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Poultry Production Clusters (PPCs) after AI Outbreaks in Thailand: Past, Present and Future Direction

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Abstract: After the outbreaks of avian influenza during the years 2003-2004, Thailand launched many policies to control the spread of the disease such as culling of poultry. Public health measures were also devised to control the transmission of disease to humans and as a result, there was no more report of avian influenza infection in humans after 2007. Based on poultry farming control measure through clustering poultry farms could be classified into 4 groups; namely, poultry farmer communities united before the avian influenza outbreaks, poultry farmer communities united before the avian influenza outbreaks and subsequently implemented cooperative farming system, poultry farmer engaged in contract farming system with large private companies and poultry farmer under compartment system of large private companies. The future direction of these poultry farm clusters should be the improvement of the quality of life of farmers, the promotion of appropriate management and caring of environmental changes, the strengthening of biosecurity, the clustering of farmers within the communities; which would allow farmers in these poultry clusters to have a better quality of life.

Key words: Poultry production clusters (PPCs), zoning, compartment, co-operative farming system, contract farming system, Thailand

INTRODUCTION

During the 1950s-1970s, Thailand started to launch a policy to produce food for export besides rice and rubber. Farmers shifted to multicrop production of plants such as cassava, kenaf, maize, sugar, mung beans and sorghum. In the late 1970s, Thailand experienced a shift in agricultural production to the production of fruits, vegetables, oil-yielding plants, beef cattle, poultry, swine, dairy cattle and shrimp (Christensen, 1992) and so on. The changes in consumption culture of Thai people had a huge impact on the local demand for poultry. As a result, poultry production became a highly successful livestock business in Thailand. Adoption of poultry breeding improvement and modern poultry production technology, which could be considered a pioneering action leading to the initiation of contract farming system, in conjunction with relatively low cost of raw materials for animal feed and labour; resulted in not very high price of poultry products, which brought about consequential culture change in the consumption of Thai people from fish products to chicken products (Borelli *et al*., 2005). Thailand's poultry production had stepped up continuously throughout the period of 20 years, with the increase of chicken meat export volume from 33,000 tons in 1983 to 530,000 tons in 2003. Before 2004, Thailand was among the world leaders in chicken meat exports, whereby the chicken production volume was approximately 0.8-1.0 billion chickens per year. Production areas were mainly located in the central and eastern regions of the country. In villages, however, there was still backyard chicken and duck farming for household consumption (Tiensin *et al*., 2007). In 2005, poultry accounted for approximately 52% of meat production in Thailand. Such production had changed and developed from the backyard production pattern. After 40 years, Thailand became a leader in poultry export (Heft-Neal *et al*., 2009a). Poultry production of Thailand could be divided into several categories, whereby broiler production was the largest and highest value sector. However, about 90 percent of domestic producers were still small farms (Heft-Neal *et al*., 2009b) mainly located in rural villages where backyard farming was largely employed. Based on a study of Heft-Neal *et al*. (2009b), it was found that people in rural areas reared 20-100 chickens per household. Farmers let their animals find their own food. Small number of

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farmers gave supplements such as food remains or paddy. However, based on volume, the poultry being produced most in the country were broilers raised in commercial farms for both domestic and foreign markets, creating local employment for about 110,000 people.

Burgos *et al.* (2008) studied and classified poultry farming in Thailand into 3 systems. The first system was traditional production system, which was used in the raising of approximately 3 fifths of the total number of chicken flocks having a corresponding population of about 1 fifth of the total poultry population in the country. The poultry being raised were mostly native breed commonly referred to as Thai Indigenous Chickens (TIC). They were cultured in the backyard and fed twice daily while also allowed to find food independently. Vaccination and de-worming were not arranged for. The second system was semi-industrial one. This type of system was quite large and connected with commercial production system. Such system was used in the raising of approximately 1 fifth of the total number of chicken flocks produced having a corresponding population of about 1 eighth of the total poultry population in the country. Feed used in this system was from local feed mills and also from natural sources. Majority of baby chicks or ducklings were obtained from own-stock hatching, while certain number such as day-old chicks or ducklings were obtained from local hatchery or market. In general, the flock size was about 100-1,000. For backyard or garden rearing; fence made of bamboo, nylon mesh, or concrete block was constructed. Biosecurity system such as disease prevention was also implemented. Treatment and management were slightly better than those of the traditional system. The third system was industrial system. In 2004, the number of flocks raised under this system was about 3% of country's total, but the proportion of poultry population was as high as 70% of the total population. Modern industrial production pattern was employed. Rushton *et al.* (2005) reported that this production pattern had evolved for more than 20 years; with the introduction of modern technology in farming such as closed housing with evaporative cooling system in the late 2003 to increase production efficiency. The factor contributing to rapid growth of the industrial production was contract farming system, which was a combined effort between large and small producers making it possible to adjust the volume of production to suit both domestic consumption demand and export demand whereby poultry producers could effectively reduce the risk of price swings (Burgos *et al.*, 2008).

AI outbreaks in Thailand during 2003-2008: The avian influenza outbreaks in Asia began in late 2003 and continued up to early 2004. The period got the attention of policy makers, international communities and the media. These stakeholders were on high alert over the outbreaks of this disease causing the government of various countries to issue control policies such as culling of infected poultry, monitoring the transmission of disease to humans and measuring the spread of the disease at airports. In 2004, the outbreaks of this disease affected the poultry export industry of the country (Verbiest and Castillo, 2004). The first outbreak of H5N1 avian influenza in Thailand was reported in layer chicken farm in central region of Thailand in January 2004. Subsequent outbreaks occurred in all regions of the country, but mostly in the central region (43%), followed by the lower northern region (37%) and eastern region (9%) respectively. After that, the outbreaks of the disease had dropped significantly. In 2005, outbreaks were still detected in the lower northern and central regions. They were mainly found in poultry farms under backyard system with low biosecurity level and not in closed housing system or systems with high biosecurity level. The outbreaks of avian influenza during 2004-2005 had severe impacts on poultry production, social community, farmers' livelihood, human health and socioeconomics. H5N1 virus was detected not only in reared poultry, but also in wild birds. Such virus was transmitted from poultry to humans and other mammals (Tiensin *et al.*, 2007). Indirect impact of avian influenza outbreaks was very important for small-scale poultry farmers in that some of them had to discontinue their farm operation. After the year of severe outbreaks, the epidemics gradually declined, whereby recurrences were mainly detected (Heft-Neal *et al.*, 2009b). After avian influenza outbreaks in 2003, the Thai government launched many control policies; including stamping out, cleaning and disinfection, surveillance, movement control, campaign to increase awareness and reduce panic, improvement of biosecurity and restructuring of poultry production. This resulted in continuous decline of the outbreaks. The policy was implemented through 4 processes; namely, quarantine, screening, zoning and compensation. However, there was no policy on vaccination in the country (Rushton *et al.*, 2005). Details of the implementation of government's policies are shown in Table 1.

The national strategic plan for avian influenza control: The National Strategic Plan for Avian Influenza Control in Thailand was a three year plan (2005-2007) which set targets for the control of the spread of HPAI in both animals (poultry) and humans. The National Strategic Plan had six components as follows:

1. Development of a disease free poultry management system through the improvement of poultry housing and husbandry, enactment of a system of zoning and compartmentalization system, development of effective disease surveillance (in domestic poultry and wild birds) and (re-)assessment of the feasibility of vaccine use.

Table 1: Thailand's policies for controlling avian influenza outbreaks during 2003-2007

Waves of outbreak	Losses	Month	Policies and actions
The first wave (January 23 - May 24, 2004)	Avian influenza outbreaks in 42 provinces, culling of 26,000,000 heads of infected poultry	January	1. All H5N1 infected poultry within 5 kilometer radius were to be culled after the infection was confirmed and movement of poultry within 50 kilometer radius around the infected area was restricted. 2. The diagnosis of infection was based on a positive result on HPAI tests. Such policy was applied to all aspects related to poultry; namely, products, feed, litter, waste materials and droppings of the infected poultry; which would be destroyed immediately by the veterinary officers in charge. Culling of poultry in the infected flocks took about 1-2 days after receiving the laboratory confirmation. While waiting laboratory testing, movement of poultry and their products were restricted within a 5 kilometer radius by officials of the Department of Livestock Development in cooperation with local police, whereby temporary check points were established in each area. Moreover, the infected premises and equipment were to be cleaned and disinfected.
		February	1. Definition of the word "case" was given, which referred to the case where the test result was positive in the area where the death proportion of poultry was higher than 10% within a day, or where the cumulative death rate was higher than 40% within 3 days and there was other symptom of infection within the flock such as diarrhea, ruffled feathers, depression, etc. The flocks tested positive were to be culled. 2. The government's new policy was to eliminate sick poultry within a 1 kilometer radius, to restrict movement within a 5 kilometer radius and to define a poultry flock as either "a farm unit" or "a village".
		January - May	1. Free-grazing ducks were determined to represent a key risk factor in the spread of H5N1 virus. 2. Under the stamping-out policy for HPAI outbreak control, farmers would receive a damage compensation of 100% of the market price.
The second wave (July 3, 2004 - April 12, 2005)	Culling of 63,000,000 heads of poultry in 51 provinces	July	1. Culling of infected poultry was limited to the village or within a 1 kilometer radius around the outbreak area. Random sampling of poultry droppings (cloacal swab) within a 5 kilometer radius around the outbreak area, together with clinical surveillance, was conducted. Movement of poultry and poultry products within a radius of 5 kilometers around the infected flock was restricted. In addition, throughout the duration of outbreaks, the Department of Livestock Development (DLD) devised various measures to reduce the time between the infection and the control and prevention. If the poultry mortality rate was higher than 10% within a day; the whole flock, its products, materials and equipment likely to be infected were to be readily destroyed. 2. Cloacal swabs of affected flocks were then collected for laboratory confirmation. Before movement of commercial flocks, cloacal swabs were also collected. The owners were allowed to move their poultry to slaughterhouses or other places after cloacal samples were determined to be negative for the virus.

Table 1 Cont.:

			3. Poultry exhibition or contest and cockfighting were prohibited. A violation of this regulation was subject to a fine. Additionally, registration of fighting cocks was compulsory; cloacal swabs from the cocks were collected every 3 months for disease monitoring. In addition, before movement of fighting cocks, cloacal swabs were also taken again. 4. Damage compensation for culling of infected poultry was determined at 75% of the market value.
		October	The X-ray survey was first implemented. The goals of these X-ray surveys were to thoroughly detect HPAI infection in all villages in Thailand and to cull suspected and positive flocks without delay, whenever and wherever the infection was suspected or detected based on the H5N1 HPAI case definition or as a result of laboratory confirmation. After the implementation of X-ray survey, the amount of disease detection increased remarkably during October-November 2004.
The third wave (July 1 - November 9, 2005)	Culling of 450,000 heads of poultry in 11 provinces		1. A case definition of HPAI was revised in order to improve early detection and quick response. This definition dictated that if the daily poultry death rate in any facility was higher than 1% for commercial farms or 5% for backyard flocks, all poultry, their products and other contaminated materials in these flocks would be destroyed immediately. Pre-emptive culling was implemented only within a village or within a 1 kilometer radius around the outbreak area. A restriction on the movement of poultry and their products was extended from a 5 kilometer radius to a 10 kilometer radius around an infected area. 2. The Thai Government persuaded farmers to change from free-grazing practice to a housed system. 3. Farmers were allowed to move their ducks for grazing within a group of provinces designated by the DLD. Each group of provinces consisted of three provinces sharing administrative boundaries.
		February, July and October	1. The DLD carried out the X-ray survey three times in February, July and October.
The fourth wave (July 24 - August 2, 2006)	In 2006, endemic infection in poultry was detected in 2 provinces leading to culling of 320,000 heads of poultry		1. The practice of free grazing of ducks became illegal; all ducks were required to be housed. Until this point, vaccination was not allowed in Thailand. 2. The X-ray survey was also implemented in 2006. 1. By late 2006 Thai public health officials appeared to have been successful in decoupling the spread of infections in humans from poultry outbreaks and from 2007 onward, no human case of the disease was recorded.

Source: Adapted from Rushton *et al*. (2005); Tiensin *et al*. (2005); Tiensin *et al*. (2007); Barbazan *et al*. (2008); NaRanong (2008); Heft-Neal *et al*. (2009a); Safman (2009) and Prakarnkamanant *et al*. (2010)

2. Disease surveillance and response during outbreaks - A slight expansion and institutionalization of the X-ray surveillance system to allow for near real-time monitoring of disease outbreaks at a very local level with recurrent aggregation and analysis of data at a national level.
3. Knowledge generation and management - The plan outlined an ambitious program of both basic and applied research, including expenditures on studies of the basic biology and transmission of virus as well as attempts to develop appropriate vaccines and diagnostic kits and medicines for treatment of influenza infection.
4. Capacity-building of organizations and manpower - The medium to long-term objective of the plan was to increase Thailand's ongoing ability to deal with an outbreak of epidemic disease (or a related health crisis). To this end, the plan specified investment in infrastructure, disease surveillance networks (particularly veterinary surveillance) and the training of specialized personnel.
5. Creating understanding and participation in civil society and the private sector - The Strategic Plan recognized a role for non-governmental bodies in the control of HPAI and containment of the downstream impact of the epidemic. To this end, it called for responsible government bodies to reach out to their counterparts in civil society and the private sector and to enlist their aid in developing locally appropriate programs.
6. Development of sustainable integrated management systems and mechanisms - In keeping with the understanding that HPAI (and epidemics of zoonotic origin, more generally) would be an endemic or recurrent problem in Thailand, the Plan called for the establishment of more enduring coordinating bodies to both manage information and organize the response at both a local and national level (Safman, 2009).

Poultry production after AI outbreaks in Thailand: During the period of this study, farming in Thailand was categorized based on farm management, biosecurity system and market orientation into 4 sectors. The first sector was industrial integrated production system where broilers, layers and ducks were raised in a closed house with evaporative cooling system. This system had strict physical protection and disease control. Full cycle production management run by a single large private company comprised hatchery plant, feed mill, poultry farm, slaughterhouse, processing plant and transportation system. The second sector was semi-vertical integrated production system known as contracted farming system, where farmers owned poultry houses while receiving 1-day-old chicks, feed, medical supplies and veterinary services from a private company which was the contracted party. Poultry were raised in a closed house with evaporative cooling system or an open house with nylon or metal nets to prevent birds or other animals from entering the house. The third sector was usual farming system with low biosecurity where broilers, layers and ducks were raised. The houses were open and constructed without netting. Sometimes the flocks were left outside the house. Majority of these poultry entered local markets. This sector included free-grazing ducks in rice fields. The fourth sector was backyard or village poultry production system operated without biosecurity consideration. About 5% of poultry flocks in the country were raised mainly in commercial farms, which produced approximately 90% of the total production of the country (Tiensin *et al*., 2007). This was consistent with Rushton *et al*. (2005), who reported that poultry production classification of the FAO consisted of 4 sectors. The first sector was industrial integrated production, where farms had high biosecurity; the second sector was commercial production, where farms had moderate to high biosecurity; the third sector was commercial production, where farms had low to minimal biosecurity and the fourth sector was village or backyard system, where farms had minimal biosecurity.

In 2009, Thailand ranked no. 9 of the world for the production of chicken meat and ranked no.4 of world chicken product exporting countries. The total export value of chicken meat and products were 49,038 million Baht, which could be divided into 1,583 million Baht of frozen chicken and 47,267 million Baht of processed chicken corresponding to 3.23% and 96.77% of total poultry meat export respectively. The total value of broiler industry accounted for 2.55% of agricultural GDP and 30% of livestock sector. Egg was the product which had very sensitive price according to the supply and demand of the market. The 96% of eggs production was for domestic market and the remaining 4% for export was aimed to trade off the oversupply eggs to stabilize the egg's domestic price. In 2010, poultry was estimated to share 59% of total meat production in Thailand. The country's broiler meat production was forecasted to grow modestly by 8% from 1.28 MMT in 2010 to 1.38 MMT in 2011. The EU and Japan remained major markets for Thai chicken meat exporters, accounting for 85-90% of total exports. There was a growing trend of Thai broiler's meat export to Asian markets, especially ASEAN countries. Thailand's chicken exports were forecasted to be worth around 1.65-1.73 billion USD in 2011, a 10% rise compared with 1.57 billion USD in 2010. There were 2.5 millions families who bred approximately 266 million heads of poultry in 2010 (Italia Trade Commission, 2010).

Poultry Production Clusters (PPCs) in Thailand

Definition: The definition of Poultry Production Cluster (PPCs) in Thailand is "areas of concentrated poultry production in rural areas usually separated from

residential areas - where farms practice certain economies of scale and use comparative advantages of localities, resulting in improvements to and increased intensification of poultry production. The farms in the cluster apply standard biological safety and environmentally friendly practices and install related facilities. Major drives for the formation of PPCs and changes to PPCs include: government programs for enhanced bio-security at both national and local levels, extended families, cooperatives and improved links to contracting companies that supply inputs and purchase outputs and outbreaks of highly pathogenic avian influenza".

Past, present and future directions of PPCs in Thailand: As post-incidence response to the avian influenza outbreaks, the Thai government launched a zoning policy and the implementation of compartmentalization system in Thailand (Rushton *et al*., 2005; Safman, 2009) to be operated by the Department of Livestock Development (DLD), where the department officials worked in collaboration with the Thai Broiler Processing Exporters Association, local producers and farmers. Five regions of the country; namely, upper northern, lower northern, northeastern, central and southern regions were organized into zones and clustering of poultry farmers was then promoted. Knowledge was disseminated in the areas affected by this disease concerning biosecurity based on the OIE outlines (Rainat, 2004) and also concerning housing improvement and netting to prevent animals from entering the poultry houses. With regard to export production, particularly broilers; it was operated mostly by large private companies and these companies were required to obtain a permit for poultry production under compartmentalization system from the Department of Livestock Development. Prakarnkamanant *et al*. (2010) gave a definition of "compartmentalized farm" as a "cooperative or contract chicken farms which have implemented the animal management and biosecurity measures specified by the OIE and the DLD". Based on Thailand's aforementioned avian influenza control policies, it was possible to classify Poultry Production Clusters (PPCs) into 4 groups. The first group comprised poultry farmer communities united before the avian influenza outbreaks and subsequently developed into clusters according to the avian influenza control policy. The second group comprised poultry farmer communities united and implemented cooperative farming system and improved their biosecurity based on farm standard. The third group comprised poultry clusters engaged in contract farming system with large private companies. The fourth group comprised broiler clusters under compartment system of large private companies, whereby a buffer zone was established. Buffer zone referred to "an area of 1 kilometer radius around a compartmentalized broiler chicken farm in which targeted disease surveillance (e.g. routine clinical surveillance and sampling of cloacal swabs) has been implemented. Abattoirs and live poultry markets are not permitted within a buffer zone" (Rushton *et al*., 2005). For the purpose of reviewing this document, examples of poultry clusters in group 1-3 who were at risk and were more prone to disease recurrences than those under compartment system are given as follows:

Poultry farmer communities united before the avian influenza outbreaks and subsequently developed into clusters according to the avian influenza control policy: This group of poultry farmers clustered naturally; for example, the one found in Nongkhai. The characteristics of how this cluster was formed started as the farmers began raising layers along with fish rearing. The development of this farming pattern in Nongkhai took more than 20 years from the beginning stage up to the time of this study. Its special feature was raising layers in a house constructed on a fish pond, which allowed farmers to earn from the sale of both eggs and fish reared below at the same time. The highlight of this type of farming was that it helped reduce pollution problem caused by odors from the accumulation of droppings and also by the flies in the poultry farm. After avian influenza outbreaks in Nongkhai, government officials started promoting the clustering measure among farmers; but as they were already united, the officials needed only to support and educate the farmers on biosecurity system and housing improvement to prevent the avian influenza disease. There were 4 clusters of layer farmer communities of this type in Nongkhai. Each cluster comprised 40-60 farms. The social trait of these clusters was unique in that they were extended family cluster (Fig. 1-2).

Poultry farmer communities united and implemented cooperative farming system and improved their biosecurity based on farm standard: An example of this type of cluster was found in Nakhonphanom. Before avian influenza outbreaks, farmers in the cluster had raised layers for over 20 years, where the poultry house was constructed with raised open basement. Egg production was intended for local consumption within the province and nearby provinces including Lao People's Democratic Republic. After the outbreaks, government officials started promoting the avian influenza control measures; but in the same manner as Nongkhai layer farmer communities, they were already united and the officials thus needed only to encourage the farmers on biosecurity system development, implementation of layer standard farming system and cooperative farming system, whereby farmers would invest in the shares within their cluster and have a center to serve members in the acquisition of feed, medical supplies and farm chemicals (Fig. 3-4).

Fig. 1: Poultry house for layer raising constructed on a fish pond, making it possible for droppings to become fish feed and thereby allowing farmers to earn from the sale of both eggs and fish reared below

Fig. 2: Layers reared in poultry house with grooved floor, which allowed droppings to fall into the fish pond below

Poultry farmer engaged in contract farming system with large private companies: This type of poultry clusters could be found in various provinces throughout the country. An example of such clusters was the layer cluster in Mahasarakham, which entered into contract with a large private company based on a poultry farmer clustering measure of the avian influenza control policy. This cluster comprised 40-50 farms in the same area, which raised pullets, male layers and broilers. Farmers owned the land and poultry houses and received feed, medical supplies and farm chemicals from private companies such as Charoen Pokphand Group (CP), Betagro and Sriviroj Farm. After poultry grew up to the required size, they were sold back to the contracted parties. All farms in this cluster were inspected and had to meet the poultry farm standard of the Department of Livestock Development. Each farm had high biosecurity and their layers were raised in closed houses with evaporative cooling system (Fig. 5-6).

Fig. 3: Spraying of disinfectant around the farm to prevent pathogens from entering the farm

Fig. 4: Feed storage facilities for members of Nakhonphanom layer farmer cooperative

Fig. 5: Example of poultry farmer cluster raising layers, male layers and broilers under contract farming system in Mahasarakham

Fig. 6: Farm environment and biosecurity management of poultry farmers under contract farming system in Mahasarakham

After the avian influenza outbreaks threatened Thailand and the government devised a poultry farmer clustering measure, a large number of farms were then moved to the same area resulting in a high density farming structure which might affect the poultry farmers such as air pollution caused by the fermentation of poultry droppings where ammonia was produced (Ritz *et al*., 2004; Nicholson *et al*., 2004). This had direct impact on the mucous membranes in the respiratory system of poultry (Wheeler *et al*., 2000; Ritz *et al*., 2004; Patterson and Adrizal, 2005) and caused air pollution which spread to the community and posed health problems to the farmers; for example, causing toxic pneumonitis, airways inflammation and chronic bronchitis (Wheeler *et al*., 2000; Ritz *et al*., 2004; Rylander and Carvalheiro, 2006). Flies in the poultry houses were likely to cause nuisance (Winpisinger *et al*., 2005) and also served as carriers of human diseases (Crespo *et al*., 1998; Geden, 2005; Nazni *et al*., 2005). Dust contaminated by pathogens in poultry houses could cause diseases in the farmers, such as *Bacillus* spp., *Micrococcus* spp., *Proteus* spp., *Pseudomonas* spp., *Staphylococcus* spp. and *E. coli* and common anaerobic bacteria such as *Clostridia* spp. (Just *et al*., 2009). Moreover, dust could also cause allergic rhinitis in farmers (Rimac *et al*., 2010) as well as emerging diseases of poultry that could be transmitted to humans such as avian influenza which might infect farmers (Dejpichai *et al*., 2009; Hadipour, 2010). Apart from health problems of both poultry and farmers, concentrated farming in the same area might also affect the environment of the surrounding areas or the communities around these poultry clusters. It could therefore be seen that government policies launched to tackle the spread of avian influenza might cause other problems to ensue.

At the time of this study, the concept of Ecohealth, which focused on the surrounding ecology such as physical environment, economic and social aspects and culture relating to health and welfare of human beings (Plaen and Kilelu, 2004) had played a key role in studying the impact of environment on human health; for example, if there were environmental changes, they could affect the control of infection outbreaks, the increased proliferation of pathogens and the increase in disease vectors. Moreover, the environmental changes might indirectly affect human health; such as lifestyle changes which resulted in stress (Patz, 2006), etc. Recognizing the importance of the evaluation of poultry farmer cluster's Ecohealth would therefore help in the understanding of the impacts caused by government policies to control and prevent avian influenza and the impacts of poultry farmer clustering on economic, social, environmental, cultural, biodiversity, farmer and poultry health and farm biosecurity aspects which affected the health of these poultry farmers. The understanding of these impacts would enable the farmers to adapt and behave in accordance with environmental changes. The future direction of these poultry farmer clusters should therefore be in the improvement of the quality of life of farmers, the promotion of appropriate management and caring of environmental changes, the strengthening of biosecurity, the clustering of farmers within the communities; which would allow farmers in these poultry clusters to have a better quality of life and which would also lead to more appropriate policies of the country.

Conclusion: Poultry farming in Thailand dated back long time in the past; until the late 1970s, the government had a policy to support the production of poultry for export. In addition, with the change in poultry consumption culture, local poultry production became highly successful. In 2005, poultry accounted for 52% of the total meat production in the country. Poultry industry created local employment for more than 110,000 people. After the outbreaks of avian influenza during the years 2003-2004, Thailand launched many policies to control the spread of the disease such as culling of poultry and compensation for damages, destroying products, litter, waste materials and droppings of the infected poultry, cleaning and disinfecting the poultry houses, disease surveillance, poultry movement restriction, enactment of legislation to control poultry farming that focused on biological safety, zoning of poultry farms, clustering of poultry farms and use of compartment system in farming intended for both domestic consumption and export. Public health measures were also devised to control the transmission of disease to humans and as a result, there was no more report of avian influenza infection in humans after 2007. Based on poultry farming control measure through clustering, poultry farmers could be

classified into 4 groups; namely, poultry farmer communities united before the avian influenza outbreaks and subsequently developed into clusters according to the avian influenza control policy, poultry farmer communities united before the avian influenza outbreaks and subsequently implemented cooperative farming system according to the avian influenza control policy, poultry farmer engaged in contract farming system with large private companies and poultry farmer under compartment system of large private companies. However, after the poultry farm clustering policy was launched, there was still a lack of information concerning Ecohealth with regard to economic, social, environmental, cultural, poultry biodiversity and farm biosecurity aspects which affected the health of poultry farmers in these clusters. It was therefore necessary to study these data sets to determine the direction or policy related to the poultry farmer clusters in Thailand.

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