"Impact of avian influenza outbreaks in the poultry sectors of five South East Asian countries (Cambodia, Indonesia, Lao PDR, Thailand, Viet Nam) outbreak costs, responses and potential long term control"

by

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INTRODUTION

Highly pathogenic avian influenza (HPAI), in most cases the strain H5N1, was known to be present in all countries of this study in 2003 and was officially reported by all countries in January 2004 (OIE, 2005; FAO, 2004). The outbreak appears to be most widely spread in Indonesia, Thailand and Viet Nam, with the latter two countries also reporting human cases and fatalities (FAO, 2005). The importance of this disease is a combination of:

- The high levels of mortality with flock mortality rates often above 50%. The highly infectious nature of HPAI also requires severe control methods to restrict an outbreak, which would normally include the culling of apparently healthy birds that have been in contact with infected ones. In addition, some countries have adopted vaccination strategies to reduce the numbers of susceptible birds. The high bird mortality caused by HPAI and the costly control methods will be demonstrated with data from the study countries in this document.
- The presence of HPAI restricting international trade in live birds and poultry meat products and affecting tourism. Where poultry export industries have been developed, there are impacts in terms of threats to important investments and employment in the poultry industry and the service sector to this industry. Leslie and Upton (1999) report the positive benefits from disease freedom of livestock product orientated countries. The reappearance of FMD in the Southern Cone of South America and the emergence of HPAI in Thailand demonstrate how animal disease related trade embargos severely affect the economies of exporting countries.
- Infection of other poultry and livestock species, with HPAI reported to infect ducks, geese, quails and pigs. The importance of these infections is less about morbidity and mortality in these species, and more about maintaining a reservoir of disease, especially in ducks, and potentially creating influenza strains that threaten human health.
- Zoonotic impact – there have been 67 confirmed human cases (17 Thailand; 30 Viet Nam; 20 Hong Kong) of avian influenza A (H5N1) in Asia with 41 deaths (12 Thailand; 22 Viet Nam; 7 Hong Kong) (WHO, 2004a; 2005). Fears about the zoonotic impact have also reduced demand for poultry products in the countries affected.
- The danger that a new strain may evolve that could infect humans and be transmitted within the human population. WHO (2004b) estimate that between 2 to 7.4 million human deaths could be caused by a new influenza pandemic, and report that the current situation with avian influenza A (H5N1) has satisfied two of the prerequisites of the start of a new human influenza pandemic three times in the last 8 years.

However, the epidemiology and ecology of the HPAI virus are currently inadequately understood to determine full strategies for its eradication. An important aspect of the

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epidemiology is the understanding in detail of the economics and social impact of HPAI and its control. These impacts have importance in terms of understanding the secondary spread of disease and also the choice of the most effective control methods. The current paper presents information on these aspects based on studies of the poultry sectors, veterinary services and potential strategies for HPAI in Cambodia, Indonesia, Lao PDR, Thailand and Viet Nam.

The countries in the review are very different in terms of their size, level of development, population and density of population. Indonesia has the largest population, the smallest proportion of its population in the rural areas, but has a similar population density to Thailand. Viet Nam has the highest population density and Lao PDR the lowest (see Table 1)

Table 1. Land area, population and population density in the five study countries (CIA, 2004; FAOSTAT, 2004).

Country	Land area ('000 km2)	Population			Population density
		Total (million 2004)	Rural		
			Number (million 2000)	%	
Cambodia	176.5	13.4	10.9	81.5	75.9
Indonesia	1.919.4	238.5	124.8	52.3	124.3
Lao PDR	230.8	6.1	4.3	69.9	26.4
Thailand	511.8	64.9	48.8	75.3	126.7
Viet Nam	325.4	82.7	59.3	71.7	254.1
Total	3.163.8	405.6	248.2	61.2	128.2

In terms of economic development, Indonesia has the largest economy and Thailand the highest GDP per capita. The total labour force in the region is estimated to be 196 million, of which half are employed in the agricultural sector, with as many as 80% employed in Lao PDR. The difference between incomes in the urban and rural areas is greatest in Thailand and lowest in Lao PDR (Table 2).

Table 2. The economy, labour force and GDP per capita (PPP$[3]) in rural and urban areas of the five study countries (data from FAOSTAT, 2004; CIA, 2004; author's analysis).

Country	Economy			Labour force		GDP per capita (2004 PPP$)		GDP per capita in rural areas as a % of	
	GDP (2004 PPP$)	GDP per capita (2004 PPP$)	% from Agriculture (2003)	Number (Million)	% in agriculture	Urban*	Rural**	GDP per capita	GDP per capita in urban areas
Cambodia	25.0	1 900	35.0	7.0	75	6 568	802	42.2	12.2
Indonesia	758.8	3 200	16.6	105.7	45	5 568	1 009	31.5	18.1
Lao PDR	10.3	1 700	49.4	2.6	80	2 840	1 196	70.4	42.1
Thailand	477.5	7 400	9.8	34.9	49	26 883	958	12.9	3.6
Viet Nam	203.7	2 500	21.8	45.7	63	6 817	749	29.9	11.0
Total	1 475.3	3 638	15.7	195.9	51	7 907	931	25.6	11.8

* Urban GDP per capita - All aspects of the economy except agriculture divided by the urban population

** Rural GDP per capita - The agricultural economy divided by the rural population

All the economies of the study countries have grown rapidly over the last 15 years, but all reported difficulties during the late 90s due to the Asian financial crisis. However, the following data show very strong recovery (CIA, 2004):

[3] Purchasing Power Parity

- Cambodia reported 5% annual growth in the period 2000-03 and it is estimated to have grown at 5% in 2004;
- Indonesia despite difficulties is expected to have grown at 4.1% in 2004;
- Lao PDR is reported to have grown annually at 7% between 1988 and 2000 and is expected to have grown at 5.5% during 2004;
- Thailand is reported to have grown at 6.3% in 2003 and is expected to have grown at 6.7% in 2004; and
- Viet Nam reported 9% growth in the early 90s, 6 and 7% between 2000 and 2002 and it is expected to be 7.2% in 2004.

The region as a whole, therefore, is experiencing strong growth, but in the case of the smaller economies of Cambodia and Lao PDR this is from a very small base.

These background details on human population and economic development are important when putting the impact of avian influenza into perspective. There are two aspects of relevance: the reliance of the economies and labour markets on the agricultural sector and the ability of individual countries to finance and deal with a crisis in the agricultural sector. While none of the countries could be placed in the developed category, it would appear that the potential tax base for Indonesia and Thailand are much larger and more robust than those of the other countries reviewed.

DESCRIPTION OF THE POULTRY SECTORS

Where possible the paper will use a classification system developed by FAO (2004) to describe the poultry sectors. This is not the only classification system for poultry (Rushton and Ngongi, 1998; Spradbrow, 1993), but is probably the most appropriate for macro level analysis of poultry sectors with regard to avian influenza control. The classification system has defined four poultry production systems according to the level of biosecurity and the marketing of birds and products (see Table 3).

Table 3. Classification system for poultry production systems (FAO, 2004).

	Sector 1	Sector 2	Sector 3	Sector 4
System	Industrial integrated	Commercial	Commercial	Village or backyard
Biosecurity	High	Moderate to high	Low to minimal	Minimal
Bird and product marketing	Commercial	Usually commercial	Birds usually sold in live bird markets	Birds and products consumed locally

It is believed that infection is more likely in sectors 3 and 4, but if sectors 1 and 2 get infected the impact will be greater (FAO, 2004).

There are important differences between the countries with Cambodia and Lao PDR having relatively low poultry densities in comparison to the other countries. The number of domestic birds per person is highest in Thailand and lowest in Cambodia and the proportion of species other than chickens is highest in Viet Nam and Cambodia. Ducks are particularly important in these countries (see Table 4).

Table 4. The number of chicken and total domestic birds per Km2, person and rural person (data from FAOSTAT, 2004; Ministry of Agriculture, Indonesia, 2005; CIA, 2004; analysis by the authors).

Country	Number of chicken per			Number of all domestic birds per		
	KM2	Person	Rural person	KM2	Person	Rural person
Cambodia	94,5	1,2	1,5	130,2	1,7	2,1
Indonesia	143,6	1,2	2,2	167,5	1,3	2,6
Lao PDR	66,2	2,5	3,6	74,0	2,8	4,0
Thailand	459,6	3,6	4,8	509,1	4,0	5,3
Viet Nam	501,3	2,0	2,7	716,1	2,8	3,9

In the following section, these very general details will be supplemented by more specific information for each country.

CAMBODIA

VSF (2004) identify two different systems in the Cambodian poultry sector: backyard/small-scale and commercial. The commercial sector is further sub-divided into broiler, layer, duck and hatchery systems. The most important poultry populations are found in Pursat (15%), Takéo (11%), Kampong Cham (10%), Kandal (8.6%), Prey Veng (8.6%), Kampot (7%) and Kampong Speu (7%).

The backyard systems dominate the poultry sector in terms of the number of farms and the population, but the farm size is small. The commercial sector has much less than 1% of the total farms, but 10% of the national flock (see Table 5).

Table 5. Number of farms and bird populations in the different Cambodian poultry systems (data source FAO, 2005b and VSF, 2004; analysis by the authors)

System	Number of farms				Population ('000)				Farm size	
	Chicken	Duck	Total	%	Chicken	Duck	Total	%	Chicken	Duck
Backyard	1,881,000	380,000	1,900,000	99.94	11,955	2,727	14,682	90.07	6.36	7.18
Commercial										
Broilers	74		74	0.00	379		379	2.32	5,117	
Layers	108		108	0.01	400		400	2.45	3,704	
Duck systems		951	951	0.05		841	841	5.16		884
Hatcheries, parent stock	58	30	88	0.00				0.00		
Cambodia			**1,901,221**	**100.00**			**16,301**	**100.00**	**8.57**	

The backyard systems are low input-output systems. Where chickens are kept very few eggs are eaten, and birds are the main output either for home consumption or for sale as live birds. Ducks are important providers of eggs both for sale and consumption. Mortality rates are high, with between 50 to 60% annual rates being common. In the VSF (2004) study, 80% of the household keep only chickens, 19% chickens and ducks and 1% only ducks.

The broiler and layer industry is concentrated in the provinces of Kampong Speu, Kandal, Phnom Penh and Siem Reap, which combined have 88% and 95%, of these flocks respectively. Within the exception of Siem Reap, all these provinces are close to the capital Phnom Penh. There is only one chicken hatchery in Cambodia, which is found in Kandal and owned by the Thai firm CP. This company also dominates the broiler sector where two thirds of the farms are part of their integrated system. CP is also important in the production of pullets with 57 integrated farms, but less important in egg production where it has 12% of the layer farms under contract. The investment in housing in these commercial chicken sectors is relatively high, but not all systems have closed housing.

The commercial duck population is more widespread, but there are concentrations of the national flock in the provinces Takéo (29%), Battambang (21%) and Kampong Cham (10%). With the exception of Battambang all these provinces are close to the capital Phnom Penh. The duck systems generally have low levels of investment in housing and the ducks are raised outdoors.

For the commercial sectors there is a reliance on imported eggs and day old chicks before the HPAI outbreak with the purchase of between 160 to 260 thousand chicks per month from Thailand. In addition, the CP hatchery had the capacity to produce 120 thousand broiler chicks and 24 thousand layer chicks per month. It is noted that the parent stock are also imported from Thailand. There are 20 to 30 local duck hatcheries concentrated in Takéo, which were started some time ago and there are imports of ducklings from Thailand and Viet Nam.

Chickens and ducks are generally marketed live, being brought into the main centres of consumption by car and then distributed locally on motorbikes.

From the data available, the Cambodian poultry sector is dominated by backyard or sector 4 systems. There appears to be no systems that could be classified as sector 1, and the majority[4] of commercial chicken systems could be classified as sector 2 with the rest plus the duck systems in sector 3. Cambodia does not export poultry or poultry products.

INDONESIA

CASERED (2004) present a classification of the Indonesian poultry sector based on the FAO system. In commercially orientated production systems (sector 2) there are thought to be 58.2 million birds in 83 thousand farms, and these systems employ a total of 385 thousand people. They are also nearly 16 thousand farms that have high level biosecurity (sector 1) and are associated with industrially integrated system. These farms are intended to have an export focus and are estimated to have a total population of 9.7 million birds. Johnston *et al*. (1992) in study on Newcastle disease in South Asia estimated that 174 million birds were kept in backyard systems (sector 4) with an annual offtake of 175 million birds and 43.5 million eggs. Assuming that there has been little change in this backyard production flock over the last 15 years this would suggest that the remaining 32.4 million birds are found in sector 3 (see Table 6).

Table 6. Indonesian chicken population by production system (data from CASERED, 2004; Ministry of Agriculture, Indonesia, 2004; Johnson et al, 1992; authors analysis).

	Nucleus*	Number of farms	Population (million birds)	Average farm size
Industrial Integrated (sector 1)				
Broiler	354	13 520	3.00	222
Layer	128	2 418	6.70	2 771
Total	482	15 938	9.70	609
Commercial (sector 2)				
Broiler		45 934	38.30	834
Layer		37 707	19.90	528
Total		83 641	58.20	1 362
Other (sector 3)**			32.39	
Backyard (sector 4)			175.00	
Total			275.29	

* Centres for the integrated systems.

[4] The CP integrated farms.

** Estimated by the authors using the national population minus the populations in all other systems.

The real size of the national poultry flock is open to question, the authors having encountered three different estimates that vary widely (1 218 million from FAOSTAT in 2002, 900 Million from a FAO report of HPAI impact and 275 million from the Ministry of Agriculture, Indonesia). It is suggested that the only sector that is likely to be relatively constant is the backyard system.

Fabiosa et al (2004) report that the Indonesian broiler industry (sectors 1 to 3) is protected by restrictions on the import of chicken pieces. This protection meant, that before the HPAI outbreak, domestic prices for chicken were 55% higher than world prices. The broiler sector has responded to this protection with rapid expansion based on imported maize and soya bean. Therefore, the broiler industry was severely affected during the financial crisis in the late 1990s. Production in 1998 was half that recorded in 1996 and only recovered to the 1996 levels in 2002. Therefore, the Indonesian broiler industry was just recovering when the HPAI outbreak began.

Exports from the broiler industry are minimal and do not seem to be competitive (Fabiosa et al, 2004). The household group identified by Fabiosa *et al*. (2004), which would probably correspond to sector 3, received higher prices for their birds (in 1996 5 514 versus 3 771 Rupiah/bird) but had lower feed conversion ratios (2.48 versus 2.39) than the commercial sector. Average bird weight from the broiler sector was between 0.8 to 1 kg suggesting that the majority of the birds are local breeds. Despite the Fabiosa *et al.* (2004) analysis not including fixed costs, they suggest that even without HPAI the Indonesian broiler industry would have difficulties in responding to growing domestic demand for poultry meat in the near future.

LAO PDR

In Lao PDR poultry production is dominated by smallholders backyard systems (80 to 90% of birds), with a relatively small private sector that raise chickens in semi-intensive systems. It is reported that women and children are responsible for poultry production in the smallholder systems, and that it is normally combined with other livestock production systems such as ducks, pigs and cattle (Dolberg, 2004; Vannasouk, 2004). A majority of farm households keep poultry and the number of birds per household is between 10 and 28 (Vannasouk, 2004).

The poultry population is concentrated in the provinces of Vientiane Capital, Champasack and Savannakhet. The Vientiane Capital also has over half of the national broiler and layer population and has by far the highest density of poultry at 943 birds per km2. The duck population is found in the provinces of Vientiane Province, Khammouane, Borikhamxay and Vientiane Capital, with these four provinces holding 98% of the national duck flock. The commercial sector is reported to rely on replacement chickens from Thailand and ducks from Viet Nam (Webb, 2004).

Local poultry breeds are important in the production systems and are preferred by consumers. In late 2004, the price for a local breed chicken was nearly twice that for an exotic breed broiler (US$2.20 versus US$1.30). Chicken is the cheapest meat in the market. There also appears to have been a shift from chicken to pork during 2004 as pork prices have increased more sharply than other meats during this period (Dolberg, 2004). Webb (2004) reports that there are no large poultry markets or slaughterhouses in Lao PDR.

According to Vannasouk (2004) and Webb (2004) Lao PDR does not export poultry or poultry products, but imports these products from Thailand, Viet Nam and China depending on prices. The volume of this trade is not available as the majority takes place illegally. It is

also noted that the provinces of Savannakhet and Borikhamxay in the central region of the country are important routes for livestock trade between Viet Nam and Thailand.

In the case of Lao PDR, the use of the FAO classification system would mean that the poultry production systems could be placed in either sector 3 or 4. This would not appear to be a problem if these sectors are relatively homogenous, but if there are major differences in the groups there may be a need for further sub-division. This is perhaps of greatest relevance in the regions of the country where ducks are important and may be kept in mixed systems with chickens.

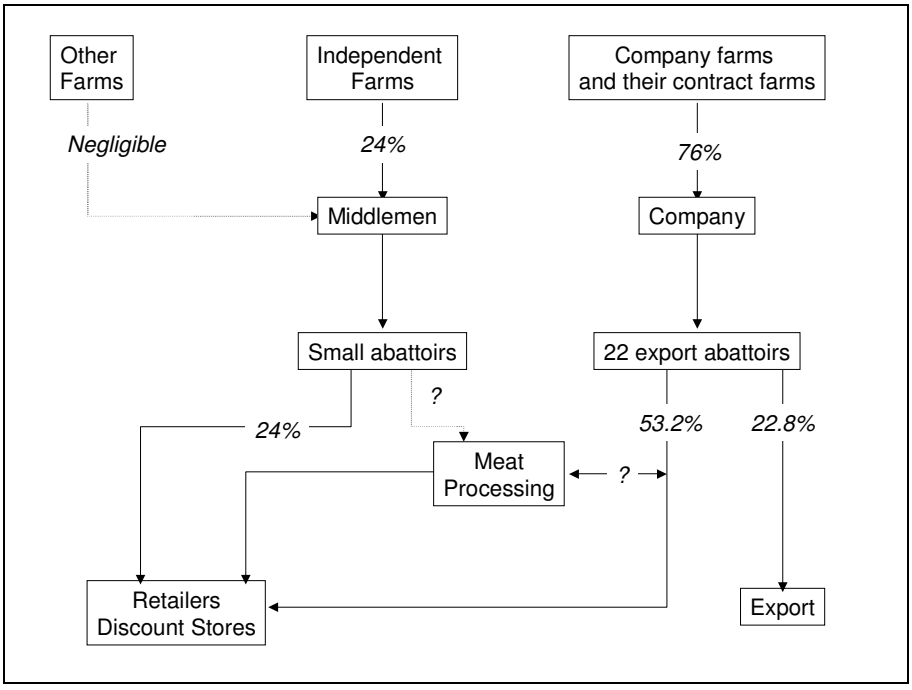
THAILAND

During the last 20 years the Thai poultry industry has grown rapidly, but this growth has been concentrated in broiler production. Broiler production is estimated to be around 50% of the livestock GDP and contribute 90% of the livestock product export in the country (Costales, 2002). The main export market is Japan, but during the 1990s there has been an increase in exports to the European Union, the latter is important as the Thai poultry sector has had to comply with strict rules on animal health and food processing. In 2002 Thailand was the fourth most important poultry meat exporter in the world with 7.52% of the world poultry meat exports (USDA, 2004).

The growth in the sector is seen as remarkable given the humble background of poultry production in the 1970s. The major advances have been achieved through contracting systems for production, introduction of improved production system technologies and government regulations and tax incentives that have allowed and promoted dual systems for processing. In forefront of the Thai broiler production development is the company CP.

The domestic system for processing uses small slaughterhouses, whereas the export-orientated system uses more advanced systems that allow access to other markets. However, it appears that these two systems are converging with more and more product being processed through the export orientated systems. Information on the broiler marketing chain is presented in Figure 1.

Figure 1. Flow of products in the Thai broiler marketing chain (modified from Costales 200?).



Costales (2002) presented data on populations and the number of producers in the large-scale formal sector, but this excludes the back-yard systems and potentially small scale commercial units. In addition, there is an important fighting cock sector, where it is reported that bird genetics are of great value. Therefore, the authors have made some estimates to have some idea of the importance of all sectors (see Table 7).

Table 7. Poultry production systems in Thailand (data from FAOSTAT, 2004; Statistics Branch, Planning Division, DLD, MAOC, 2001 cited by Costales, 2002; analysis by the authors)

Poultry system	Farms		Population		Average farm size
	Number ('000)	%	Number (Million birds)	%	
Other farms*	9 491.36	99.67	35.40	14.01	4
Broiler**	10.48	0.11	91.57	36.25	8 741
Native chicken**	8.37	0.09	72.97	28.89	8 719
Layer**	7.46	0.08	24.80	9.82	3 325
Duck (all types)**	4.77	0.05	27.88	11.04	5 848
Total	**9 522.43**	**100.00**	**252.63**	**100.00**	**27**

* Number of farms is based on the rural population divided by 5 (estimated average family size) and multiplied by 0.8 (assuming 80% of rural families keep poultry). Population[5] is estimated on the difference between the MAOC data and FAOSTAT

** MOAC data, which does not include broiler, native bird and duck farms with less than 500 birds nor layer farms with less than 100 birds.

Broiler, layer and duck farms are concentrated in the Central region of Thailand. Relatively large farms, where the majority have more than 2,000 birds, dominate the broiler sector. Egg production is divided between farms with between 100 to 300 birds and much larger farms of more than a thousand birds. The duck farms are generally small-scale. This Central region includes the Bangkok metropolis, which is the largest meat market. The recent expansion in broiler production has been in the Northeast region. The bird production systems with native breeds are concentrated in the North and Central regions and are mainly small-scale production systems of between 500 to 1000 birds. These data indicate that small-scale egg and duck production operates close to large-scale broiler and layer farms in areas with high bird concentrations. It should also be noted that this analysis does not include the backyard production nor the fighting cock systems (sector 4).

There have been changes in the geographical distribution of chicken farms between 1992-2001. The traditional poultry raising provinces were Cholburi, Chacherngsao, Nakorn Pathom, Ayuhaya, and Nakorn Ratchasima. Recent expansion areas were observed to be towards the east of Bangkok in the provinces of Saraburi, Nakorn Nayok and Prachinburi, towards Supanburin in the west, and Lopburi in the Central region. Sector 1 producers are choosing new locations, which are some distance from the traditional poultry producing areas and close to the major maize and soya producing regions (Costales, 2002).

VIET NAM

Delquigny *et al.* (2004) identified three basic systems of poultry production in Viet Nam: family, semi-industrial and industrial (see Table 8). In isolated areas, the villages and their flocks have been likened to islands in rice fields (Nguyen, 1992). In a description of problems with Newcastle disease control, Nguyen (1992) states that these isolated flocks are

[5] This estimate is much lower than that made by Johnston et al (1992) based on the ACIAR work on the control of Newcastle disease in the 1980s and 1990s.

susceptible to disease brought in by purchased birds, whereas in the more populous areas there is much more contact between flocks and hence more regular circulation of disease.

Table 8. The systems of poultry production in Viet Nam with estimates of their importance in terms of national poultry production (data from Delquigny et al. 2004; analysis by the authors).

Characteristic	System		
	Family	Semi-industrial	Industrial
Number of Producers	13 million	5 000	2 000
Average flock size	<500	1 to 3 groups of 500 to 2 000 birds per year	> 2 000
% of national production	65%	10-15%	20-25%
Details of their systems	Buy day-old-chicks sell live birds. Much of the produce is consumed locally.	Buy in day old chicks from foreign and Vietnamese companies	Includes State farms

Delquigny *et al*. (2004) report that a small number of birds are processed through slaughterhouses, but the majority are marketed as live birds. This would indicate that few systems could be classified as being in sector 1.

A Thai firm called CP, which is the only integrated firm in the country dominates industrial sector. CP import eggs from Thailand, and it represents half the industrial sector or 10% of the national production. Cargill are the second largest firm and they import parent stock from Malaysia. Jafa, an Indonesian firm and PROCONCO are also important in the market.

SIMILARITIES AND DIFFERENCES BETWEEN THE IDENTIFIED SECTORS IN EACH COUNTRY

Cambodia and Lao PDR have similar poultry systems, which are dominated by smallholder backyard systems with small commercial sectors. The commercial sectors are dependent on outside inputs and both countries are small importers of poultry products. Viet Nam has more developed poultry systems, but again these are dominated by backyard systems (sector 4). The Vietnamese commercial sector is also dependent on the imports of hatching eggs, day old chicks and parent stock. In all these three countries the marketing is through live birds, with only Viet Nam processing some poultry meat through official slaughterhouses. The Indonesian poultry systems have all four identified sectors. There are some exports from this country, but these are insignificant in comparison to national production. Thailand has the most advanced systems of all the study countries with a majority of the production coming from sector 1, whilst the majority of the producers are found in sectors 3 and 4. This country is an important exporter of poultry meat and poultry genetics. A summary of the poultry systems and their classification into sectors is presented in Table 9.

Table 9. Classification of the poultry systems in the five study countries using the proposed FAO system (2004).

Country	Sector 1	Sector 2	Sector 3	Sector 4
Cambodia	Believed not to exist	68 broiler units 9 layer units 1 hatchery 57 pullet raising units Estimated to be around 400 thousand birds	40 broiler units 65 layer units 20-30 duck hatcheries 951 duck units Estimated to have 400 thousand chickens and 841 thousand ducks	99.9% of the farms (1.9 million) and 90% of the poultry population (11.96 million chickens and 2.73 million ducks)
Indonesia	9.7 million poultry, export orientated, but with a large proportion of the production for national consumption	58.2 million poultry for the national market	32.4 million poultry	174 million birds producing 175 million birds per year and 43.5 million eggs
Lao PDR	Believed not to exist	Relatively insignificant	10% of the poultry population concentrated around Vientiane	90% of the poultry population
Thailand	70% of national production. This sector has an important export market.	20% of production	10% of production, but almost 99% of producers	
			36% of farms and 20% of the population[6]	61% of producers and 10% of the population[7]
Viet Nam	Relatively insignificant	20-25% of production, but very few producers	10-15% of production, but very few producers	65% of the production with a significant proportion of the population involved possibly 70% of the population

With regard to the appropriateness of the FAO classification system, there are difficulties in placing farms and populations into the identified sectors, but in particular sectors 2 and 3. With the exception of Cambodia, the data available was inadequate to strictly apply the system. For this system to be truly useful national statistics institutions need to adopt the classification criteria during their data collection activities.

INTERRELATIONSHIPS BETWEEN THE COUNTRIES

It is worth noting at this point the importance of Thailand in the region, not just as the most advanced country for poultry production and export of poultry meat, but also as a major supplier of poultry genetics, poultry production inputs and technical assistance. The Thai companies are obviously influencing the development of the poultry sectors, particularly in Cambodia and Viet Nam. This is a strength in terms of regional poultry technology transfer, and the need to supply cheap protein to growing populations who are becoming richer. However, it is also a potential weakness in the regional control of HPAI.

IMPACT OF AVIAN INFLUENZA

Verbiest and Castillo (2004) separate the impact of HPAI into macro and micro-economic impacts. They state that macro impacts will be greater for a poultry exporting country such as

[6] Farms with between 20 and 99 birds in 1998 (FAO, 2005b)

[7] Farms with between 1 and 19 birds in 1998 (FAO, 2005b)

Thailand[8], where they believe that between a half and 1.5% of GDP growth could be lost depending on the length of the outbreak. These figures compare well with World Bank macro level estimates for the HPAI outbreaks in Viet Nam of between 0.3% to 1.8% of GDP (FAO, 2004). Two outbreaks in the USA have been estimated to have cost US$65 and 140 million in disease control and loss of poultry (FAO, 2004). In Thailand, it is estimated that agricultural growth halved during the year of the outbreak (FAO, 2004). In Hong Kong the 1997 outbreak led to the slaughter and destruction of the entire poultry flock of 1.5 million birds and is estimated to have cost hundreds of millions of dollars when taking into account the knock on effects on the general economy (FAO, 2004). However, WHO (2004a) report that the rapid response to this outbreak probably avoided a human flu pandemic.

In general, Verbiest and Castillo (2004) state that HPAI is relatively unimportant at the macro-level because the poultry sector is not of great importance to the economies in the region and this view would be supported by the robust growth of the countries most badly affected by the disease in 2004. However, Verbiest and Castillo (2004) do recognize that HPAI would have strong micro impact particularly in regions where smallholder farmers are dependent on poultry production and would have difficulties in overcoming the costs of culling and restocking in the face of an outbreak. These authors recommend the need to think about direct support where this is the case, but they believe that this will be difficult in countries such as Cambodia and Lao PDR due to fiscal constraints. They also recommend the need for studies of poultry production in smallholder systems. In response to this need FAO have conducted micro-level studies of the impact of HPAI in four of the five study countries (TCP/RAS/3010) using local institutions to carry of the research (Cambodia VSF, 2004; Indonesia CASERED, 2004; Lao PDR MAFPD, 2004; Viet Nam Delquigny, 2004). The following sections provide a summary of the key data collected during this study.

Cambodia

Cambodia first reported HPAI in the Kandal and Kean Suay provinces in January 2004, with their last official report in September of that year. The affected farms were predominantly in the commercial sector and the total number of birds lost due to HPAI and its control was minimal at nearly 23 thousand (see Table 10).

Table 10. The provinces, systems and number of birds affected by HPAI in Cambodia in 2004 (OIE, 2005).

Month	Provinces affected	Number of birds affected			System
		Killed	Destroyed	Total	
January	Phnom Penh	3 200	3 300	7 500	Layer farm
March	Kandal Phnom Penh Siem Reap Takéo	4 799	6 125	10 924	3 layer farms 2 broiler farms 1 duck flock 3 local chicken farms 1 wildlife rescue centre
September	Kandal	360	4 400	4 560	Broiler farm
Total		**8 359**	**13 825**	**22 984**	

The very minor impact of HPAI in Cambodia in terms of direct deaths and control measures of stamping out have to weighed against the impact in the markets for egg and poultry meat

[8] According to data from USDA (2004) in 2002 Thailand exported 38% of its poultry meat production, Indonesia exported only 0.4% and the other countries did not report any exports. Thailand also exported what was equivalent to 3.7% of its chicken population and 0.6% of its duck population as live birds. Viet Nam is reported to have exported 1.5% of its egg production, Thailand 0.5% and Indonesia 0.1%.

during the early stages of 2004. VSF (2004) report significant reductions in price in poultry products during the first 2 months of 2004, but these prices recovered and were higher than the 2003 prices in mid 2004. Combining this information with the quantities sold by traders, the authors have estimated the losses incurred in terms of the difference between the monthly market before and during the outbreak and how long it would take for these losses to be recouped at the higher prices after February 2004. It would appear that the broiler and then the egg market were most severely affected (see Table 11).

Table 11. The price, quantity[9] and market value per broiler, egg and duck before, during and after the initial stages of the HPAI outbreak in Cambodia (data from VSF, 2004)

Item	Price per unit (US$)*			Quantity			Total Value per month (US$)*			Estimated Losses during Jan and Feb	Number of months to recoup losses
	Before	During (Jan and Feb)	After	Before	During (Jan and Feb)	After	Before	During (Jan and Feb)	After		
Broiler	1.04	0.39	1.30	4,500	250	3,800	4,678	97	4,938	9,161	35.3
Eggs	0.05	0.03	0.05	22,000	1,000	22,000	1,029	29	1,201	2,001	11.7
Ducks	0.91	0.81	1.30	300	10	300	273	8	390	530	4.5

* Exchange rate US$ = 3 848 Riel (Financial Times, 2005)

In addition to changes in poultry product prices, there was an increase in prices for pork, beef and fish from early 2004 indicating a clear shift to other protein sources. These price increases remained even after people began buying poultry products again in March. There were no data on quantities of these products sold, but the people who would gain from these changes would probably be the retailers, and possibly the farmers. The losers would be the poorer consumers who presumably reduced their protein intake during the early months of 2004. Details of this impact of HPAI in Cambodia are not clear and deserve further investigation.

The exact impact of HPAI in Cambodia is very difficult to determine. There has been little or no impact in terms of bird losses, but there have been major changes in the markets for poultry products and also changes in the prices for other protein products. These changes have affected the profit margins of various poultry systems, with probably the most seriously affected being producers with high fixed costs and borrowings. However, the other losers in the protein market changes are likely to be poor consumers who would have had to pay higher prices for protein during and after the outbreak. It is likely that these people will have reduced their protein intake.

Lao PDR

Lao PDR officially reported HPAI in January 2004 close to the city of Vientianne, but has not reported the disease again since (OIE, 2005). Webb (2004) stated that 38 of the 45 outbreaks occurred in the Vientiane capital province, with a majority of the reports from Xaysettha district (12) and the lowest number from Sisattanak. A majority of the reported outbreaks (42 out of 45) occurred in the commercial sector (Webb, 2004). These figures look insignificant in terms of their general impact on the poultry industry in Lao PDR, even in the most badly affected province where only just over 3% of the total flock was affected (see Table 12).

[9] These are not total quantities for the market, they are based on quantities bought by a small number of traders interviewed by VSF (2004).

Table 12. The number of farms and birds lost during the HPAI outbreak in Lao PDR (data from Webb, 2004; Vannasouk, 2004; authors analysis)

Province	Bird Population		Number of farms affected		Losses			% of provincial population	% of national losses
	Total ('000)	%	Commercial	Backyard	Birds killed	Birds destroyed	Total		
Vientianne Capital	3,700	19.0	42	3	40,024	79,811	119,835	3.2	79.4
Savannakhet	2,031	10.4	4	1	9,283	16,602	25,885	1.3	17.2
Champasack	2,412	12.4	2	0	1,363	3,837	5,200	0.2	3.4
Lao PDR	**19,474**	**100.0**	**48**	**4**	**50,670**	**100,250**	**150,920**	**0.8**	**100.0**

However, there were certain systems more badly affected than others during the outbreak, with the commercial systems losing as much as 20% of the national layer flock and 40% of the layer flock in the Vientianne Capital province. The other system to be badly affected was the commercial quail system where just over a third of the national flock was lost (see Table 13).

Table 13. Losses by system in the Lao PDR HPAI outbreak (data from Webb, 2004; Vannasouk, 2004; authors analysis).

Province	Layer		Broiler		Quail	
	Losses	% flock	Losses	% flock	Losses	% flock
Vientianne Capital	88,158	40.5	17,255	3.8	10,947	35.5
Savannakhet	5,300	14.0	860	0.4	16,975	No data
Champasack	500	3.3			4,700	10.3
Lao PDR	**93,958**	**20.1**	**18,115**	**2.1**	**32,622**	**34.1**

The impact of HPAI in Lao PDR has been in sector 3 and more specifically in the chicken layer and quail systems in the Vientianne Capital province.

Indonesia

CASERED (2004) have concentrated their data collection and the findings of their report on sectors 1 to 3, with a strong sense that the most heavily affected by the avian influenza problems are sector 3. Hartono (2004) identified two different periods in terms of HPAI impact:

1. Between July 2003 until 24 January 2004 when the outbreak took place a total of 15 million layers, 2 million parent stock and 86,000 broilers died or were slaughtered. The weekly supply of day-old-chicks went down (17.5% for broilers and 25% for layers). Prices remained constant as reduced supply was met with reduced demand due to fears of human infection. The implication is that the size of the market was smaller.
2. From 24 January 2004 onwards. There were large fluctuations in supply and demand. During the initial period, demand fell sharply as consumers become increasingly worried about food safety. This was combined with an increase in supply reducing chicken prices to 1,200 Rupiah[10] per kg. By April demand was beginning to recover and by June 2004 prices had reached 10,000 per kg. However, an oversupply during the months of August and September led to another drop in prices

According to Hartono (2004) there was little impact on the egg market, except for a period when eggs were smuggled into Western Java from Malaysia during the outbreak in this country.

[10] US$ = 9 159 (Financial Times, 2005)

The losses due to mortality during the avian influenza outbreak have been concentrated in the provinces of West Java, Central Java, East Java, Lampung and Bali. They were particularly severe in Central Java and Bali where it is estimated that nearly a quarter of the flock were killed (see Table 14). The OIE (2005) reports indicate that the outbreak continued through to October and the provinces, which regularly reported HPAI were Central Java, East Java, Yogyakarta, Lampung and Bali.

Table 14. Indonesian human and poultry populations and the losses due to mortality caused by avian influenza in the poultry flock in the Indonesian provinces worse affected (data from CASERED, 2004; Ministry of Agriculture, Indonesia, 2005; authors analysis).

Province	Human Population (2000)		Poultry Population (2003)		Losses due to AI Mortality		
	Number ('000)	%	Number ('000)	%	Number ('000)	% the provincial population affected	% of national losses
Lampung	6,741	3.3	12,602	4.7	2,372	18.8	14.7
West Java	43,828	21.2	31,295	11.7	1,962	6.3	12.1
Central Java	31,229	15.1	34,262	12.8	8,178	23.9	50.5
East Java	34,784	16.9	38,155	14.3	2,260	5.9	14.0
Bali	3,151	1.5	4,042	1.5	930	23.0	5.7
Other provinces	86,531	42.0	146,437	54.9	485	0.3	3.0
Indonesia	**206,265**	**100.0**	**266,794**	**100.0**	**16,188**	**6.1**	**100.0**

CASERED (2004) have carried out an analysis to determine the impact on the systems and sectors of the Indonesian poultry industry. They have focussed their analysis on sectors 1 to 3 stating that sector 4 was not influenced by the HPAI outbreak as the prices for their products did not change, their investment was small and poultry make insignificant contributions to household income. CASERED report that 15 out of 30 of the Indonesia provinces were affected with 16.2 million poultry being killed or stamped out in control efforts. The losses in terms of bird cost alone would be between US$16.2 to 32.4 million.

In addition to farm level impacts, CASERED (2004) report drops of between 45 to 60% in the demand for day old chicks and feed inputs during the outbreak and a reduction of just over a third in the employment in the poultry industry.

Thailand

The first official report of HPAI came from the province of Suphanburi in the central region of Thailand in the third week of January 2005. The following week the disease was reported through extensive and connecting parts of the central and north regions of the country where 93% of the farms affected were reported. There were also outbreaks reported in the north-east region, which were geographically unconnected to those outbreaks in the other regions of the country. The most badly affected provinces were Ang Thong, Kanchaburi and Uthaithani (see Table 15).

Table 15. Regions and provinces affected in the epidemiological week ending 30/1/04 in Thailand (Data from OIE, 2005).

Region	Province	Farms		Farms depopulated	
		Affected	% of national total	Total	% of farms affected
Central	Ang Thong	1313	19.3	287	21.9
Central	Bangkok	73	1.1		0.0
Central	Chainat	2	0.0	2	100.0
Central	Kanchaburi	2863	42.1	1892	66.1
Central	Ratchburi	15	0.2	9	60.0
Central	Singburi	45	0.7	7	15.6
Central	Suphanburi		0.0	850	
Central		***4311***	***63.4***	***3047***	***70.7***
North	Kampaengphet		0.0		
North	Phichit	36	0.5		0.0
North	Phitsanuloke		0.0		
North	Sukhothai		0.0	2	
North	Uthaithani	1524	22.4	536	35.2
North	Uttadit	477	7.0	59	12.4
North		***2037***	***30.0***	***597***	
North East	Kalasin	7	0.1	81	1157.1
North East	Nakhonpathom	242	3.6	10	4.1
North East	Sakonakhon	203	3.0	203	100.0
North East		***452***	***6.6***	***294***	
Total		**6800**	**100.0**	**3938**	**57.9**

Only two areas reported the depopulation of all affected farms and only the province of Sakanakhon has not continued to report HPAI during 2004.

There are no data available on the micro-level impact in Thailand, but FAO (2005b) report that 25.9 million birds have been culled in trying to control HPAI. However, from the OIE data it appears that the HPAI continues in many areas of the country.

Viet Nam

In Viet Nam 58 out of the 64 provinces were affected by HPAI. However, the impact of HPAI has not been the same throughout all regions of Viet Nam with 87% of the HPAI losses occurring in the Mekong delta, HCMC and South East and the Red River Delta. It is noted that these regions only have 57% of the poultry population (see Table 16).

Table 16. The proportion of the poultry population and estimated losses due to HPAI in the regions of Viet Nam (unpublished data from Jim Hancock FAO).

Region	Poultry population		Poultry destroyed			Estimated losses	
	Number ('000)	%	Number ('000)	Proportion of Regional flock	Proportion of the national losses	US$ ('000)*	%
North Central	36,680	14.0	1,902	5.2	4.4	5,133	4.4
Northern Mountains	42,190	16.1	923	2.2	2.1	4,626	3.9
Mekong Delta	58,499	22.3	18,842	32.2	43.6	49,747	42.3
HCMC and South East	25,114	9.6	9,551	38.0	22.1	27,503	23.4
South Central	16,192	6.2	1,215	7.5	2.8	2,788	2.4
Red River Delta	65,503	25.0	9,137	13.9	21.2	24,778	21.1
North West	8,040	3.1	476	5.9	1.1	1,331	1.1
Central Highlands	9,645	3.7	1,123	11.6	2.6	1,584	1.3
Viet Nam	**261,864**	**100.0**	**43,170**	**16.5**	**100.0**	**117,490**	**100.0**

* Exchange rate US$ = 15 780 Dong (Financial Times, 2005)

[11]It is noted that the Red River Delta provinces of TP Hai Noi (41%), Vinh Phuc (21%), Ha Tay (18%), Tai Binh (16%) and Nam Binh (14%) have been particularly badly affected. In the region of HCMC and South East the following provinces have suffered badly: TP Ho Chi Minh (99%); Bi Ria Vung Tau (81%); Binh Duong (79%) and Ninh Thuan (35%). In the Mekong Valley the losses have been high in Long An (87%); Tien Giang (66%); An Giang (70%) and Dong Thap (29%). Of great concern in the Mekong Valley is that the provinces with the highest losses have continued to report HPAI throughout 2004 and in January 2005 (OIE, 2005). This indicates that either the control efforts are having little impact or that outbreaks are being identified and dealt with quicker than in other regions of the country.

Delquigny *et al*. (2004) estimate the average losses per farm affected by HPAI are between US$70 and 108. In a further analysis they present a loss per bird of between US$1.11 and 1.74 per bird that dies which is much lower than US$2.72 per bird used for the estimates presented in Table 18. It is suspected that the latter estimates includes the costs of bird slaughter and disposal. There was also an impact in the market for poultry and poultry products affecting traders and retailers. During the initial stages of the outbreak demand for poultry meat fell sharply. There were also heavy restrictions on the movement of live birds. This in part was compensated by a more than doubling of prices when markets returned to normality, but it would be suspected that quantities traded would be far less than prior to the outbreak.

The impact on the backyard systems is very severe and in a village outbreak (see the following section for quantitative details) described by VSF (2004) shows that out a total village flock of nearly two thousand birds only 4% remained after the outbreak. It would be expected that similar losses would be experienced for HPAI outbreaks in backyard systems throughout the region, indicating an important micro and poverty impact.

Summary of the impact of HPAI

The impact of HPAI is generally felt throughout the chain from producer, processor to consumer (see Table 17).

[11] Figures in brackets are estimates of the bird population that has died or been destroyed.

Table 17. The impact of HPAI across the chain of the poultry industry and the general economy.

Part of the Industry	Heavy losers	Losers	Neutral	Winners
Supply Industry	Feed industry	Day old chick suppliers (assuming demand will be high after an outbreak has ended)		Veterinary profession Vaccine producers
Production	Producers with high investments in fixed capital and loans (sectors 1 and 2 and possibly 3) More important in Thailand, Indonesia and Viet Nam	Producers who lost poultry either through HPAI or stamping out (all sectors)	Producers who were not directly affected by HPAI (all sectors, but particularly sectors 1 and 2) (assumes that the lack of a market is compensated for by higher prices after an outbreak)	Beef, pig, sheep and goat producers
Marketing	Sole traders of poultry in areas badly affected by HPAI	Sole traders in areas not directly affected by HPAI	General traders of livestock	Traders of other livestock
Processing	Export orientated poultry abattoirs (sector 1 and specific to Thailand)	National supply poultry abattoirs	General abattoirs	Other livestock abattoirs
Consumers	Urban poor	Rural poor in areas affected by HPAI	Rural poor in areas not affected by HPAI Urban medium and rich who can afford other protein sources	
General	People who have died and their families. Workers in poultry export industry (sector 1 and specific to Thailand)	Workers in national poultry industry processing Tourism industry (more specific to Thailand and Bali, Indonesia)		Workers in other livestock processing industries

HPAI has also affected countries and regions of countries differently. The large scale impact depends on two factors, the importance of the poultry export market and tourism. In the case of Thailand, these two factors are very strong and HPAI will have more widespread impacts in the economy.

There are difficulties with assessing the HPAI impact detected during this study, which are as follows:

- At the micro producer level, the stage in a cycle at which an outbreak occurs will determine how much a producer will lose. At the beginning of a cycle the losses will be far less than at the end. This may have importance in the epidemiology and compensation payments, as producers at the end of cycle may be tempted to sell birds even if they suspect HPAI.
- Current information on the poultry value chains for all study countries is insufficient to identify patterns of movement, important actors in the chains and issues with regards HPAI epidemiology and economics.
- Further information is also required on how protein markets compensate for low demand in poultry products and low supply after the initial fear of eating poultry. Prices of other proteins have increased in all countries, but no information seems to be available on whether these prices are passed on to producers nor the quantities of protein products sold.

This list supplements the problems of estimating costs and benefits of HPAI control developed by FAO (2004).

PUBLIC AND PRIVATE SECTOR RESPONSE TO THE OUTBREAKS

The response to the outbreak in the study countries by the public sector is summarised in Table 18. Indonesia and Viet Nam have introduced a modified stamping out policy and Indonesia has introduced vaccination. Thailand with important export interests has banned the use of vaccine.

Table 18. Control measures and actions in the five study countries (modified from FAO, 2005 using data from FAO, 2005b)

Country	Control Measures	Actions
Cambodia	• Inter Ministerial Committee • Temporary ban on poultry imports • Establishment of technical task forces for Surveillance and diagnosis Communication and mass media Control and eradication • Stamping out within 3 kilometres of an outbreak • Investigation and surveillance between 3 and 7 kilometres from an outbreak • Movement control in outbreak areas • No compensation	• Disinfection • Quarantine
Lao PDR	• Stamping out • Movement control • Surveillance	• Import ban • Quarantine
Indonesia	• Selective Stamping out • Vaccination • Surveillance • Compensation to layer farms with less than 10 000 hens and broiler farms with less than 15 000 bird per cycle. • Credit schemes for farms who had HPAI	
Thailand	• Stamping out • Cleaning and disinfection • Surveillance • Movement control • Campaign to increase awareness and reduce panic • Other measures Improvement of biosecurity Restructuring of poultry production • No Vaccination	• Quarantine • Screening • Zoning • Compensation
Viet Nam	• Modified stamping out • Movement control • Limited compensation	• Import ban • Quarantine • Disinfection • Screening

Delquigny et al (2004) report three different outbreaks in Viet Nam of HPAI, which reveal quite different reactions:

- In the first outbreak recorded in the country, it was the company CP who informed the Vietnamese veterinary services of high levels of deaths in late December 2003. In this region birds were destroyed, but there were difference in the level of destruction of birds and eggs in different villages. No information was available on restocking.
- In a village outbreak where there were no official veterinary services detailed data were collected on the fate of sick and healthy birds affected (see Table 19). A third of the birds were consumed, just over half were destroyed and 15% were either kept or sold. In this area restocking began a month after the outbreak using the birds that remained and the purchase of some chicks. This case study is important as the actions were carried out by the villages with an animal health worker. It is suspected that similar villages in Viet Nam, Lao PDR, Cambodia and Thailand may react in similar ways, with producers perhaps believing that HPAI is similar to Newcastle disease.

Table 19. Fate of birds in a Vietnamese village affected by HPAI (Delquigny et al. 2004).

	Sick			Healthy				Total
	Consumed	Destroyed	Sold	Consumed	Destroyed	Sold	Kept	
Number	402	984	16	282	41	182	84	1991
Percentage	20.2	49.4	0.8	14.2	2.1	9.1	4.2	100.0

- An outbreak is also described for two commercial farms. In a broiler farms with 5 thousand chickens birds begin dying on day one with a mortality rate of 50% at the end of day 2. On day three the rest of the birds were slaughtered and buried using quicklime. This farm had access to a veterinarian and the producer did not want to enter the poultry unit for fear of getting HPAI. In a layer farm with 1,200 chickens, half the hens died by the second day of the outbreak and the farmer sold the rest to a trader. The farm also had 600 chicks which all died on the third day. The carcasses were disposed in a public rubbish skip.

In Cambodia all the smallholder producers interviewed said that they would continue to raise poultry, but a third said they had changed their eating habits since the HPAI outbreak. From the chicken broiler farms surveyed, 9 out of 12 wanted to continue with poultry with 2 moving to pigs, and in the duck broiler systems, 2 out of 3 farms interviewed had stopped this activity.

These case studies show the vastly different reactions to outbreaks, but that many of the reactions would suggest that awareness of removing affected birds from the environment is low.

LONG TERM ISSUES WITH AVIAN INFLUENZA CONTROL

A number of key strategies are identified and will be examined in light of the recommendations of the national workshops, the recommendations made by FAO (2004) and WHO (2004b) and authors own experience in developing disease control and eradication strategies. However, as FAO (2004) quite rightly state “The strategy adopted by governments concerning their countries, zones or compartments is determined by the perceived risk of the disease politically, socially and economically. Issues that must be considered include public health, economics, sustainability of farming enterprises, and adverse publicity associated with repeated outbreaks of the disease. For all control programmes it is recommended that:

- HPAI is notifiable; appropriate penalties for non-compliance are considered.
- If “stamping out” is used, farmers are compensated in some form (direct or indirect) for loss of stock.
- Probity and accountability in government decision making and use of public funds.
- Effective surveillance and reporting to OIE according to member country obligations.”

To this list there needs to be a recognition of the international importance and hence responsibilities in controlling HPAI in poultry and the need for flexibility in the implementation of strategies. Lesson learning needs to be a key aspect of controlling HPAI particularly as epidemiological knowledge is relatively limited. At the onset, future strategies need to have a process of prioritisation that has to be based on epidemiological and economic analysis, which in turn requires data and information generated from reliable surveillance systems. Strategies and actions can then follow from this analysis

SURVEILLANCE AND ANALYSIS

Surveillance has been identified as an important requirement in all study countries, but the authors believe that what is meant by such surveillance is limited to scientific monitoring of HPAI. This ignores a number of issues:

- In areas without HPAI producers and technical will soon lose interest in surveillance focussed on only one disease (Rushton and Viscarra, 2003).
- Understanding the movement of HPAI requires surveillance of the poultry industry in terms of bird and product movement.
- Surveillance of smallholder producers is not easy. In Lao PDR, Webb (2004) states that field surveillance for poultry diseases is virtually non-existent in backyard systems (sector 4) and villagers are reported to accept significant losses in poultry populations as “normal”.

Addressing these issues requires the incorporation of participatory methodologies such as those proposed by Mariner (2001) and Rushton and Viscarra (2003). It should also use the experience of monitoring Newcastle disease in South-East Asia (Copland, 1987; Spradbrow, 1992). With respect to the monitoring the poultry sector, the commercial sector should be required to register of incoming and outgoing birds and products perhaps using databases that have been developed for such purposes (PAN Livestock, 2004).

Data collected should be analysed to provide the most useful information. A value chain analysis would make much sense for the socio-economic data. This could then be combined with the epidemiological information to help prioritise control actions.

RESTRUCTURING

Restructuring of the poultry industry has been identified as an important issue in Thailand and Cambodia. Thailand has gone as far as establishing funds to facilitate this strategy. It is noted that sector 1 in Thailand appeared to have begun a change in its geographical location prior to the HPAI outbreak, which in part could have been in recognition of the biosecurity threats. There is potential that sectors 2 and 3 are disappearing in importance as more poultry products are channelled through the export production and processing systems. What could be the case is that the HPAI outbreak may speed up this process, but it would not seem logical to assign all the restructuring costs to HPAI.

In Cambodia the government is keen to promote private sector integration into national and regional animal health systems and to ensure coordination between public and private sectors in animal disease control. In addition it will encourage investment in breeding farms, presumably to reduce the reliance on imported hatching eggs and day old chicks. There is also a plan to encourage the establishment of poultry and farm associations.

There are difficulties in assessing the costs of restructuring as previous information is inadequate to determine trends prior to the outbreak. In societies that are getting progressively richer it would be expected that bird units would increase in size.

BIOSECURITY

Biosecurity is mentioned by all countries and usually relates to farm-level actions. There is also a need to think about biosecurity at national, regional and local levels. This in part relates to the regional reliance on Thailand for hatching eggs, day old chicks and to a lesser extent pullets. The natural reaction would be to implement border controls, but it is well known that when the price differences are high enough such movement controls are ineffective. It is suggested that there is a need for information on regional movements of birds and poultry products, which can then be used to plan regional strategies of control. At

present it would appear imperative to implement regionally supported campaigns to eradicate HPAI in countries that export poultry and/or poultry products (legally or illegally) in order to eliminate the risk of continued movement of the disease to neighbouring countries. Such eradication efforts deserve consideration for regional or international finance.

At the farm-level it seems accepted that smallholder systems cannot implement adequate biosecurity measures as an important part of the system is the need to scavenge food from the environment in order to keep down production costs. However, there is a need, as the Vietnamese outbreak example demonstrates, for greater awareness of what to do in the face of an outbreak. Social marketing methodologies would be a useful starting point for such work and have been shown to be effective in human health campaigns. There is also the need to think about incentives (see later).

In the commercial sectors, it seems widely accepted that biosecurity can be left to the producers. However, even some of the integrated units may not be as biosecure as people think (Anonymous, 1996). The authors recommend that governments present guidelines on what they would expect in terms of biosecurity with particular reference to HPAI. Plans could then be approved at farm-level with the help of government staff and the implementation would need to be monitored perhaps through the databases mentioned above. The process is not cost free, but these systems are generally found close to large urban populations and implementing such systems might not be as difficult as one would anticipate.

VACCINATION

Indonesia has adopted a vaccination strategy to control HPAI and FAO (2004) recommend the use of vaccine strategies in very specific situations. The full impact of the use of HPAI vaccine in smallholder village situations is at present difficult to determine in terms of epidemiology and economic impact. One of the major problems is that it may help to hide the disease, which has implications in terms of exports of poultry products and in the potential risks to human health. These areas need further investigation and good starting point would be the carefully documented experiences of Newcastle disease vaccination in smallholder farms coordinated by ACIAR in the 1980s and early 1990s (Copland, 1987; Spradbrow, 1992; 1993).

STAMPING OUT, CREDIT AND COMPENSATION

Stamping out of diseased and birds in contact with diseased birds is recommended and has been implemented by all studies countries. However, the reaction of these countries for the need to soften the blow of HPAI outbreak and the control measures at producer level has been very different. Cambodia, one of then poorer countries, has made it very clear that compensation is not and will not be an option. Indonesia has a paid compensation for certain flock sizes and will probably offered soft credits in the future. Hartono (2004) expressed the need to create a fund that would encourage smallholder farms to report HPAI. There clearly needs to be some incentive, as the Vietnamese case studies clearly show that poor reporting and reaction to the disease may lead to a future endemic situation in smallholder systems and poor disposal in commercial farms.

GENERAL

There is a need to recognise the difficulties in working in smallholder productions systems (Rushton and Ngongi, 1998) where HPAI may be present and not fully recognised or reported. Expectations that these systems will in future generate greater incomes when free of disease need to be tempered with the limitations of backyard production due to feed constraints (Roberts, 1992; Guaratne *et al*, 1993). In addition it appears that it is the

smallholder producers who are greatest risk from human HPAI infections, but to qualify this statement requires socio-economic profiling of those people who have contracted the disease. The present information appears to indicate that people most at risk are those who eat undercooked meat from infected poultry.

Future economic assessments should be aware of the valuable work carried out by ACIAR on the economics Newcastle disease control in backyard systems (Johnston *et al*. 1992) and more recent evaluations on the control measures for avian influenza in Hong Kong (van Konkelenberg, 2005).

Finally recommended strategies need to be placed into a human capacity context. Data from the OIE (2005) on the number of veterinarians and veterinary personnel indicate that there is a shortage of training professional staff in some countries of the study (see Table 20).

Table 20. Number poultry per veterinarian and technical personnel in the study countries (data from OIE, 2005; FAOSTAT, 2004; Ministry of Agriculture, Indonesia, 2005; authors analysis)

Country	Number of veterinarians					Total Technical Personnel	Number of poultry per	
	Government	Laboratory, Training Institutions	Private	Other	Total		Veterinarian	Technical Personnel
Cambodia	NA	NA	NA	NA	NA	NA	NA	NA
Indonesia	735	2 323	524	594	4 176	9 734	77 009	33 038
Laos	42	20	7	0	69	5 847	247 377	2 919
Thailand	510	450	800	1 000	2 760	4 530	94 394	57 511
Vietnam	1 120	245	220	20	1 605	11 830	145 171	19 696

These personnel issues are of concern where the control of contagious diseases requires professional judgement in field conditions. The response to staff shortages in the UK during the 2001 FMD crisis was to hire veterinarians from other countries. This is not an option in poor countries unless aid agencies are open to providing extra personnel for short periods when an outbreak is in its early stages. Here there is need for such agencies to demonstrate flexibility and speed of response. The HPAI situation in Viet Nam is such that is difficult to see how their veterinary services can cope with the present demands of HPAI without requesting external assistance. The epidemiologist's report from Lao PDR in early 2004 also indicates that a shortage of veterinarians created difficulties in reporting procedures (Webb, 2004), and Abbott and Pearson (2004) make the same conclusions for both Cambodia and Lao PDR. Encouragingly Cambodia plans to strengthen its veterinary services in response to HPAI outbreak (FAO, 2005b).

CONCLUSIONS

Macro-level impact appears to be negligible, but can be important where countries have export potential and/or tourism. However, it is the potential danger of a human influenza pandemic, which is of greatest concern with regard to HPAI control and eradication (WHO, 2004a; 2004b). This requires the countries affected to take on international responsibilities. However, the countries affected are generally poor or middle income and do not have extensive resources for dealing with major epidemics. The data analysed would suggest that certain regions with these countries are more badly affected than others and there is a need for the prioritisation of resources in these areas.

In order to develop plans of control and future eradication determining micro-level impacts of the disease is critical. There needs to be an understanding of the winners and losers in an outbreak situation in order to set policies and actions that will motivate all actors to become actively involved in a control campaign. The epidemiological role of the different sectors

identified appears to be poorly understood at present. Value chain analysis of the formal sectors would allow the identification of key control points and important actors in the movement of eggs, day old chicks, live birds and products. Experiences of studying Newcastle disease in backyard systems in 1980s and 1990s (Copland, 1987; Spradbrow, 1992) would be a useful starting point for the determining the epidemiology in this sector, having a more complete basis to examine economic impact and for determining the risks to human health. An analysis of the socio-economic circumstances of those who have died and their relationship with poultry systems would be of great use in developing risk factors and prioritising scarce resources.

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