

REVIEW

POULTRY RAISING SYSTEMS AND HIGHLY PATHOGENIC AVIAN INFLUENZA OUTBREAKS IN THAILAND: THE SITUATION, ASSOCIATIONS, AND IMPACTS

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Abstract. Highly pathogenic avian influenza (HPAI), caused by the virus strain H5N1, currently occurs worldwide with the greatest burden in Southeast Asia where the disease was first reported. In Thailand where the disease was first confirmed in January 2004, the virus had been persistent as a major threat to the poultry industry and human health over the past several years. It was generally hypothesized that the main reason for the disease to circulate in Thailand was the existence of traditional backyard chickens and free-range ducks raising systems. Consequently, this study reviewed the structure of poultry raising systems, the recent outbreaks of HPAI H5N1, the disease association to the backyard and free-grazing poultry production, and consequences of the outbreaks in Thailand. Although the major outbreaks in the country had declined, the sustaining disease surveillance and prevention are still strongly recommended.

Keywords: avian influenza, outbreak, poultry raising, Thailand

INTRODUCTION

The recent emergence and spreading of the HPAI A/H5N1 in Thailand and other countries in Southeast Asia has brought Avian Influenza (AI) to the forefront of important animal diseases and, at the same time to overall public concerns. Beyond the countries in Southeast Asia,

currently the disease occurs worldwide with a total of over 60 countries having reported H5N1 in domestic poultry and wildlife from 2003 - 2010 to the World Organization for Animal Health (OIE, 2010a).

In Thailand where the outbreak of HPAI was first confirmed by the Department of Livestock Development (DLD) in January 2004, thus far there were four epidemic rounds of outbreaks reported between January 2004 and December 2006 (DLD, 2004; Thanapongtham *et al*, 2007; Na Ranong, 2008). According to the OIE (2010b), several outbreaks were reported in 2007-2008. However, no outbreaks

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were reported in 2009-2010 (OIE, 2010c). To date, there were 25 Thai human cases (17 deaths) reported to the World Health Organization (WHO, 2010a).

Backyard poultry, including free-grazing ducks, were recently incriminated as having been the source of AI outbreaks in Thailand (Gilbert *et al*, 2006, 2007; Songserm *et al*, 2006; Tiensin *et al*, 2007). These traditional systems of raising poultry are strongly practiced in this particular area. Being that the birds can freely roam around the households, they are more likely to come in close proximity to people and other animals.

This study is aimed to investigate poultry production systems and the significant roles of backyard poultry and free-grazing ducks as a likely source of disease infection to the rest of the poultry industry and humans. The comparison in terms of poultry production, disease situation, and associated risk factors (before, during, and after major outbreaks of HPAI H5N1) were objectively revealed. The disease impacts in aspects of animal and human health effects, economic losses, and social consequences were reviewed.

POULTRY PRODUCTION SYSTEMS IN THAILAND

According to the Food and Agricultural Organization of the United Nations (FAO, 2004), the poultry production system can be categorized into four sectors based on the level of biosecurity and marketing of birds and products. Sector 1: Industrial integrated system with high level biosecurity and birds/products marketed commercially (*eg*, farms that are part of an integrated broiler production enterprise with clearly defined and implemented standard operating procedures for biosecurity). Sector 2: Commercial poultry

production system with moderate to high biosecurity and birds/products usually marketed commercially (*eg*, farms with birds kept indoors continuously strictly preventing contact with other poultry or wildlife). Sector 3: Commercial poultry production system with low to minimal biosecurity and birds/products entering live bird markets (*eg*, a caged layer farm with birds in open sheds, a farm with poultry spending time outside the shed, and a farm producing chickens and waterfowl). Sector 4: Village or backyard production with minimal biosecurity and birds/products consumed locally (*eg*, a backyard native chicken farm and a free-ranging, meat or egg type, duck farm produced for household consumption).

Structure of poultry production in Thailand

Over two decades before the unexpected emergence of H5N1 in 2004, the structure of poultry production in Thailand had been moving toward greater industrialization and increased vertical integration (Na Ranong, 2008). Although, the intensive farming was very high biosecurity and semi-vertical, the traditional systems of raising backyard poultry with minimal biosecurity (Sectors 3 and 4) were still widely practiced. Almost 99% of poultry producers were segregated in the latter two, as illustrated in Table 1.

Numbers of poultry production: before the emergence of H5N1

Generally, there are five major species of poultry mostly produced in Thailand. The favorably raised species is chicken, secondly is duck, while the other species (goose, quail, and ostrich) are also commercially produced but in lesser extent. Since the information of other species is rarely reported, the most commonly produced species, chicken and duck, are the

Table 1
Classification of poultry production systems in Thailand.

Sector 1 Industrial and integrated	Sector 2 Commercial with high biosecurity	Sector 3 Commercial with low biosecurity	Sector 4 Village or backyard
70% of national production	20% of production	10% of production but, almost 99% of producers	
This sector has an important export market		36% of farms and 20% of the poultry population	61% of producers and 10% of the poultry population

Source: Rushton *et al*, 2007

main focus in this education. Obviously, the production trends of chickens and ducks had been significantly increased during the 1995-2003 period (Figs 1 and 2). Such changes were considered to be the results of structural changes in the poultry sector as mentioned earlier.

Traditional poultry raising system

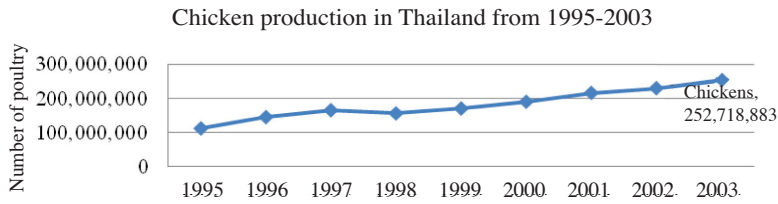
Backyard poultry and free-range husbandry is traditionally practiced, and is generally found in Thailand rural areas. The birds freely roam around the household and are in close proximity with humans and other animals. They are fed regularly by the owner(s) at least once a day, but they mostly rely on the natural feeds (*eg*, earthworms, insects, snails, rice, grains, grasses, household vegetables or leftover human foods). The backyard poultry were typically classified by a small number of native chickens and free ranging, egg, meat, or Muscovy ducks (less than 1,000 birds per a household).

The most chicken breeds classified in Sectors 3 and 4 are native and mixed breed (*eg*, 3-blood-breed) chickens. In 2006, Songserm *et al* and Gilbert *et al* indicated that the domestic ducks raised in open flocks, which were freely ranging and counting mostly more than 1,000

birds, were classified as the "free-grazing ducks". This kind of widespread-raising ducks composed of egg-laying ducks (khaki Campbell) or a crossbreed of khaki Campbell and native laying ducks, including a small number of "meat" ducks, such as Pekin and white Cherry Valley is common. Traditionally, the ducks were raised in the open on rice fields for 5 to 6 months. During that period, the ducks were moved by truck from one field to another to feed on leftover rice grains after the harvest. They were finally brought back to the farms in the open system for egg production and meat purposes.

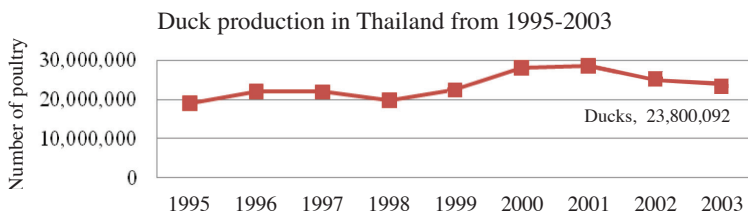
The specific information concerning the numbers of traditional poultry was not provided until 2010 when the Department of Livestock Development (DLD, 2010) revealed the number of poultry as it is classified in Sectors 3 and 4. The most produced poultry in these sectors were native chickens (89.9%), while the rest of the species were egg-type and meat-type free grazing ducks (9.0% and 1.1%).

The largest number of traditional poultry production was corresponded to the largest area, the northeastern region (40.4%). This region is approximately one-third of the overall area in Thailand



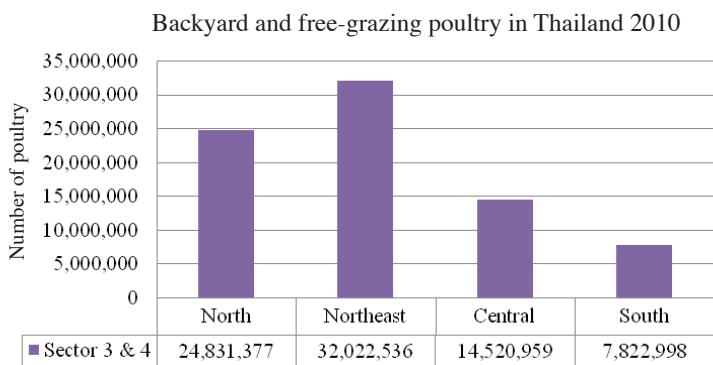
Source: Department of Livestock Development, Thailand (DLD, 2009a)

Fig 1–Number of chicken production and trends (before the emergence of H5N1).



Source: Department of Livestock Development, Thailand (DLD, 2009b)

Fig 2–Number of duck production and trends (before the emergence of H5N1).



Source: Department of Livestock Development, Thailand (DLD, 2010)

Fig 3–Number of backyard poultry, native chickens, and free-grazing ducks.

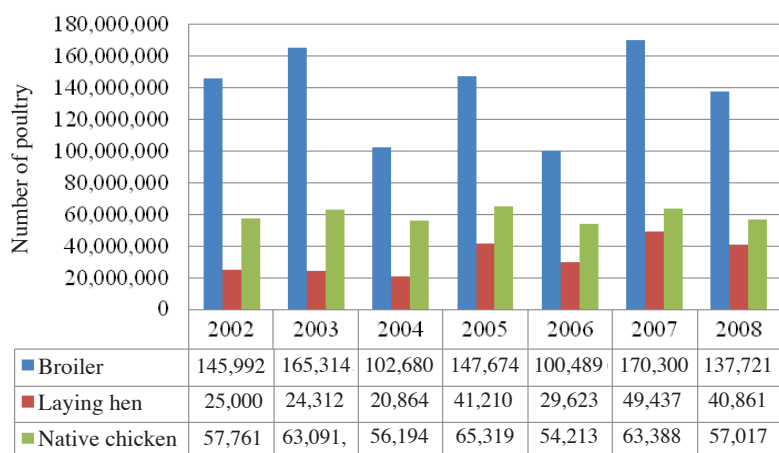
(th.wikipedia.org, 2010). The largest number of native chickens was also reported in the northeastern region (44.8%), while the highest number of egg- and meat-type free grazing ducks was reported in the northern region (54.7%). Approximately 18.3% of this kind of poultry was reported in the central region, and the least number of poultry (12.1%) had been reported in the Southern region (Fig 3).

POULTRY INDUSTRY IN THAILAND

The Thailand poultry industry has been depending mainly on the meat-type breed chickens (broilers), which mostly are produced for international markets. The other breeds (laying-type hens, egg ducks, and native poultry) are obviously less in production numbers, and are mostly produced for local and national consumption.

The broiler meat industry in Thailand is made up of the western breeds (Aviagen, Cobb, and Hubbard) and mixed-native backyard. Most of the breeds are bred by the large integrators who have their own facilities and are raised by contract farmers who are strictly controlled by the integrators

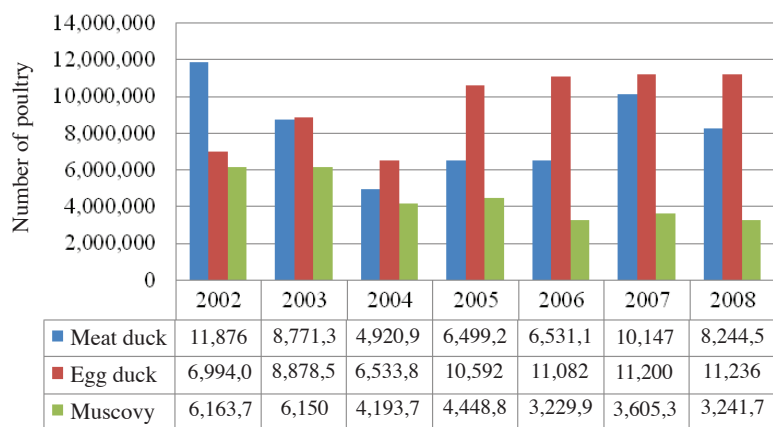
Chicken breeds in Thailand 2002-2008



Source: Department of Livestock Development, Thailand (DLD, 2009c)

Fig 4—Number of chicken production in Thailand classified by breed type.

Duck breeds in Thailand 2002-2008



Source: Department of Livestock Development, Thailand (DLD, 2009d)

Fig 5—Number of duck production in Thailand classified by breed type.

(Jullabutradee, 2005). The varieties of chicken and duck breeds produced in Thailand are presented in Figs 4 and 5.

Before the unexpected emerging of H5N1 in January 2004, Thailand was ranked in the top four of the most exporting countries in the world for

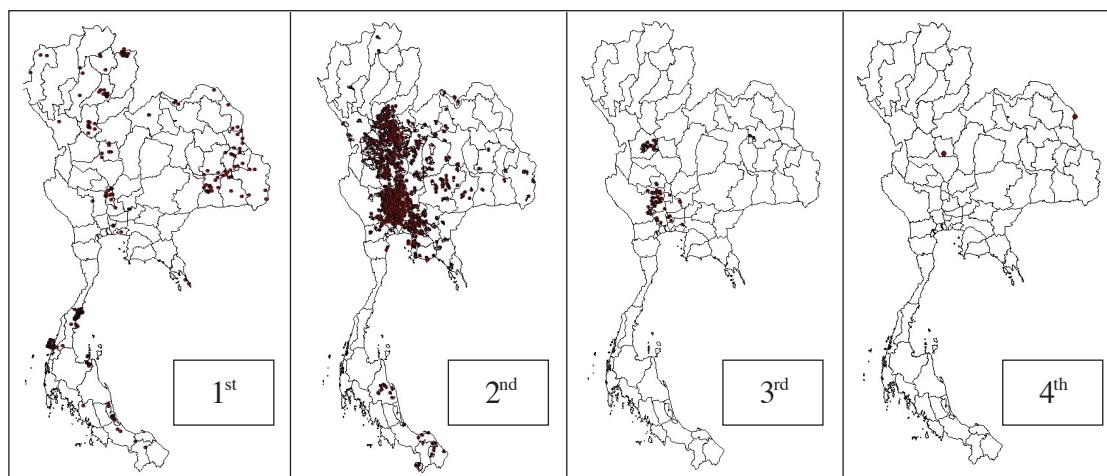
broiler-meat trade, only to be surpassed by the United States, Brazil, and European Union (EU). The two largest markets for Thailand's broiler meat were Japan and EU: value-added parts (semi-cooked and cooked) products were supplied to Japan, and frozen parts were exported to the EU (Food-marketexchange, 2008).

DISEASE SITUATION IN THAILAND WHEN H5N1 OUTBREAKS

On January 23, 2004, Thailand Department of Livestock Development announced that H5N1 influenza had been identified as the cause of poultry die-offs in Thailand (DLD, 2004; OIE, 2004; Simmerman *et al*, 2004). According to OIE (2004), the first case of HPAI in poultry was reported in a layer farm in Suphan Buri, a province in the central region of Thailand. Thereafter, there were 89 districts from 42 provinces in Thailand (which is more than one-

half of all 76 provinces in the country) that indicated the virus had been widely spread throughout the country in a relatively short time.

There were four major rounds of outbreaks reported between 2004 and 2006: (1) January 23- May 24, 2004; (2) July 3,



Source: Thanapongtham *et al*, 2007

Fig 6—The disease distribution during the 1st to the 4th round of H5N1 outbreaks in Thailand, 2004-2006.

2004 - April 12, 2005; (3) July 1 - November 9, 2005; and (4) July 24 - 29, 2006. The disease occurrences for all four rounds of outbreaks were mostly reported in the central and lower northern parts of Thailand (Thanapongtham *et al*, 2007) (Fig 6).

For each species of poultry affected during the first round of H5N1 outbreaks, 63.7% (almost two-third) of the cases and deaths were reported in native chickens, 11.6% was in broilers, 10.5% was in laying hens, 6.3% was in ducks, 4.7% was in quails, and 3.2% was in other species.

For the second round of outbreaks, 57.6% (more than half) of infected poultry was in native chickens, 28.8% (a third) was in ducks, 5.3% was in broilers, 4.7% was in laying hens, 2.0% was in quails, and 1.5% was in other species.

As for the third round of outbreaks, 76.3% (more than three-fourth) of infected poultry was in native chickens, 7.9% was in quails, 6.6% was in ducks, 5.3% was in broilers, 2.6% was in layer hens, and 1.3% was in other species.

For the fourth round, H5N1 outbreak was reported in native chickens and laying hens in Phichit and Nong Khai. All together 2,272 birds (39.2%) were infected and finally died, while the other 3,523 were humanely destroyed (DLD, 2006; OIE, 2006).

HPAI A/H5N1 outbreaks in 2007 and 2008

Three outbreaks were reported in 2007, and four in 2008. No outbreak was reported during 2009-2010 (OIE, 2010c).

BACKYARD POULTRY AND FREE-GRAZING DUCKS: THE ASSOCIATED RISK FACTORS

In 2006, Gilbert *et al* revealed that the spatial distribution of HPAI outbreaks in Thailand was not corresponded to the areas with high densities of chickens, and the geographic pattern of H5N1 outbreaks mostly found in native chickens was not primarily driven by long-distance transmission between chicken production units or villages. The researchers concluded that the national disease distribution in

Table 2
HPAI A/H5N1 outbreaks in Thailand, 2007.

No.	Province	Poultry type	No. of cases	Confirmed date
1	Phisanulok	Layer ducks	130	Jan 15, 2007
2	Nong Khai	Layer hens	236	Jan 23, 2007
3	Ang Thong	Native chickens	16	Jan 31, 2007

Source: Department of Livestock Development, Thailand (DLD, 2007)

Table 3
HPAI A/H5N1 Outbreaks in Thailand, 2008.

No.	Province	Poultry type	No. of cases	Confirmed date
1	Nakhon Sawan	Broilers	4,085	Jan 22, 2008
2	Phichit	Native chickens	30	Jan 25, 2008
3	Sukhothai	Native chickens	5	Nov 9, 2008
4	Uthai Thani	Native chickens	5	Nov 23, 2008

Source: Department of Livestock Development, Thailand (DLD, 2009e)

Thailand showed the strongest association with the distribution of the free-grazing ducks. The additional information revealed that the free-grazing ducks were highly associated with the paddy fields in the central region of Thailand (Gilbert *et al*, 2007).

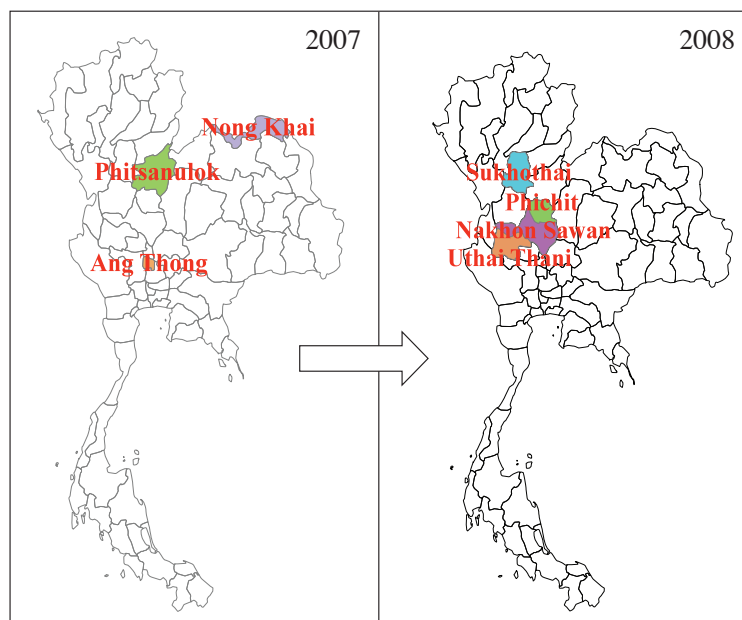
Teinsin *et al* (2005) and Songserm *et al* (2006) indicated that open-flock, grazing system, and backyard poultry (namely the backyard chickens and free-raising ducks) played the essential roles as the hosts of H5N1, and evidently, the free-grazing ducks had been identified as the risk factors for the occurrence of H5N1 outbreaks in Thailand.

With the high susceptibility and ability of movement, ducks were presumed to be the pandemic threat of the HPAI endemic in Asia (Hulse-Post *et al*, 2005). The infected ducks showed a few clinical signs of disease, but were capable of shedding the H5N1 avian influenza virus for pro-

long period of time. The virus circulated in native chickens may have remained unnoticed because disease presence was not prominent (Chen *et al*, 2004; Gilbert *et al*, 2006).

NATIONWIDE SURVEILLANCE AND CONTROL PROGRAMS

There was no specific surveillance program for traditional poultry raising systems; however, in late 2004 and several times later, the Thai Government launched a thorough surveillance program in all poultry sectors (including other animals and humans), which was called the "X-ray Campaign". The campaign was implemented in collaboration with many authorities under the Thai government, such as, the Ministry of Agriculture and Cooperatives, the Ministry of Public Health, the CEOs, and the Provincial Governors. The new and improved features of this surveillance system included an



Source: Department of Livestock Development, Thailand (DLD, 2007, 2009e)

Fig 7—The outbreaks of HPAI A/H5N1 in Thailand in 2007 and 2008.

establishment of over 1,000 Surveillance and Rapid Response Teams (SRRT), 12 Regional, and 1 Central Networking Laboratory. In strong collaboration with the higher authorities and expertise, the Village Health Volunteers (VHV) and the well-trained livestock workers (under the DLD control) played the important roles to detect, investigate, report, support, control, and operate the “Influenza-like” cases (WHO SEARO, 2007).

The control measures and actions implemented in poultry sectors in Thailand compose of: stamping out, cleaning and disinfection, surveillance, movement control or quarantine, campaign to increase awareness and reduce panic, and other measures (eg, biosecurity and poultry compartmentalization). Note that no vaccination was allowed to apply in any poultry sector in Thailand (Rushton *et al.*, 2007).

IMPACT OF AI OUT-BREAKS ON POULTRY PRODUCTION

According to the senior executive of the Thai Broiler Processing Exporters Association (FAO, 2006), the poultry production in Thailand had rapidly declined after the outbreaks of H5N1. The reduction in number of chickens and ducks was obviously observed in 2004, while the other species had slightly significant changes in the following years after the major outbreaks. Total chicken number reduced from 1.35 million tons in 2003 to 0.92 million tons in 2004. As for local consumption and

export volumes, demands for chicken meat were considerably decreased: 0.805 and 0.545 million tons in 2003 to 0.701 and 0.219 million tons in 2004. According to Na Ranong (2008), more than 65 million birds were killed to control highly pathogenic avian influenza in Thailand in 2004-2006 outbreaks, which incurred costs of more than 1 billion Baht (more than USD35 million) of public-money as compensation to the owners affected. Additionally, the significantly decreased chicken production was due mainly to the frozen broiler-meat being banned from the most important importers, especially the two largest markets, Japan and EU.

ECONOMIC IMPACT ON THE POULTRY INDUSTRY

The senior executive of Thai Broiler Processing Exporters Association revealed

that almost 100,000 million Baht (around USD3,330 million) was lost during the outbreaks of H5N1 in Thailand (FAO, 2006). According to the DLD (2009f), the chicken fresh-meat exports (consequently the country income) were rapidly decreased since the first outbreak of H5N1 (Figs 8 and 9).

IMPACT OF AI OUTBREAKS ON HUMAN CASES

As of December 9, 2010, there are 510 human cases from 15 countries reported to the World Health Organization. Of the 510, 303 cases have been fatal. In Thailand, 25 human cases (17 deaths) were reported thus far (WHO, 2010a). The overall human cases and deaths reported in Thailand are presented in Fig 10.

In summary, the descriptive statistics of confirmed human cases in Thailand is as follows: of all 25 cases, 16 (64%) are male and more than 50% are children aged less than 15 years. The median age is 17 years old, and the mean is 22.4 (range 1.5-59 years). Of the 25 cases for which H5N1 infection is finally confirmed, 17 died (case fatality = 68%). In the 18 provinces for which the data are available, Kanchanaburi (a province located in western Thailand) had the highest, which are four confirmed human cases. The exact occupation of each case was not provided. However, the history of direct contact to the chicken carcasses appeared to be related to H5N1 infections in humans reported in Thailand. Thus far, there is no human-to-human transmission reported in the country.

PUBLIC AWARENESS AND SOCIAL CONSEQUENCES

Direct effects from the outbreaks of H5N1 in Thailand, *ie* poultry, died from

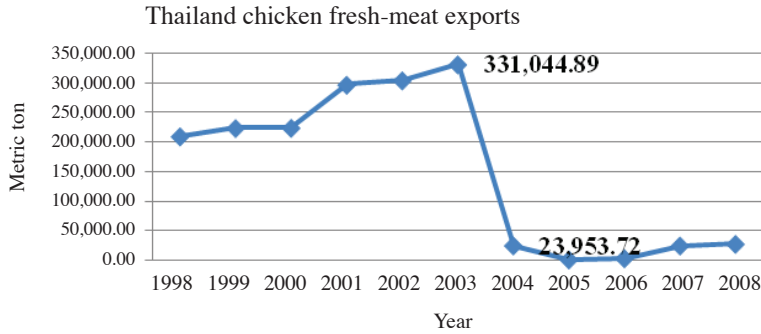
the disease infection, and the production had extremely lost due mainly to massive poultry culling and international trade barriers. On the other hand, indirect effects for the Thai society, such as sales of feed and animal health products, had gone down so contract farmers had no more work; therefore, leaving the industry all together. Some broiler farmers switched to other poultry farming or other businesses. Less of them continued to operate the broiler farm, but with fewer numbers of birds (Na Ranong, 2008).

Consumer panic of the disease was also the main problematic issue for the Thai government. During the outbreaks of bird flu, there was no chicken or egg menu in restaurants or even in school luncheon. Many chicken restaurants, including catering businesses, were completely closed or switched to another kind of food retails. As such, many people were jobless.

Before H5N1 outbreaks, the per capita consumption of broiler meat in Thailand was estimated to be about 13-14 kg per annum (USDA, 2004). Per capita consumption reduced from 14 kg to 8 kg in 2004 (FAO, 2006). However, in 2010 the per capita consumption of chicken meat in Thailand has been substantially increased to 12-13 kg, and the consumption trend is estimated to be 14 kg per capita in 2011 (USDA, 2010).

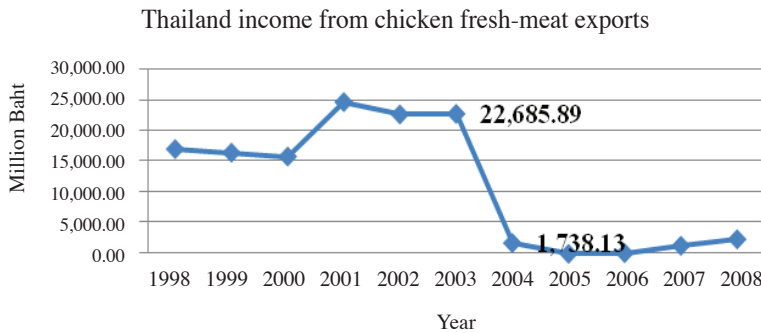
THE LESSONS LEARNED FROM DEALING WITH H5N1 OUTBREAKS

It has become apparent lately that high poultry population density, especially large free-grazing duck populations and the production of other backyard poultry with minimal biosecurity (Sectors 3 and 4), represent the major risk factors for maintenance and transmission of HPAI. Evidently, domestic ducks



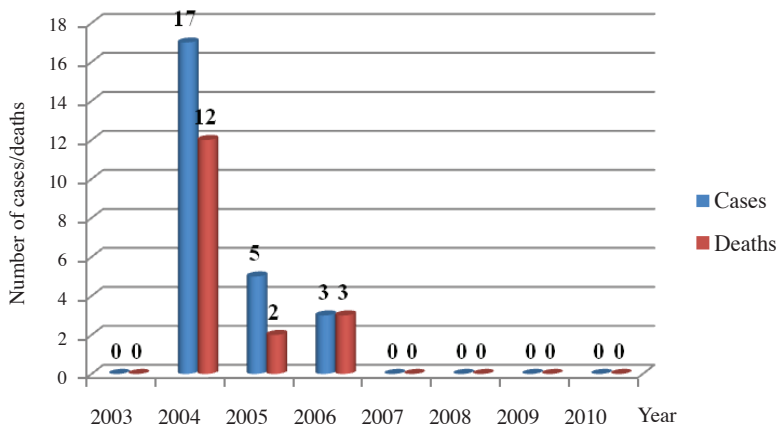
Source: Department of Livestock Development, Thailand (DLD, 2009f)

Fig 8–Reduction of chicken fresh-meat exports.



Source: Department of Livestock Development, Thailand (DLD, 2009f).

Fig 9–Reduction of country income from chicken fresh-meat exports.



Source: Adapted from the World Health Organization (WHO, 2010a).

Fig 10–The overall number of H5N1 human cases and deaths in Thailand.

and backyard poultry have played a key role in the persistence of infection because they can be infected silently and the disease could be underestimated.

During the first phase of the outbreaks in Thailand, it seemed not easy to achieve effective progress on reducing the incidence of HPAI since the potential risk factors and dynamics of disease transmission were not well defined for public perception. As a result, the disease rapidly spread in the susceptible poultry in more than half of the country (42 out of 76 provinces) during the first 3-month-period. Additionally, more than 12 human cases were affected within a relatively short time in the first 2 months. Therefore, public education on the full information, especially the preventive and control strategies, of the disease should be conducted first to increase public awareness and to delay or limit spreading of the disease. Moreover, attempts at controlling HPAI by culling, movement control and decontamination in areas of high HPAI incidence

in the country have had limited success. Improved outbreak response needs to be promoted, and sustainable reduction in HPAI incidence in entrenched areas requires more attention to risk reduction measures (FAO, 2010).

In summary, strong collaboration between the Thai government and other related authorities, such as the poultry industry sectors, was a key component of the successful campaign in Thailand; leading to a situation in which the disease was essentially under control with only infrequent isolated outbreaks of HPAI.

CONCLUSION

Although the major outbreaks of HPAI H5N1 had declined in Thailand, nobody dares to say that the virus has been completely wiped out from the country as long as our neighboring countries, *ie* Cambodia, Lao PDR, Myanmar, and Vietnam, still continue reporting HPAI cases in poultry to the World Organization for Animal Health (OIE, 2010d).

Interestingly, up until December 9, 2010, many new human cases were continually reported in Indonesia; leading the country with 171 cases include 141 deaths, thus far. Similarly in Vietnam, the second ranked country for confirmed human cases, 7 new human cases (2 deaths) were still reported in 2010. Not so much far from Thailand, one human case (which had been fatal) was recently reported in Cambodia in May 2010 (WHO, 2010b).

Since it is difficult to tell when and how the highly pathogenic avian influenza viruses will re-enter our country, it is strongly recommended that the thorough, on-going, systemic disease surveillance and prevention should be persistently applied.

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