 May 2004. Therefore, results of and conclusions drawn from the investigation only refer to this time period. Later AI outbreaks and subsequent improvements and implementations of control measures were not subject of current investigation.

The origins of avian influenza in Thailand are "uncertain" but what is globally known of the general biology of this infection is that a variety of risk factors are highly supportive for its spread in susceptible hosts. Domestic poultry form the basis for the entry and spread to other hosts, as well as shifting to highly pathogenic forms of influenza. The rapid spread of the first wave of Avian Influenza (AI) outbreaks in 42 provinces in Thailand within a 4-month period points to efficient dissemination pathways within and among poultry farms, for example movements of either infected live birds or poultry-associated materials. The risks involving live birds appear the likelihood sources of this spread for they have been elucidated in the past in many countries.

Therefore in this investigation, the approaches of on-location interviews with all actors (veterinarians, village chiefs, farmers of index (outbreak) and of farms surrounding the index farms within a control circle of radius 5 km, did prove valid. These interviews provided more detailed and diversified results than those contained in the administrative reports compiled by central authorities. These reports are compilations of e.g. provincial records, that neither contain nor are they complemented by "own active follow-up investigations in the fields" where the outbreaks occurred, and where the different actors in their different capacities each was asked by the law to respond according to the regulations contained in it. The law prescribes a combination of actions to be timely and sequentially implemented in the event of outbreaks. For example, farmer notification to officials (veterinary and chiefs), visitation by the veterinarian to the suspect farm and sampling, laboratory confirmation, quarantine, imposition of movement control and stamping-out, decontamination and re-population procedures. In a situation of an emergency of multiple outbreaks occurring within a short a time, like what happened during the first wave of AI outbreaks in Thailand, demands well coordinated management approaches of these actions/responses.

However, this investigation shows that reactions of actors in regards to these prescribed completeness and the timing of regulatory measures/actions against the AI outbreaks were at least more diverse if not contradicting than what can be read or concluded from the official administrative reports (see e.g. DLD: 'X-ray surveys' of October 2004 and July 2005). Omissions of essential details in the official reports not only do not permit a true picture of the events following the outbreaks, but also do blind disease control regulators on concentrating and improving on those control measures where shortcomings obviously and clearly did occur. Furthermore, it is worthy noting that over time modifications of implementing these management measures based on results of continuous "own" field investigations are necessary. For example, based on new understanding of the epidemiology and ecology of agents and hosts, potential reservoirs and disseminating pathways. This new information should come from well designed passive and active surveillance as well as monitoring investigations.

This study cannot claim statistical validity at all levels. While the study provinces were selected randomly, giving proportional weight to the geographic region in which the provinces are located, index and surrounding farms by nature of contact and access to them had to be selected conveniently. In each case, the final selection of farms though was done by the principal investigator and not by respective province veterinary officers, and partly the village chiefs, who as civil servants or auxiliaries, may have had a vested interest to only present the 'better' farms.

Further, additional to the potentially compromised 'delivery side' of province veterinarians and village chiefs, information also was collected from the 'receiving side', the owners of index and surrounding farms. Not being aware of all details before the interviews were conducted, it seems quite unlikely that the farmers were equally compromised concerning their answers.

The homogeneity of questionnaire responses also permits to draw valid inferences on the validity of events and times. Corroboration of the same events and their times by all actors strongly supports the general validity of the data.

Recall of dates and times was based on using the dates of notice and depopulation as points of orientation. This did permit to approximate dates prior to and later than these points of orientation as close as possible.

Lastly, robust techniques were used for data analysis. The 95% confidence interval of mean values and the range of values reported in each case add considerable weight to the interpretation of data.

Avian Influenza did hit Thailand not un-prepared but un-experienced. General control measures against contagious disease are contained in the Animal Epidemic Act of 1956. Veterinary regulatory personnel however had principally not familiar with epidemic disease control in poultry. Additionally, during the outbreak insufficient guidance and monitoring of the successes of control measures by central authorities was "not effectively" and continuously advanced, otherwise the follow-up waves of AI outbreaks could not have emerged. Containment of AI outbreaks consequently was carried out by largely inexperienced personnel, which was not adequately supported and monitored by central disease control authorities.

The strict centralisation of decision making, communication and monitoring at the Bangkok Headquarters, rather than the ability of the provinces or regions to immediately and responsibly act on their own, may have been the basic structural obstacle.

Results of the investigation identify and substantiate 3 major areas of deficits which did affect the efficiency and success of AI containment measures during the first outbreak wave from January to May 2004: 1) chronology of AI outbreaks, 2) central coordination and supervision of measures and, 3) control measures and production systems. Deficit areas 2) and 3) address organisational/technical details of AI control, deficit 1) is of political dimension and 4) Bio-security measures and Avian Influenza.

1) Chronology of AI outbreaks

The first official declaration date for AI outbreaks (OIE, 2004) was 23 January 2004 for outbreaks in three districts in one province, Suphanburi (DLD, 2004). However, widespread outbreaks may occurred much earlier than that date, as early as from November 2003, if not longer. Outbreaks did cover a large number, if not all, of the 42 provinces registered in the official reports as from 23 January and did affect a larger number of farms.

This finding is clearly substantiated by interview results. Close to 26 percent of all interviewees did recall suspicions of outbreaks of a epidemic disease in poultry in November and December 2003 and in January 2004 prior to the 23rd. 79% of the provincial veterinarians did report such suspicions. Moreover, such suspicions of earlier outbreaks were recalled by veterinarians of 84 percent of the 20 randomly selected study provinces, representing 48 percent of the 42 outbreak provinces in the outbreak wave as from 23 January 2005. These recalls of earlier outbreaks by official province veterinary officers for their province are in 81 percent by identical recalls of at least two other groups of actors, owners of surrounding farms, of index farms and village key men. It seems very unlikely that this density of identical recalls of earlier outbreaks is due to accident.

Provincial veterinary officers did report their suspicions of outbreaks as from November 2003 to central authorities. Why these reports were not responded to correctly remain unanswered. It seems unlikely that only technical factors were responsible. The good quality veterinary service was in a position to within 3 months clearly differentiate Avian Influenza from any other potential epidemic poultry disease, also logistic problems with diagnostic facilities and test equipment should not have been very likely. After all, first episodes of AI in the wider region range back to the 1997 events in Hong Kong and to 2003 in South Korea, countries since then were alerted to AI.

2) Central coordination and supervision of measures

All steps of the AI control chain were carried out in each outbreak case. However, in individual cases there were serious delays before a measure was carried out and completed. Time data in this investigation are reported by their mean values, the 95% confidence interval of the mean and by the range. Mean data are reported to underline the major average thrust of time used for a measure compared to targets (Table 4.7). Mean values though are strongly influenced by the distribution of data. In order to detect particular fast or slow action, the ranges of data (Figures 2 and 3, Tables 4.10 and 4.11) offer better insight. Thus, while individual AI control activities on farms, particularly index farms were carried out appreciating very fast (immediate veterinary visit after notification, sample taking even before visit, fast laboratory confirmations on samples, stamping out even before arrival of laboratory confirmation and immediate cleaning and disinfection after depopulation), the same measures in other cases were carried out with unduly delays.

Thus on index farms it took up to 7 days before a veterinarian visited the farm after notification, sample collection after the visit took up to 14 and laboratory confirmation 7 days and up to 5 and 7 days were used before farms were depopulated after laboratory confirmation and cleaned/disinfected after being depopulated respectively.

Times used for stamping out after confirmation and cleaning/disinfection on surrounding farms were even considerably longer.

Provincial veterinary officers in particular indicated that there were delays of longer than one week in laboratory confirmation, or official declaration, in about 58% of outbreaks, the shortest and longest time spent between suspicion to laboratory confirmation or official declaration of outbreaks were 2 and 73 days respectively. Within that, the average time spent between suspicions to declaration was long (30 days). Control of movement consequently could not be enforced until the authorities declared an outbreak situation. Without movement restriction being immediately enforced, it could have caused the spreading of the virus to other area.

Whether delays of control measures were due to unrealistic targets set or by failures of central authorities to closely monitor control success and immediately intervene in cases of non-compliance, can be argued.

Related to national targets, the time interval from reporting from the farm to the veterinary visit of index farms generally took was longer than prescribed, while less time was used from the veterinary visit to sample collection. Compared to other countries (Hong Kong, Belgium, Virginia and Pennsylvania in the US, commercial flocks in Canada) more time was used between sample collection and confirmation for depopulation.

Again, more time than prescribed by the national target was used from confirmation to depopulation but was shorter than laid down for Hong Kong and recommended by FAO.

Successful disease control essentially depends on strong monitoring capacity of the central disease control authority. Failures to detect the listed unduly delays in individual control measures point out that this monitoring capacity was deficient. Central authorities in several individual cases in particular failed to early detect delays and take or initiate respective immediate corrective actions.

3) Control measures and production systems

Between index and surrounding farms and between different production systems (broiler, layer, backyard) in them, control measures were carried out with different intensity and success.

Within index farms, measures were carried out faster in broiler than in layer and particularly in backyard chicken farms.

For index layer farms the longest period of 7 days was taken for a veterinary visit after report from the farm, it took up to 14 days before samples were collected after the visit and up to 7 days passed before infected layer farms were cleaned/disinfected after depopulation. From notice to depopulation it took up to 5 days for index backyard farms.

The same picture is illustrated for surrounding farms. While broiler farms were cleaned and disinfected after depopulation within 2 days, the same measure took up to 12 days in other farm types, a long 7 days were used for surrounding layer farms before they were depopulated.

More important though is that several backyard index farms did not depopulate completely. While all index farms carried out depopulation, four backyard index farms did not depopulate completely. On 18% of the surrounding farms, all being backyard farms, depopulation was not carried out at all, and on another 30% of the backyard farms depopulation was carried out only incompletely. Strict compliance to the official policy, destruction of all birds in the 5 kilometres radius from index farms, has to be taken as compliance criteria.

Concentration of AI control activities on closed broiler farms may seem pragmatic in terms of e.g. access to farms, availability of handling and labour resources, attention and support of owners, but is not prudent in terms of disease epidemiology. Remaining virus in less accessible farms with e.g. less cooperative owners undoubtedly poses the greatest threat of disease spread.

Difficulties in disease control arising out of non-compliance by farmers are explained by e.g. Breytenbach (2005). Lack of transparency and co-operation between national authorities and farmers and the high ratio of informal small-scale poultry farmers in a disease area are cited as major obstacles. Lack of co-operation from small-scale farmers though is understandable (FAO/OIE, 2005), because it is a rational decision of the individual farmer. Considering the number and well-being of small scale farmers prevailing in an AI area, avoidance to have their non-infected birds unnecessarily killed only to satisfy an 'international standard' in the country, is without question a understandable and rational reaction of individual farmers.

Public interest though supersedes individual interest. While acknowledging that problems always in all countries exist to carry out disease control measures completely, timely, consistently and decisively, such problems cannot be taken as an excuse for non-enforcement of measures. Ultimately, epidemic disease control is and remains the sole, exclusive responsibility of the mandated disease regulatory agency. Problems in implementing control measures do not relieve authorities from their responsibility to ensure enforcement of the measures.

4) Bio-security measures and Avian Influenza

All farm and poultry production types were affected by Avian Influenza outbreaks, including commercial layer and particularly broiler farms, which in contrast to backyard farms did record several bio-security measures in action. These farms were economically most affected, a relatively higher number of birds had to be depopulated during the AI outbreaks. Although several bio-security measures were obviously implemented on these farms, they could not avoid or evade the catastrophic epidemics.

The value of bio-security measures was demonstrated in this investigation. The risk of an AI outbreak on a farm was statistically significantly reduced if farms were cleaned between batches, secured against unauthorized persons and having washing facilities installed. Other measures did not show significant effect. Protection against birds and rodents, availability of footbath and use of protective clothing in this investigation did not exert a preventive effect against AI outbreaks.

It may be argued that several of these measures were not carried out thoroughly and consistently. Alternatively, the difficulties to totally secure individual farms within an environment of large numbers of respectively unsecured backyard farms are indicated. The difficulty or complexity to completely and ultimately eradicate AI is reported by, for example, Laddomada (2004) and FAO/OIE (2005). Considerations of implementing a system of compartments should be seen from this perspective.

5.2 Conclusion

On-location investigation with involvement by interviews of all major actors responsible or involved in AI disease control activities identified 4 major problem areas during the first outbreak burst in early 2004.

Control activities only started after AI already had spread over large areas and after an enormous number of farms were affected. The central authority failed to correct in time major delays in the execution of measures, particularly concerning depopulation and desinfection procedures. Also, non-compliance in many actions taken, particularly by backyard farmers, was not responded to adequately and decisively by the authorities. Bio-security measures in the commercial broiler system did not prevent outbreaks.

The authorities in-charge of prescribing and dispensing management of AI control measures in Thailand need to review the matrix of responses and their associated time-schedules if AI outbreaks are to be finally contained and AI as disease possibly eradicated. Total transparency, the implementation of a contingency and exercises of that contingency plan as part of an effective emergency response system are key elements of that approach.

It would be beneficial for the Thailand authorities to review the levels of responses especially of early detection, quarantine, stamping out and movement restriction by active monitoring, to control cross-border marketing and to decentralise actions so as to halt any further spread of AI. Active surveillance and monitoring as well as mapping out (use of GIS) of various AI zones might enhance the rapid eradication of AI within the country. In order to re-gain the confidence of the consumers, locally and internationally, and of farmers and trading partners these reforms require quick actions.

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APPENDICES

Appendix A: Questionnaire

QUESTIONNAIRE FOR SURVEY OF POULTRY MANAGEMENT PRACTICES DURING AI OUTBREAK(S)

Date-------Interviewer --------Interviewee ---------Province ---------District ----------

Nature of enterprise

1. ☐ Chicken ☐ Duck ☐ Bird ☐ Others
2. ☐ Layer, numbers--------------- ☐ Broiler, numbers------------------
   ☐ Mix, numbers----------------- ☐ Others, numbers------------------

Sheds	**Yes**	**No**
Secured against entry of all birds	☐	☐
Secured against entry of all rodents	☐	☐
Secured against entry of all feral and domestic animals	☐	☐
Sheds are thoroughly cleaned and disinfected between each batch	☐	☐
Secured against entry of all unauthorized personnel	☐	☐
Hygiene Practices		
Washing facilities available	☐	☐
Protective clothing (e.g., overalls/coats, boots) available for farm personnel	☐	☐
Footbaths used for entry into the farm	☐	☐

During AI outbreak

Number of birds involved---

Suspicion date---

Date diagnosis confirmed--

Dead birds are disposed off by:

Yes	**No**	
☐	☐	Burning---
☐	☐	Composting-------------------------------------
☐	☐	Contract pick-up---------------------------------
☐	☐	Other (specify)-----------------------------------

Feed supply: Types------------------Source(s)------------------Means of Transportation----------------------

Movement control of Poultry and poultry products (Veterinary authorities/DLD, Others)

Applicant to move poultry and poultry products---------------------------------

Name(s) of Authority granting permission---

Key bodies involved--

Assessment of health status of the farm birds/products to be moved: Time, Procedure

Conditions at the destination

☐ No ☐ Yes ---

Approaches to re-stocking the farm

☐ No ☐ Yes ---

Requirements for moving fighting cocks

☐ No ☐ Yes ---

Requirements for moving poultry products or carcass

☐ No ☐ Yes ---

Requirements for moving hatching eggs

☐ No ☐ Yes ---

Requirements for moving table eggs

☐ No ☐ Yes ---

Requirements for moving broilers to slaughterhouse for export

☐ No ☐ Yes ---

Practices of raising ducks in rice paddies
During normal situations
☐ No ☐ Yes --
During AI outbreaks
☐ No ☐ Yes --
Criteria for poultry restocking
Sources of birds
☐ No ☐ Yes --
Advise to farmers and Authorization to restock
☐ No ☐ Yes --
Calculation of days for restocking: Requirements
1. ----------------Days for ------------------------------------- -----------------------------------
2. ----------------Days for ------------------------------------- -----------------------------------

Steps implemented during AI outbreak - Farmers

Yes	No	
☐	☐	1. --
		▼…….. hours / days
☐	☐	2. --
		▼ ……hours / days
☐	☐	3. --
		▼…….. hours / days
☐	☐	4. --
		▼ ……hours / days
☐	☐	5. --
		▼…….. hours / days
☐	☐	6. --
		▼…….. hours / days
☐	☐	7. --
		▼…….. hours / days
☐	☐	8. --

Steps implemented during AI outbreak - Authorities

Yes	No	
☐	☐	1. --
		▼…….. hours / days
☐	☐	2. --
		▼ ……hours / days
☐	☐	3. --
		▼…….. hours / days
☐	☐	4. --
		▼ ……hours / days
☐	☐	5. --
		▼…….. hours / days
☐	☐	6. --
		▼…….. hours / days
☐	☐	7. --
		▼…….. hours / days
☐	☐	8. --

Passive surveillance
☐ No ☐ Yes --
Active surveillance
☐ No ☐ Yes --
Other important bodies involved (e.g., OIE, FAO, WHO)
☐ No ☐ Yes --
General public reaction
Comments:--- ---
Other important information ------------------------------------ -----------------------------

Appendix B: Number of Thai chicken and chicken farmers in 2003 (from first outbreak provinces)

Province	Layer chicken		Broiler chicken		Native chicken	
	No Poultry	No Farmers	No Poultry	No Farmers	No Poultry	No Farmers
Bangkok	160.527	238	12.020.148	367	124.310	2.994
Chainat	38.201	532	1.249.870	174	1.154.430	16.415
Ayudthaya	860.932	454	2.524.275	758	721.588	7.456
Lopburi	75.367	318	16.262.012	667	447.748	9.311
Singhburi	25.570	187	767.200	74	173.182	3.251
Angthong	729.843	718	728.456	520	461.810	11.244
Suphanbubri	1.629.891	1.061	4.212.470	916	2.373.734	18.800
Chonburi	2.210.025	261	25.733.905	1.298	465.379	9.352
Nakornnayok	1.034.301	256	3.063.252	504	346.656	10.926
Prachinburi	301.203	246	9.360.394	739	808.708	19.703
Samutprakarn	6.100	141	19.400	80	215.312	4.770
Chaiyaphum	141.406	415	4.486.888	994	1.399.382	57.171
Nakornrachasima	1.133.824	1.415	9.302.340	3.374	3.512.915	111.573
Roi-et	225.366	2.619	395.847	3.091	1.759.177	92.609
Sisaket	203.003	198	853.128	1.135	2.148.892	98.016
Surin	15.735	249	184.590	2.359	1.665.586	106.835
Kalasin	8.767	241	71.179	541	934.367	48.838
Khonkaen	664.612	298	1.173.789	2.625	1.455.000	80.671
Nakornpanom	291.168	1.222	152.978	493	847.790	34.056
Mahasarakarm	5.000	1	533.000	54	1.464.188	70.173
Sakolnakorn	26.508	55	246.420	229	936.348	42.172
Nongkai	225.680	117	174.000	27	602.316	17.786
Udornthani	133.698	1.098	263.998	2.069	1.751.201	54.458
Chiangrai	234.765	512	381.111	534	2.015.189	51.643
Chiangmai	786.743	419	959.955	794	2.025.720	93.749
Nan	2.142	185	16.725	163	409.214	19.346
Maehongsorn	18.750	14	-	-	242.265	13.393
Lampang	264.812	352	726.630	257	1.263.860	45.249
Lampoon	65.405	127	196.394	300	723.698	20.713
Kampangpetch	33.809	163	351.017	211	967.949	13.517
Tak	12.527	339	168.968	216	485.373	36.815
Pichit	36.014	532	975.190	284	1.819.226	35.417
Pitsanulok	58.264	198	675.394	283	803.516	18.475
Petchaboon	74.397	232	2.062.637	483	1.326.549	20.753
Sukhothai	42.022	334	94.882	435	980.448	44.746
Uttaradit	269.317	106	448.728	87	872.728	22.510
Uthaithani	14.446	286	683.141	139	595.741	7.095
Kanjanaburi	172.465	174	4.077.911	354	422.293	16.335
Nakornpathom	1.898.612	483	2.925.267	656	390.400	4.797
Petchaburi	199.689	145	1.363.053	300	727.320	11.375
Ratchaburi	233.236	238	3.592.366	417	660.613	10.730
Samutsakorn	43.265	41	143.217	137	53.869	609
Pang nga	97.317	223	537.362	102	224.750	8.695
Total of the country	24.312.523	36.476	165.314.786	45.777	63.091.574	2.136.664

Source: Provincial Livestock Office, Information and Statistics Group, Information Technology Center, Department of Livestock Development Tel. 0-2653-4925

Appendix C: Chronology of AI-outbreaks in Thailand (OIE reports)

Report period	Location	No. outbreaks	Susceptible	cases	deaths	destroyed
19.01-23.01.04	Banlam Sub-District, Bandplamah District, Supanburi Province	1 farm	66,350	8,750	6,180	60,170
23.01-30.01	32 provinces	6800 farms	10,712,615			16,195,137
30.01-06.02	8 provinces					26,427,548*
06.02-13.02						706,895.
20.02-29.02						8,230
29.02-05.03						
05.03-12.03	1 province	1				22,001
12.03-19.03	4 provinces	4				29,405
19.03-02.04						
02.04-09.04	2 provinces	2				11,326
09.04-16.04						
16.04-23.04	3 provinces	3				31,473
23.04-14.05						
14.05-25.05	1 province	1 farm				1,575
25.05 -1.06						
11.06-07.07	2 provinces	2				25,230
07.07-13.07	14 provinces	26				32,846
13.07-22.07	16 provinces	45				56,110
22.07	12 provinces	18				8,058
22.07-05.08	8 provinces	11				2,220
05.08-03.09	20 provinces	61				39,412
03.09-17.09	19 provinces	28				39,049
17.09-24.09	13 provinces	21				18,432
24.09-01.10	21 provinces	46				24,993
01.10-08.10	17 provinces	37				81,669
08.10-15.10	17 provinces	54				158,626
15.10-22.10	30 provinces	167				20,442

Source: Thailand reports on AI to OIE (http://www.oie.int/downld/AVIAN%20INFLUENZA/A_AI-Asia.htm)

Remarks: * Number of birds destroyed from 23 January 2004 to 5 February 2004)

Appendix D: Chronology of Reported HPAI cases

Weekly report	Case no.	Report_D	Collect_D	Province	District	Species
E	1	23.01.2004	21.01.2004	Suphanburi	Bang Pla Ma	Layer
	2	23.01.2004	21.01.2004	Suphanburi	Bang Pla Ma	Layer
	3	23.01.2004	20.01.2004	Suphanburi	Song Phinong	Broiler
	4	24.01.2004	22.01.2004	Kanchanaburi	Phanom Thuan	Layer
	5	24.01.2004	21.01.2004	Kanchanaburi	Phanom Thuan	Quail
1	6	24.01.2004	22.01.2004	Kanchanaburi	NongPrue	Broiler
2	7	26.01.2004	24.01.2004	Kampaengphet	Khlong Lan	Native Chicken
2	8	26.01.2004	23.01.2004	Kampaengphet	Sai Nham	Native Chicken
2	9	26.01.2004	24.01.2004	Kampaengphet	Muang Kampaengphet	Native Chicken
2	10	26.01.2004	24.01.2004	Kampaengphet	Muang Kampaengphet	Native Chicken
2	11	26.01.2004	24.01.2004	Kampaengphet	Muang Kampaengphet	Native Chicken
2	12	26.01.2004	24.01.2004	Kampaengphet	Muang Kampaengphet	Native Chicken
2	13	26.01.2004	24.01.2004	Kampaengphet	Lan Krabu	Native Chicken
2	14	26.01.2004	24.01.2004	Kampaengphet	Lan Krabu	Native Chicken
2	15	26.01.2004	24.01.2004	Kampaengphet	Lan Krabu	Native Chicken
2	16	26.01.2004	24.01.2004	Chainat	Manorom	Layer
2	17	26.01.2004	24.01.2004	Chainat	Manorom	Duck
2	18	26.01.2004	23.01.2004	Chainat	Hankha	Native Chicken
2	19	26.01.2004	23.01.2004	Chainat	Hankha	Native Chicken
2	20	26.01.2004	24.01.2004	Phichit	Pho Prathapchang	Native Chicken
2	21	26.01.2004	24.01.2004	Phichit	Pho Prathapchang	Native Chicken
2	22	26.01.2004	24.01.2004	Phichit	Pho Prathapchang	Native Chicken
2	23	26.01.2004	23.01.2004	Phichit	Wachirabaramee	Duck
2	24	26.01.2004	23.01.2004	Phitsanulok	Chat Trakan	Native Chicken
2	25	26.01.2004	24.01.2004	Phitsanulok	Wat Bot	Native Chicken
2	26	26.01.2004	25.01.2004	Phitsanulok	Bang Rakam	Native Chicken
2	27	26.01.2004	25.01.2004	Phitsanulok	Bang Rakam	Native Chicken
2	28	26.01.2004	24.01.2004	Phitsanulok	Phrom Phiram	Native Chicken
2	29	26.01.2004	23.01.2004	Phitsanulok	Phrom Phiram	Duck
2	30	26.01.2004	23.01.2004	Phitsanulok	Nuang Phitsanulok	Native Chicken
2	31	26.01.2004	23.01.2004	Phitsanulok	Nuang Phitsanulok	Native Chicken
2	32	26.01.2004	23.01.2004	Phitsanulok	Nuang Phitsanulok	Layer
2	33	26.01.2004	24.01.2004	Phitsanulok	Nuang Phitsanulok	Native Chicken
2	34	26.01.2004	23.01.2004	Phitsanulok	Nuang Phitsanulok	Native Chicken
2	35	26.01.2004	23.01.2004	Phitsanulok	Nuang Phitsanulok	Native Chicken
2	36	26.01.2004	23.01.2004	Phitsanulok	Nuang Phitsanulok	Native Chicken
2	37	26.01.2004	23.01.2004	Phitsanulok	Nuang Phitsanulok	Native Chicken
2	38	26.01.2004	23.01.2004	Phitsanulok	Nuang Phitsanulok	Goose
2	39	26.01.2004	23.01.2004	Phitsanulok	Nuang Phitsanulok	Native Chicken
2	40	26.01.2004	24.01.2004	Singburi	Khai Bang Rachan	Native Chicken
2	41	26.01.2004	23.01.2004	Singburi	Tha Chang	Native Chicken
2	42	26.01.2004	23.01.2004	Singburi	Tha Chang	Native Chicken
2	43	26.01.2004	24.01.2004	Singburi	Bang Rachan	Native Chicken
2	44	26.01.2004	23.01.2004	Singburi	Bang Rachan	Native Chicken
2	45	26.01.2004	23.01.2004	Singburi	Bang Rachan	Native Chicken
2	46	26.01.2004	24.01.2004	Singburi	Bang Rachan	Native Chicken
2	47	26.01.2004	24.01.2004	Singburi	Inburi	Native Chicken
2	48	26.01.2004	24.01.2004	Singburi	Inburi	Native Chicken

Weekly report	Case no	Report_D	Collect_D	Province	District	Species
2	49	26.01.2004	23.01.2004	Sukhothai	Si Samrong	Native Chicken
2	50	26.01.2004	23.01.2004	Sukhothai	Si Samrong	Native Chicken
2	51	26.01.2004	23.01.2004	Sukhothai	Si Samrong	Native Chicken
2	52	26.01.2004	24.01.2004	Sukhothai	Si Samrong	Native Chicken
2	53	26.01.2004	24.01.2004	Sukhothai	Si Samrong	Native Chicken
2	54	26.01.2004	23.01.2004	Sukhothai	Si Samrong	Native Chicken
2	55	26.01.2004	23.01.2004	Sukhothai	Si Samrong	Native Chicken
2	56	26.01.2004	24.01.2004	Uttaradit	Tron	Layer
2	57	26.01.2004	24.01.2004	Uttaradit	Phi Chai	Quail
2	58	26.01.2004	23.01.2004	Uttaradit	Phi Chai	Native Chicken
2	59	26.01.2004	23.01.2004	Uttaradit	Phi Chai	Native Chicken
2	60	26.01.2004	23.01.2004	Uttaradit	Phi Chai	Native Chicken
2	61	26.01.2004	23.01.2004	Uthaithani	Muang Uthai Thani	Native Chicken
2	62	26.01.2004	23.01.2004	Uthaithani	Muang Uthai Thani	Native Chicken
2	63	26.01.2004	23.01.2004	Uthaithani	Muang Uthai Thani	Broiler
2	64	26.01.2004	23.01.2004	Uthaithani	Nong Chang	Native Chicken
2	65	26.01.2004	23.01.2004	Uthaithani	Nong Chang	Broiler
2	66	26.01.2004	23.01.2004	Ratchaburi	BangKa	Broiler
2	67	26.01.2004	23.01.2004	Ratchaburi	BangKa	Broiler
2	68	26.01.2004	23.01.2004	Ratchaburi	Photharam	Broiler
2	69	26.01.2004	23.01.2004	Nakhonpathom	Muang Nakhonpathom	Broiler
2	70	26.01.2004	24.01.2004	Nakhonpathom	Muang Nakhonpathom	Broiler
2	71	26.01.2004	23.01.2004	Angthong	Pa Mok	Quail
2	72	26.01.2004	23.01.2004	Angthong	Pa Mok	Quail
2	73	28.01.2004	26.01.2004	Bangkok	Chatuchak	Native Chicken
2	74	28.01.2004	26.01.2004	Bangkok	Chatuchak	Native Chicken
2	75	28.01.2004	26.01.2004	Bangkok	Chatuchak	Duck
2	76	28.01.2004	25.01.2004	Bangkok	Bungkum	Native Chicken
2	77	28.01.2004	26.01.2004	Kalasin	Muang Kalasin	Native Chicken
2	78	28.01.2004	25.01.2004	Kalasin	Muang Kalasin	Native Chicken
2	79	28.01.2004	26.01.2004	Kalasin	Muang Kalasin	Goose
2	80	28.01.2004	26.01.2004	Kalasin	Muang Kalasin	Native Chicken
2	81	28.01.2004	26.01.2004	Khonkaen	Muang Khonkaen	Native Chicken
2	82	28.01.2004	26.01.2004	Khonkaen	Muang Khonkaen	Native Chicken
2	83	28.01.2004	26.01.2004	Khonkaen	Muang Khonkaen	Turkey
2	84	28.01.2004	26.01.2004	Khonkaen	Muang Khonkaen	Native Chicken
2	85	28.01.2004	25.01.2004	Khonkaen	Muang Khonkaen	Native Chicken
2	86	28.01.2004	25.01.2004	Khonkaen	Muang Khonkaen	Native Chicken
2	87	28.01.2004	26.01.2004	Khonkaen	Muang Khonkaen	Turkey
2	88	28.01.2004	25.01.2004	Khonkaen	Muang Khonkaen	Duck
2	89	28.01.2004	25.01.2004	Lampang	Muang Lampang	Broiler
2	90	28.01.2004	25.01.2004	Lamphun	Pa Sang/Viang Nonglong	Broiler
2	91	28.01.2004	26.01.2004	Sakonnakhon	Akat Amnuai	Quail
2	92	28.01.2004	25.01.2004	Nongkhai	BungKlah	Native Chicken
2	93	28.01.2004	26.01.2004	Nongkhai	Si Chiang Mai	Layer, Duck
2	94	28.01.2004	25.01.2004	Nongkhai	Muang Nongkhai	Layer
2	95	28.01.2004	26.01.2004	Nongkhai	ThaBoh	Native Chicken

Weekly report	Case no	Report_D	Collect_D	Province	District	Species
2	96	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	97	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	98	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	99	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	100	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	101	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	102	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	103	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	104	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	105	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	106	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	107	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	108	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	109	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	110	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	111	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Native Chicken
2	112	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Layer
2	113	28.01.2004	25.01.2004	Samutprakan	Bang Phli	Layer
2	114	28.01.2004	25.01.2004	Samutprakan	Phra Pradaeng	Native Chicken
2	115	28.01.2004	25.01.2004	Samutprakan	Phra Pradaeng	Native Chicken
2	116	28.01.2004	25.01.2004	Samutsakhon	Muang Samutsakhon	Duck
2	117	28.01.2004	24.01.2004	Chaiyaphum	Kaset Sombun	Broiler
2	118	28.01.2004	24.01.2004	Chaiyaphum	Ban Khwao	Native Chicken
2	119	28.01.2004	25.01.2004	Chaiyaphum	Muang Chaiyaphum	Native Chicken
2	120	28.01.2004	24.01.2004	Chaiyaphum	Muang Chaiyaphum	Native Chicken
2	121	28.01.2004	24.01.2004	Petchabun	Muang Petchabun	Native Chicken
2	122	28.01.2004	25.01.2004	Nakhonnayok	Ongkharak	Native Chicken
2	123	28.01.2004	25.01.2004	Nakhonnayok	Ongkharak	Native Chicken
2	124	28.01.2004	26.01.2004	Nakhonnayok	Ongkharak	Native Chicken
2	125	28.01.2004	25.01.2004	Nakhonnayok	Ongkharak	Native Chicken
2	126	28.01.2004	26.01.2004	Nakhonnayok	Ongkharak	Native Chicken
2	127	28.01.2004	25.01.2004	Nakhonnayok	Ongkharak	Native Chicken
2	128	28.01.2004	25.01.2004	Nakhonnayok	Ongkharak	Native Chicken
2	129	28.01.2004	26.01.2004	Nakhonnayok	Ongkharak	Native Chicken
2	130	28.01.2004	26.01.2004	Nakhonnayok	Ongkharak	Native Chicken
2	131	29.01.2004	26.01.2004	Chiangrai	Muang Chiangrai	Quail
2	132	29.01.2004	25.01.2004	Chiangmai	San Khamphang	Quail
2	133	29.01.2004	26.01.2004	Chiangmai	San Khamphang	Broiler
2	134	29.01.2004	26.01.2004	Chiangmai	Saraphi	Duck
2	135	29.01.2004	25.01.2004	Chiangmai	Saraphi	Quail
2	136	29.01.2004	25.01.2004	Chiangmai	Saraphi	Goose
2	137	29.01.2004	26.01.2004	Chiangmai	Hang Dong	Quail
2	138	29.01.2004	26.01.2004	Chiangmai	Jomthong	Broiler
2	139	29.01.2004	26.01.2004	Nan	Chaleamprakiet	Native Chicken
2	140	29.01.2004	26.01.2004	Nan	Chaleamprakiet	Native Chicken
2	141	29.01.2004	26.01.2004	Nan	Chiang Klang	Native Chicken
2	142	29.01.2004	26.01.2004	Nan	Chiang Klang	Native Chicken
2	143	29.01.2004	26.01.2004	Nan	BoKluea	Native Chicken
2	144	29.01.2004	26.01.2004	Nan	Pua	Native Chicken
2	145	29.01.2004	26.01.2004	Nan	Pua	Native Chicken
2	146	29.01.2004	26.01.2004	Nan	Mae Charim	Native Chicken

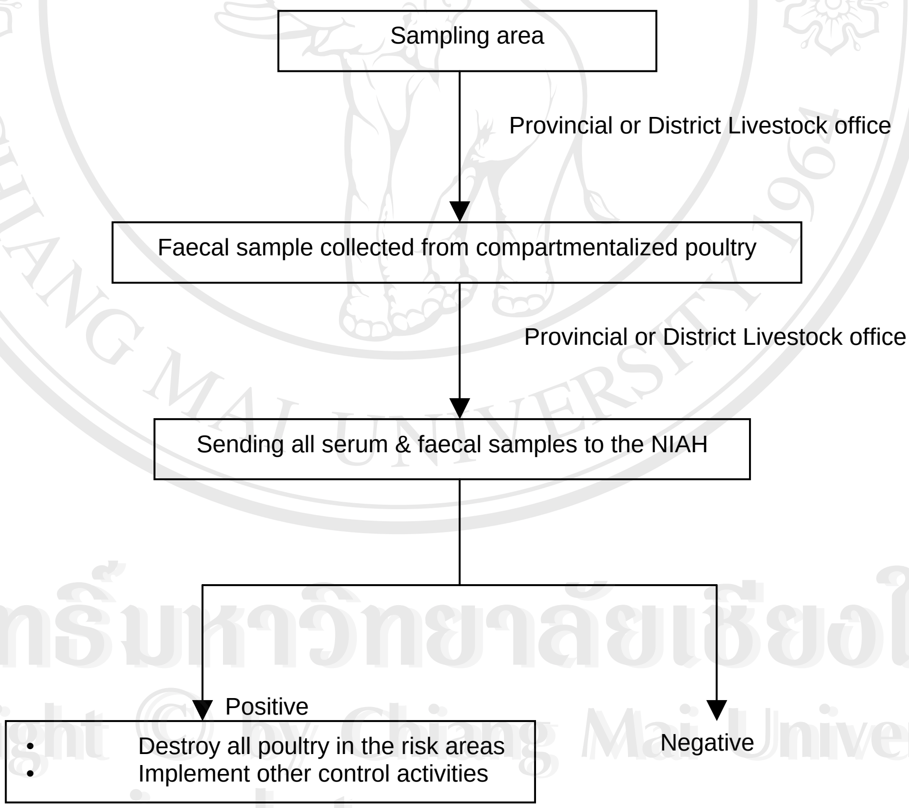
Weekly report	Case no.	Report_D	Collect_D	Province	District	Species
2	147	29.01.2004	27.01.2004	Prachinburi	Ban Srang	Layer
2	148	29.01.2004	27.01.2004	Prachinburi	Ban Srang	Broiler
2	149	29.01.2004	27.01.2004	Surin	Muang Surin	Duck
2	150	29.01.2004	26.01.2004	Surin	Muang Surin	Turkey, Peacock
2	151	29.01.2004	26.01.2004	Sisaket	Muang Sisaket	Native Chicken, Peacock
2	152	29.01.2004	27.01.2004	Pungnga	Takua Pa	Layer, Duck
2	153	30.01.2004	28.01.2004	Maehongsorn	Mae Sariang	Broiler
2	154	30.01.2004	26.01.2004	Tak	Um Phang	Native Chicken
2	155	30.01.2004	28.01.2004	Mahasarakham	Nuang Mahasarakham	Broiler
3	156	30.01.2004	28.01.2004	Udonthani	Non Sa-at	Native Chicken
3	157	02.02.2004	31.01.2004	Phetchaburi	Tha Yang	Native Chicken
3	158	02.02.2004	31.01.2004	Phetchaburi	Ban Laem	Broiler
3	159	04.02.2004	02.02.2004	Chonburi	Sattahip	Native Chicken
3	160	04.02.2004	02.02.2004	Lopburi	Ban Mi	Broiler
3	161	04.02.2004	01.02.2004	Nakornrajasrima	Pratai	Native Chicken
5	162	13.02.2004	09.02.2004	Chonburi	Ban Bung	Duck, Native chicken
5	163	18.02.2004	13.02.2004	Chonburi	Bo Thong	Layer
5	164	13.02.2004	09.02.2004	Chonburi	Panus Nikom	Native Chicken
5	165	19.02.2004	17.02.2004	Khonkaen	Muang Khonkaen	Layer
5	166	16.02.2004	11.02.2004	Uthaithani	BanRai	Broiler
5	167	16.02.2004	11.02.2004	Phetchaburi	Cha Um	Broiler
5	168	16.02.2004	11.02.2004	Nakornpathom	Muang NakhonPaThom	Duck, Native chicken
5	169	16.02.2004	11.02.2004	Kanchanaburi	Hui Krajau	Duck
5	170	16.02.2004	11.02.2004	Kanchanaburi	NongPrue	Layer
5	171	14.02.2004	11.02.2004	Chaiyaphum	Kaset Sombun	Native Chicken
5	172	14.02.2004	12.02.2004	Chaiyaphum	Ban Kaue	Native Chicken
5	173	14.02.2004	12.02.2004	RoiEt	KasetVisai	-
5	174	15.02.2004	13.02.2004	Sukhothai	SriSamRong	Native Chicken
5	175	15.02.2004	13.02.2004	Uttaradit	Tron	Layer
5	176	13.02.2004	09.02.2004	Pangnga	Takua Pa	-
5	177	13.02.2004	09.02.2004	Pangnga	Takua Pa	-
5	178	13.02.2004	09.02.2004	Pangnga	Kapong	-
5	179	13.02.2004	09.02.2004	Pangnga	Tab Pud	-
7	180	01.03.2004	29.02.2004	Chiangrai	Muang Chiangrai	Layer
9	181	13.03.2004	12.03.2004	Uttaradit	Muang Uttaradit	Layer
9	182	13.03.2004	12.03.2004	Chiangmai	San Sai	Layer
9	183	15.03.2004	14.03.2004	Chonburi	Panus Nikom	Layer
9	184	15.03.2004	14.03.2004	Ayutthaya	Bang Pa-in	Layer
12	185	06.04.2004	06.04.2004	Chonburi	Pan Thong	Layer
12	186	08.04.2004	08.04.2004	Khonkaen	Muang Khonkaen	Layer
14	187	19.04.2004	19.04.2004	Uttaradit	Thong Sankhan	Layer, Goose
14	188	21.04.2004	21.04.2004	Petchabun	Nong Pai	Broiler
14	189	21.04.2004	21.04.2004	Petchabun	Nong Pai	Broiler
E	190	24.05.2004	22.04.2004	Chiangmai	Muang	Layer, Broiler, Native Chicken, Duck, Ostrich

Source: Department of Livestock Development, Ministry of Agriculture and Cooperatives Thailand (2004): Preliminary report on Highly Pathogenic Avian Influenza outbreak in Thailand 2004.

Appendix E: Number of AI cases by species

Species	Number of cases	
Broiler	23	11.9%
Duck	13	6.7%
Goose	1	0.5%
Layer	24	12.4%
Native chicken	113	58.5%
Peacock	2	1.0%
Quail	9	4.7%
Turkey	3	1.6%
(not reported)	5	2.6%

Source: Department of Livestock Development Ministry of Agriculture and Cooperatives Thailand (2004): Preliminary report on Highly Pathogenic Influenza outbreak in Thailand 2004.



Appendix F: Flowchart of sampling and submission of samples for the national surveillance of poultry diseases (ND, AI etc.)

Appendix G: Contingency Plan

(*Bureau of Disease Control and Veterinary Services,* Department of Livestock Development Ministry of Agriculture and Cooperatives, Thailand: 31 January 2004)

Phase I: During the outbreak

Policy and strategies

Highly pathogenic avian influenza (HPAI) is a disease in "List A" of Office of International Epizooties (OIE) because of its highly pathogenic nature and destructive impact on trade. The policy set by the Department of Livestock Development, Ministry of Agriculture and Cooperatives is eradication of the disease as fast as possible to minimize potential damages. HPAI is enlisted in the highly contagious diseases under the Animal Epidemic Act B.E. 2449 (A.C. 1956) and its reversion in B.E. 2542 (A.C.1999), which allows strategic actions of stamping-out, quarantine, movement control, compensation and other necessary measures possible.

Case definition

These criteria are established in order for early detection of the disease. Target animals include chicken, duck, quail and other avian species presented with the following clinical signs.

1. Severe respiratory signs with excessively watery eyes and sinusitis, cyanosis of the combs, wattle and shanks, edema of the head, ruffled feathers

2. Diarrhea and nervous signs

3. No noticeable signs but sudden death of almost 100%, or cumulative death approximately 40% within 3 days

If one of the above criteria is observed, the disease control measures must be executed immediately.

The operation

- Pre-emptive stamping-out If suspected case is identified, that premise will be quarantined. Samples will be collected and analyzed for avian influenza and other possible pathogens. If HPAI is confirmed, that particular premise will be depopulated and disinfected. All premises within 5-kilometer radius from the index farm will be depopulated and disinfected.

- Surveillance during the outbreak The area within 50 kilometers from infected farm is on intensive surveillance. Cloacal swabs will be collected and analyzed for the virus. If the virus is detected that infected farm will be depopulated and disinfected. Other premises in this zone (50 km. radius) are on quarantine.

- Movement control Movement of avian species and their products from the area within 60-kilometer radius from infected farms are prohibited. Checkpoints will be set up by the DLD to enforce the regulations.

- Public awareness campaign Information, recommendations and guidelines will be distributed to private sector, risk groups and general public to raise awareness and good understanding of the community.

Phase II: Post-outbreak

Principle and strategy

Repopulation of affected areas will be considered if no new case or death is detected 21 days after destruction of the last affected premise. If repopulation is allowed surveillance will be carried out for 5 months to confirm freedom from disease.

Post-outbreak surveillance

Surveillance in the areas other than control zone (50 km. radius) includes testing of the flocks that show any clinical signs fit in the case definition. Virological and/or serological investigations will be conducted.

For control zone, sample collection for virological assays will be carried out in flocks at 30 days after repopulation, before selling and/or at 5 months to establish a 95% confidence of detecting infection in the flocks at less than 5%. Examination for AI includes twice weekly clinical examinations for 30 days then every two-week for 5 months, identification of virus or other pathogen will be performed on dead birds. Positive flock, if any, will be depopulated and disinfected. Necessary measures will be undertaken immediately to control the disease.

Post-outbreak surveillance entitled “Sanitary chicken project” is attached as appendix H.

Phase III: Long term surveillance and monitoring

Principle and strategy

Highly pathogenic avian influenza (HPAI) had never been reported in Thailand until January 2004. Although, active and passive surveillance have been conducted since 1997 HPAI outbreak was unexpectedly occurred and spread widely. Stamping-out strategy was executed however carrier birds or migratory birds cannot be completely destroyed. For these reasons epidemiological information is very crucial in order for early detection of the disease. This objective can only be achieved by strengthening of surveillance.

National surveillance plan for avian influenza

National surveillance plan for AI is a long tern project which composed of active and passive surveillance. Budget will be granted by the Government annually.

Appendix H: The sanitary Chicken Project

(*Bureau of Disease Control and Veterinary Services,* Department of Livestock Development Ministry of Agriculture and Cooperatives, Thailand: 30 January 2004)

The objective

The objective of this project is to monitor poultry health nationwide by means of an active surveillance by collecting samples and testing in the laboratory. The areas of operation will be divided into two zones, which are Control zone and Surveillance zone.

1. Control zone

Definition of Control zone: The area within 50 kilometres radius from HPAI infected farms

1.1 Breeding stock farms, broiler farms, layer farms and all other bird farms that has the characteristic of a farm

Guideline for sample collection

- Six cloacal swab tubes will be randomly collected from each farm. (one cloacal swab tube is a pooled sample collected from 5 animals which would mean the six swab tubes will come from 30 animals)
- Broiler farms for export, duck farm for exports, breeding stock and broiler farms should have the sample collected and send to private laboratory under the control of the Department of Livestock development. However if there are no laboratories available, send the sample to National Institute of Animal Health.
- Layer farms and farms that are not under the management of a company, personnel from the Department of Livestock development will be responsible for collecting the samples.

1.2 Native chicken and all possible carrier birds

Guideline for sample collection

- Collect samples from every village in the area
- Personnel from the Department of Livestock Development will collect one cloacal swab tube per one village (One cloacal swab sample is a pooled sample which means one tube will come from five birds)

2. Surveillance zone

Definition of Surveillance zone: Areas that are not included in the Control zone

2.1 Breeding stock farms, broiler farms, layer farms and all other bird farms that has the characteristic of a farm

Guideline for sample collection

- Twelve cloacal swab tubes will be randomly collected from each farm.(one cloacal swab tube is a pooled sample collected from 5 animals which would mean the twelve swab tubes will come from 60 animals)
- Broiler farms for export, duck farm for exports, breeding stock and broiler farms should have the sample collected and send to private laboratory under the control of the Department of Livestock development. However if there are no laboratories available, send the sample to National Institute of Animal Health.
- Layer farms and farms that are not under the management of a company, personnel from the Department of Livestock Development will be responsible for collecting the samples.

2.2 Native chicken and all birds that carry the disease

Guideline for sample collection: collect one tube for each village and sixty village for each province by calculating the ratio of the size and location each village to get a sample that best represent the province.

Example Province Number 1 has 4 districts, district A has 100 villages, district B has 400 villages, district C has 300 villages and district D has 200 villages. So, the sampling would be 6 from village A, 24 from village B, 18 from village C and 12 from village D.

- The personnel from the Department of Livestock development will collect the cloacal swab using one tube per one village. (One cloacal swab tube sample is a pooled sample, which means one tube will come from five birds)

3. Sending the sample to the laboratory

3.1 Send the sample in a container at 4oC and fill in the information as in the Newcastle disease project according to the area as follows

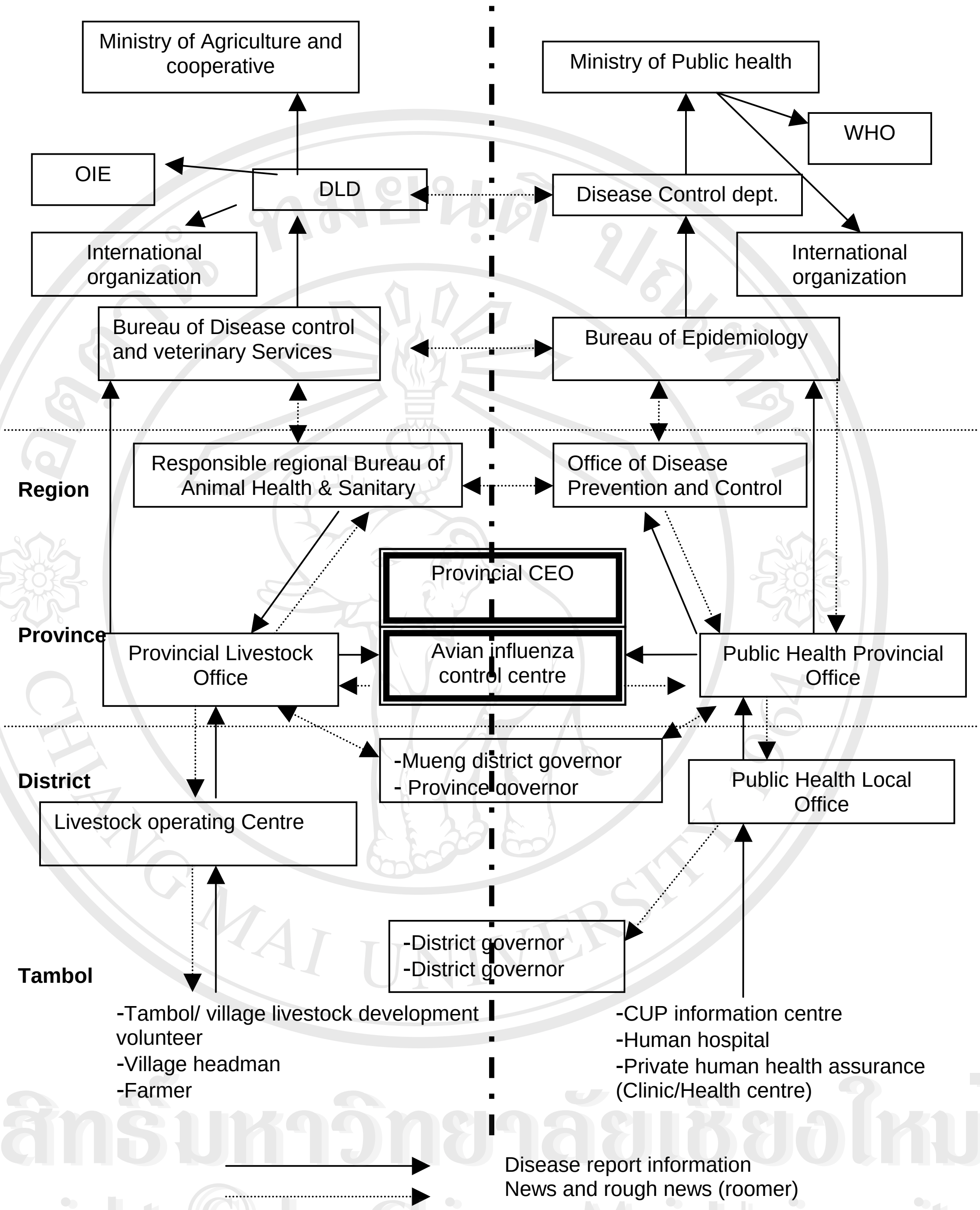
- Broiler farms for export and companies without laboratory can send sample to National Institute of Animal Health.
- Provinces in the area of Regional Bureau Animal Health and Sanitary 1 send sample to National Institute of Animal Health
- Provinces in the area of Regional Bureau Animal Health and Sanitary 2 send sample to Eastern Veterinary Research and Development Center Chonburi province
- Provinces in the area of Regional Bureau Animal Health and Sanitary 3 send sample to Upper Northeastern Veterinary Research and Development Center KhornKaen province
- Provinces in the area of Regional Bureau Animal Health and Sanitary 4 send sample to Lower Northeastern Veterinary Research and Development Center Surin province
- Provinces in the area of Regional Bureau Animal Health and Sanitary 5 send sample to Northern Veterinary Research and Development Center Lumping province
- Provinces in the area of Regional Bureau Animal Health and Sanitary 6 send sample to Lower Northern Veterinary Research and Development Center Pisanulook province
- Provinces in the area of Regional Bureau Animal Health and Sanitary 7 send sample to Western Veterinary Research and Development Center Ratchaburi province
- Provinces in the area of Regional Bureau Animal Health and Sanitary 8 and 9 send sample to Southern Veterinary Research and Development Center Nakhorn Si Thamarat

3.2 Send the samples every day, do not send them all at once, whereby

- Regional Bureau Animal Health and Sanitary 1 expects approximately 4,700 tubes each round
- Regional Bureau Animal Health and Sanitary 2 expects approximately 1,840 tubes each round
- Regional Bureau Animal Health and Sanitary 3 expects approximately 800 tubes each round
- Regional Bureau Animal Health and Sanitary 4 expects approximately 1,600 tubes each round
- Regional Bureau Animal Health and Sanitary 5 expects approximately 1,600 tubes each round
- Regional Bureau Animal Health and Sanitary 6 expects approximately 3,400 tubes each round
- Regional Bureau Animal Health and Sanitary 7 expects approximately 1,870 tubes each round
- Regional Bureau Animal Health and Sanitary 8 expects approximately 1,060 tubes each round
- Regional Bureau Animal Health and Sanitary 9 expects approximately 250 tubes each round

4. Sample collecting equipment

The equipment will be provided by the regional Veterinary Research and Development Centre.



Appendix I: Disease Surveillance Networking System (The human and animal disease surveillance information network and coordination of Thailand was established for the effective of coordination between relevant agents.)

Appendix J: Map of Thailand

CURRICULUM VITAE

Name	Ms. Sompiss Jullabutradee D.V.M.
E-Mail Address	ducks@bkk.loxinfo.co.th, jullabutradee_2@yahoo.com
Birth date	August 6, 1967
Birth place	Khon Kaen, Thailand

Education and Training:

1987-1993	Khon Kaen University; Graduated as a Doctor of Veterinary Medicine.
April 1997	Salmonella in Hatchery and Animal Feed Training Course: Certificate of Attainment from Northern Hygiene Laboratory, England
1999-2001	Sripatum University; Graduated as Executive MBA. Major in marketing and financing.
August 2000	HACCP Training Course– Certificate of Attainment from SGS (Thailand) Limited
January 2001	ISO 9002:2000 Lead Auditor Training Course– Certificate of Attainment from SGS (Thailand) Limited
April 2003	BRC auditor Training Course– Qualified as BRC Third Party Auditor no. BRC/ATP001/TPA/0114.
2003-present	Master of Science in Veterinary Public Health; Joint program between the faculty of veterinary medicine of Chiang Mai University and Freie University Berlin; emphasizes food safety.

Professional Experience:

1993-1994	Pfizer International (Thailand) Co., Ltd. Technical & Sales representative in advice farmers on Animal Health issues for poultry and hogs.
1994 – 1998	Bangkok Ranch (Public) Co., Ltd. Responsible for Animal health Manager for 2 years and then became a Regional Manager for Breeding operations

	responsible for a team of 40. Designed and implemented programs leading to significant increases in efficiency and yields. During this period worked closely with the Cherry Valley (UK) Co. Ltd., supplier of the genetic stock, including participating in a course in the UK.
1998-2000	Representative in South East Asia for UK company, Co-ordinating seminars in Asia and the USA on Salmonella and other issues of food safety.
1999-2000	Independent Consultant for EU company to audit the quality and hygiene of poultry products imported from Thailand. Inspected farms, hatcheries, slaughterhouses and cooked food premises for hygiene, use of prohibited medication, food safety and animal welfare (secondary party audit).
2000-2003	Vet Inter Pharma Co., Ltd Technical manager to responsible for technical in advice farmers on Animal Health issues for poultry and hogs.
2000-present	SGS (Thailand) Co., Ltd External auditor to assist team member and technical expert in auditing and certifying ISO 9001:2000, BRC, SQF2000, GMP and HACCP for livestock integrated companies and food factories in Thailand (third party audit).
2003-present	G&S AgriConsultants Co., Ltd Managing Director to responsible for agricultural quality and safety system consulting, business plan writing and customer audit for the buyer such as UK retailer and importer who import shrimp and poultry products from Thailand to UK in compliance with BRC standard (secondary party audit) etc.
2005-present	TÜV SÜD (Thailand) Co., Ltd. External auditor to assist team member and technical expert in auditing and certifying ISO 9001:2000, BRC, GMP and HACCP for livestock integrated companies and food factories in Thailand (3rd party audit).

Public Presentation Experience:

1. *Safety and quality practices in closed-house poultry production in Thailand: Lessons from 2004 avian influenza outbreak*: 5th World Congress Foodborne Infection and Intoxications. Proceedings. 7th-11th June 2004 Berlin, Germany.
2. *On-Farm HACCP in Thailand's Poultry Industry: Recommendations for practice in Broiler Production:* International Conference; Food Safety and HACCP in the 21st Century: "From Theory to Practice". 1st - 3rd September 2004 Bangkok, Thailand.
3. *Good Agricultural Practice (EUREPGAP) for livestock:* Thai DLD provincial veterinary meeting. August 2004 Nakornnayok, Thailand.
4. *Good Agricultural Practice (EUREPGAP) for livestock:* Thai DLD Regional 7 veterinary meeting. December 2004 Nakornpathom, Thailand.

SIGNED DECLARATION SHEET

I, the under signed, declare that the thesis is my original work and has not been presented for a degree in any university.

Name Sompiss Jullabutradee

Signature ______________________

Date of submission September 2005