Review of free-range duck farming systems in Northern Vietnam and assessment of their implication in the spreading of the Highly Pathogenic (H5N1) strain of Avian Influenza (HPAI).

FINAL REPORT

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A report from Agronomes et Vétérinaires sans Frontières for the Food and Agriculture Organization of the United Nations

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Executive summary

In Vietnam, poultry production plays a crucial economic role by providing millions of households with valuable protein sources, as well as cash opportunities. It is estimated that 70% of the total 12 millions households that the country count, own 22 heads of chicken on an average. The average duck holding per household has not been assessed, but it is estimated that 95% of the ducks in the Mekong Delta are kept on small-scale, household basis. The country currently hosts an estimated 220 millions heads of poultry (73% chickens and 27% water fowls, such as ducks, geese…).

In 2005, 56% of the overall chicken population is found in the northern region, while 44% is found in the southern region. Figures for waterfowl are similar with res. 58% and 42%. Ducks in Vietnam are kept for single purpose production, eggs or meat or dual-purpose, for both eggs and meat. Duck breeds vary according to the production purpose and the production intensity. Ducks can be of "improved" or local strains, or cross-bred between both.

In 2003, the country was affected for the first time by an outbreak of Highly Pathogenic Avian Influenza (HPAI). Over the following years, the country experienced recurrent HPAI outbreaks among poultry leading to deaths and mass culling of over 60 millions heads of poultry within 3 years, as well as fatal human cases, triggering fears of a potential worldwide human influenza pandemic[1].

Ducks, known to be silent carriers of certain diseases, have been suspected to play a pivotal role in the spread of HPAI, by being "healthy" carriers of the virus. In 2001, prior to the first HPAI outbreaks, the Centre for Disease Control and Prevention (CDC) in Atlanta, who investigated the presence of various AI viruses on live bird markets in Hanoi, found out that the highly pathogenic AI virus H5N1 was present in live, healthy geese and ducks, but not in live chickens. Thanks to these findings, the CDC was able to assert that ducks and other waterfowls (geese) were silent, healthy carriers of the HPAI strain[2]. This suspicion has been reinforced in 2005, when 71% of ducks tested in the Mekong delta were found seropositive for H5N1[3].

Retrospectively, the CDC was also able to assert that the H5N1 strain found in healthy ducks and geese on live bird markets in Hanoi in 2001, was genetically, antigenically and pathologically different from the H5N1 strain causing the epidemic in 2003-2004 and thus could not be assessed as its "*immediate progenitor*". So far, further epidemiological evidence still lack to assert with certitude that ducks convey the virus without succumbing. Evidence also lacks to assert that the viral charge found in healthy ducks is sufficient to efficiently contaminate other poultry species. Epidemiological studies aiming at further assessing the role of ducks as silent carriers have recently been undertaken and are ongoing[4].

In order to better understand the importance of ducks in Vietnam and their potential role in the spread of HPAI in the country, the Food and Agriculture Organisation (FAO) entrusted Agronomes et Vétérinaires sans Frontières Vietnam (AVSF) to carry out a study on duck production systems[5].

[1] Resolution No.15/2005/NQ-CP, dated November 4, 2005 (Cong Bao 11-12 (10-11-2005)
[2] Nguyen C. Doan et al. (2004)
[3] USDA (2005)
[4] Christensen, (2005)
[5] The budget provided by FAO was 8'000 USD. AVSF mobilised an additional 3'000 USD from other donors (Swiss and French Government)

The study was carried out between December 2005 and March 2006. The methodology is articulated around two main axes:

- a literature review aiming at assessing and understanding duck production systems in the country through a secondary data perspective
- a field survey aiming at collecting primary data from selected areas in northern Vietnam

The field survey was carried out in 10 communes of 5 selected districts of 4 northern provinces (Thai Nguyen, Phu Tho, Yen Bai and Son La), where AVSF is implementing programmes. 146 duck farmers were interviewed over a period of two months thanks to semi-structured questionnaires. The questionnaires were completed by additional field visits, as well as focus group meetings with various stakeholders of the sector (producers, para-veterinarians, traders, commune authorities…).

The literature review highlighted the fact that few documents specifically describe duck production systems in Vietnam. The few available documents usually define duck production systems by combining economic and spatial criteria, providing 3 main systems:

- Scavenging systems
- Integrated duck production systems
- Confined systems

The main systems are usually divided into sub-systems according to spatial or utilisation criteria, e.g. rice-fish-duck systems, herded-scavenging etc.

The field survey highlighted one main system, the semi-confined system, categorised according to spatial criteria, divided into 3 sub-systems, self-sufficient, intermediate and semi-commercial, according to economic criteria.

Background information on the communes concerned by the survey shows that the poverty incidence at commune level ranges between 20.3% in Thang Son (Thanh Son, Phu Tho) and 75.7% in Tuong Ha commune (Phu Yen district, Son La province). A minority of farmers interviewed during the survey (8.6% of 140) consider themselves as poor, 66.4% consider their income as average and 25% think they are well off. The main ethnic group encountered during this survey are Tay (34.7%), followed by Muong (25.7%), Kinh (23.6%), Black Thai (13.2%) and H'Mong (2.8%).

The main farm income originates from staple crops (rice). Farmers cultivate 7 *sao* of rice on an average and produce 180 kg rice per *sao* (5'000 kg per ha) per season.

The surface per farm cultivated with non staple crops (maize, potatoes, cassava, tea and fruit) varies between 1 and 55 *sao*. Beside poultry, duck farmers keep fattening pigs and breeding sows, dogs, cattle and buffaloes, as well as goats. 63.9% of the farmers practice freshwater aquaculture, out of which 88.0% practice integration duck-fish system.

38% of farmers keep ducks specifically for meat, 36% for eggs and 26% of all farmers use dual-purpose ducks. Semi-commercial laying duck farms have a much higher average holding than semi-commercial meat duck farms (100 heads against 57 heads per farm). Meat oriented self-sufficiency and intermediate farms tend to have higher average holding than the same categories of farms with laying ducks.

Duck husbandry plays an important economic role for the farmers interviewed. 75.9% of the farmers rank duck production among the three most significant productions within the farm and for 23.4% duck production is even the sector generating the highest income on the farm.

Duck production requires labour input ranging between 15 minutes to 10 hours a day (herding). It is mainly done by family members, less than 2% of the farmers hire external labour force.

Duck husbandry requires investment for the shed, which may range between 50'000 and 5'000'000 VND. Capital invested in the shed originates mostly from the household's own savings (65.0%), the bank (16.3%), family members (13.8%), moneylenders (4.1%) or credit issued by the Women's Union (0.8%). However 40% of the duck farmers built their shed by themselves and used locally available material (bamboo).

Most farmers practice confinement at night. Up to 51% of farms have a park, which does however not allow strict confinement. Only a small proportion of farmers have a "well fenced park" enabling them to strictly confine ducks. The higher the specialization grade is, the higher is the proportion of farms with strict confinement infrastructure.

Ducks are generally kept wherever natural (rivers, lakes) or manmade (ponds, inundated rice fields) water resources are found. Few farmers (up to 7%) do not make use of any water resources. Self-sufficiency oriented farms make a large use of rice fields, followed by ponds and very little by rivers. Intermediate farms tend to use ponds first, followed by rice fields. They also tend to use multiple locations (rice fields, ponds and or rivers). Semi-commercial farms largely use ponds. However one third of the semi-commercial farms use different locations, making large use of rice fields after harvest. Ducks can scavenge between the age of 3 to 90 days and often stay within the farm and village premises (maximum 350 m). When ducks go to the rice fields, they are herded and for practical reasons, farmers prevent their flock from mingling with ducks from other herds. Ducks stay between 6 to 12 hours per day in the rice fields, at the pond or the river. The higher the specialization is, the higher is the proportion of farms herding their ducks during daytime: 40,6% of semi-commercial farmers, 8,3% of the intermediate farms and 3,4% of the self-sufficient farms. Ducks come back to the farm once or twice a day, on their own. Almost all of them are enclosed at night. Though ducks from different villages do not mingle, their itinerary poses a threat for disease contamination.

Besides, ducks are in frequent contact with other poultry species, as well as other domestic animal species on farm and village premises, on rice fields, and at specific occasions (brooding of ready to hatch duck eggs by hens).

The market chain analysis showed that self-sufficient farms mostly keep their products and do not sell them outside the commune. Intermediate sub-systems sell their products directly to retailers (shops) or to end consumers (customers and hatcheries). Semi-commercial farms sell their products to retailers and end consumers, as well as middlemen. The higher the specialization grade is, the more complicated the marketing constellation becomes (various stakeholders and marketing steps are involved). By-products such as feathers are usually kept for the own use on self-sufficient farms and sold to traders by intermediate or semi-commercial farms.

Duck manure is largely used, but not often treated (by adding quick lime to disinfect or ashes and rice husk to reduce the humidity). Manure is sometimes stored in plastic bags or on the ground, but most frequently in the poultry shed or the pig sty (between 40% and 60% of the farmers, depending on the production sub-system).

Industrial food is fed by most semi-commercial farmers (94.4%) during the whole cycle. Less than half of the intermediate farmers feed industrial feed and only 28.6% of the self-sufficient farmers use such feed (during the youth period).

Ducks are recurrently affected by various diseases and other health problems (poisoning by polluted water, pesticides etc.). Self-sufficiency oriented farmers tend to let their ducks without preventive or curative treatment, less than 3% call the paravet in case of problems. Intermediate farmers use antibiotics, antihelmintic drugs and vaccines, but only 6.0% of them call the paravet. Semi-commercial duck farmers use antibiotics, antihelmintic and vitamins, but only one third of

them vaccine their ducks and 25% are accustomed to call paravets, in case of problems. Farmers still largely count on their "own knowledge" or resources to treat ducks.

According to the farmers interviewed their traditional or usual duck husbandry practices did not change after HPAI outbreaks. The trend is stronger with self-sufficient farmers: 88% of them did not change anything to their traditional duck production practices. HPAI outbreak generally resulted in a meat and eggs consumption drop and consequently in a commercialization drop. A positive consequence is the reduced movement of duck products and live ducks. An adverse consequence is the release of ducks for scavenging in order to spare on expensive, commercial feed. This measure was more adopted by semi-commercial farmers (12%) than others. Culling of ducks was not largely applied. In the context of HPAI, only few farmers (7.7% on an average) envisaged abandoning their activity.

According to farmers, the HPAI vaccination had adverse consequences on the duck health: mortality and morbidity were very often mentioned, especially in intermediate and self-sufficient farms. Another unexpected adverse effect of the vaccination could possibly increase the risk of HPAI virus spreading: most of the egg production farms, even the semi-commercial ones, said that vaccination induced a decrease in the daily number of laid eggs.

As a consequence, farmers decided to artificially induce moulting of their female ducks, by stopping feeding them with industrial feed and letting them scavenge to feed themselves.

The present study illustrates two of the three sub-systems by taking two communes as examples of sub-systems. Cuc Duong commune in Vo Nhai district in Thai Nguyen province is an example of self-sufficiency oriented production, functioning under circular, closed market chain. Dong Thinh commune in Dinh Hoa district in Thai Nguyen province illustrates the intermediate duck production level, involving various stakeholders spread out in different locations. A third sub-system has further been highlighted by the survey, a migratory pattern involving fisherman, moving with their rafts and ducks according to the seasonal water level of the Song Da river in Thuong Ha commune in Phu Yen district (Son La province). The study highlights potential passive and active threats for each sub-system in the context of HPAI. It appears that the rather closed self-sufficiency sub-system is less actively and passively at risk than other systems. The migratory system is the most active threat for other communes. Intermediate open systems are at risk, as well as potential threats themselves, due to the number of stakeholders involved, as well as their scattered location. Threats could be greatly mitigated thanks to a developed, controlled and labelled local duckling production.

The present report exhibits some methodology constraints mainly linked to the time and budget scope of the study, as well as to the sensitiveness of the topic. This study did not focus on chicken or other poultry (quails, geese, pigeons) production, although duck farmers keep more or less large amounts of chicken or other poultry beside ducks. It would be interesting to assess the possible "silent" role in the spread of AI of other poultry species. Besides, some results obtained from interviews, such as disposal of dead animals, shall be interpreted cautiously as they might reflect the farmers' political correctness and not necessarily the field reality.

Moreover, the survey did not focus on areas heavily affected by HPAI outbreaks. This constraint was imposed by the fact that AVSF is working in mountainous provinces and districts.

The present study attempts to depict the role that ducks could potentially play, it can however not give an affirmative statement on the role that ducks played. Maps drawn basing on the January/February 2005 HPAI episode in Vietnam tend to show that HPAI outbreaks are linked with a high human and poultry population density and a high number of communications roads. Such conclusions are consistent with the finding of the National Institute for Veterinary Research, which listed as main risk factors the animal and animal product movement and the delayed

diagnosis.[6]Such a hypothesis shall remind experts to be particularly cautious when linking high incidence of HPAI in ducks with small-scaled, scavenging duck production. Reducing the number of small-scaled duck production systems should be cautiously thought of. In northern Vietnam, such production units are namely mostly encountered in villages and communes with little interactions with other areas and are thus not most at risk.

The reduction of small-scale duck (or chicken) production systems would have major consequences on poverty issues in Vietnam, especially for the self-sufficient and intermediate farms, as their poultry but also the fish and rice production would be concerned.

The present study draws a list of risky management practices (absence of confinement, mixing of poultry species, use of water bodies, use of excreta…) assigned per each sub-system examined. All sub systems have risky practices, irrespectively of their production scale. Although numerous risky practices still exist, it has to be mentioned that in spite of such practices, no or relatively few outbreaks were reported in the studied areas.

Farmers did not much change their practices in the HPAI context. They fear the epizooty, but are used to recurrent disease episodes periodically decimating their flocks.

The present report presents a number of recommendations which could be implemented such as:

- pilot projects, monitoring and supporting groups of farmers in duck production
- additional studies to better understand the occurrence of AI outbreaks (similar study on chicken raising under scavenging production. This study could be undertaken to assess the chicken/duck/pig interactions, survey on HPAI outbreaks quantifying the link between HPAI outbreaks and the main communication means, marketing chain analysis with emphasis on live birds markets and middlemen, analytic epidemiology survey)
- Policies for the control of poultry production units limiting access of the market to "professional" farmers, namely registered farmers, who could be allowed to sell their products and could be easily contacted in case of AI outbreaks.

[6] T.D. Nguyen et al. (undated)

Acronyms/Abbreviations/Vietnamese terms

AI	Avian Influenza
AVSF	Agronomes et Vétérinaires Sans Frontières
CDC	Centre for Control Diseases
DARD	Department of Agriculture and Rural Development
FAO	Food and Agriculture Organisation (of the United Nations)
GAS	Golden Apple Snail
HPAI	Highly Pathogenic Avian Influenza
Kg	Kilogramme
LW	Live Weight
MARD	Ministry of Agriculture & Rural Development
Mau	Local measurement of land area, equivalent to 4'500 m^2
Mt.	Metric ton (1'000 kg)
n.a.	Not assessed
NIAH	National Institute of Animal Husbandry
NGO	Non Governmental Organisation
OIE	Office International des Epizooties
Paravets	Para-veterinarians or veterinary para-professionals, a definition used by the OIE, equivalent to Animal Health Workers (AHW)
Sao	A Vietnamese measure for land usually equal to 360 m^2 in the North and 500 m^2 in the South
TOR	Terms of Reference
VAC	*Vuon* (garden), *Ao* (pond), *Chuong* (sty) integrated farming system
Viz.	namely, that is to say (from latin *videlicet*)
VND	Vietnam Dong

1 Introduction

1.1 Rationale to the study

Since the winter period of the years 2003–2004, outbreaks of Highly Pathogenic Avian Influenza (HPAI) have been reported in several South-East Asian countries.

Although numerous control and preventive measures have been undertaken and implemented since the first outbreak, the disease has spread again over the subsequent winter periods. The epizooty has now gained in spatial force, as it affected the European and African continents during the last outbreak in winter 2005-2006.

Various explanations on the origin of those recurrent outbreaks and the persistence of the disease within Asia have been advanced:

- Movement of day-old poultry across the region
- High poultry trade and consumption during the Chinese New Year in concerned countries (China, Vietnam, Thailand…)
- Industrial sector and the high density of poultry it exhibits
- High survival rate of the virus under cold weather conditions
- Poultry management practices enhancing the risk of spreading the disease (free ranging systems, close contact between species…)
- Wild birds spreading the disease on their migration route
- Role of ducks as silent carrier and conveyers of H5N1

So far, none of these assumptions could be assessed as one of the main reasons behind the spread of Avian Influenza. However, some reports on the epidemiology and ecology of HPAI in Thailand[7], as well as on inspection of live bird markets in Hanoi[8] strongly suggest that ducks have an important role as silent carriers and conveyers of H5N1. This assumption needs to be addressed and verified (confirmed or infirmed) in Vietnam as well. Duck husbandry systems in Vietnam are known to be various and usually well adapted to local agro-ecological zones. Although numerous reports mention different duck husbandry systems, so far none of them specifically describes the systems prevailing in the northern part of the country. The FAO has mandated Agronomes et Vétérinaires sans Frontières (AVSF) to carry out a survey aiming at assessing and describing relevant duck husbandry systems and linking them with the possible spread of AI virus. The Terms of Reference can be consulted in annex 1.

1.2 Objective of the study

This study shall contribute to the overall goal of better understanding the recurrent HPAI epizooty in the country.

The specific objective of this study is to assess the possible implication of ducks and their husbandry practices in the spread of the HPAI in Vietnam.

The expected results are:

- an assessment of the diversity and characteristics of poultry raising systems in general and scavenging and herding duck farming system in particular by studying of "production

[7] Gilbert M . and J. Slingenbergh (2004),
[8] Nguyen C. Doan (2004)

chain" (area where all the actors of the poultry production system co-exist, viz. parental farms, incubators, raising farms, markets, services)

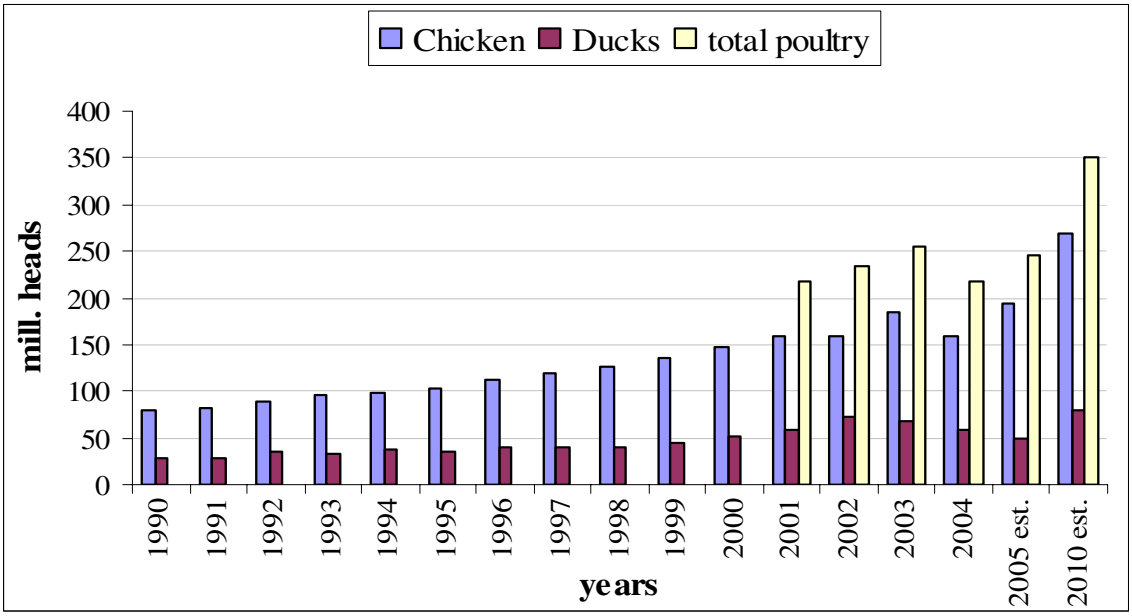
- an assessment of the possible role of the different duck raising systems in the spread of the disease locally
- an assessment of the local AI control measures and their impact on these production systems
- a proposal of good management practices for those systems and thus, of possible options to reduce the risk of HPAI infection

2 Review of duck production in Vietnam through a literature perspective

2.1 Overall poultry, chicken and duck population

Latest statistic figures[9] show that there were 219,358 millions poultry in 2005, among them 159,349 millions (73%) were chickens and 60,009 millions (27%) were ducks and other water fowls (mostly geese, Muscovy ducks…). Other poultry species such as pigeons, quails, etc. are considered negligible although they can be found on markets and in restaurants throughout Vietnam. The evolution of the overall poultry population, as well as chicken and duck respective populations over the years is given by the following figure.

Figure 1: evolution of the overall poultry, chicken and duck population (in million heads) in Vietnam between the years 1990 and 2005 and projections for the year 2010



Sources: USDA (2005), USDA (2004), Nguyen Dang Vang and Le Viet Ly (2000)

2.2 Geographic distribution of ducks

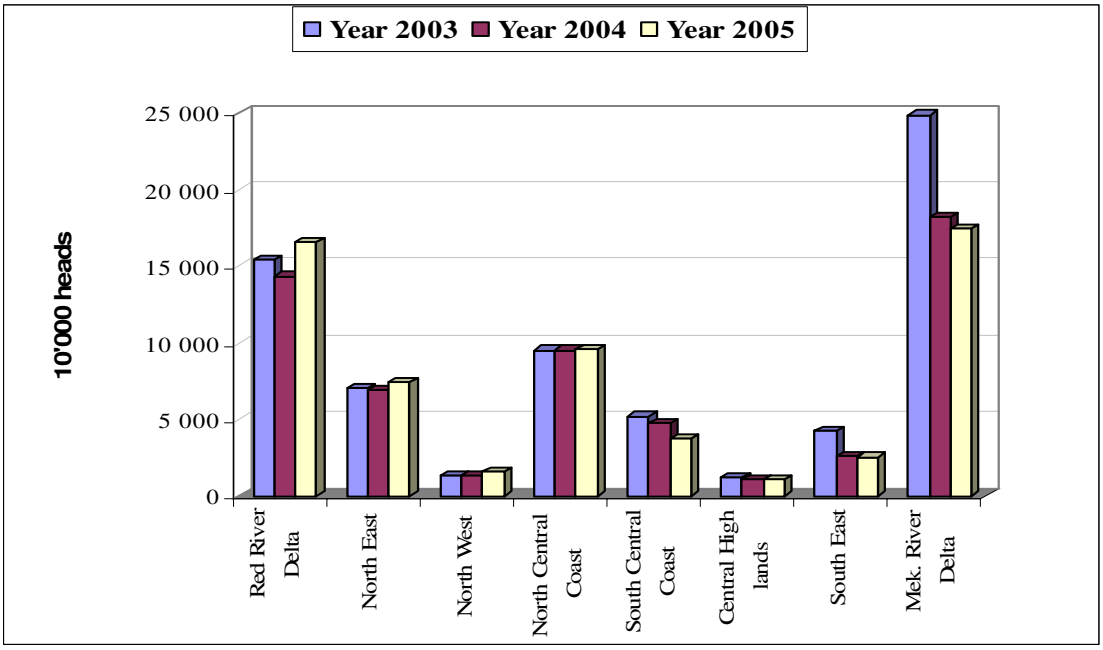
According to the latest official statistics, 68% of the whole poultry flock is found in the North, while 32% is found in the South. Data on the relative geographic repartition of ducks vary according to sources and were estimated to range from 50%[10] to 90% (in 2003)[11] in the Mekong Delta.

Latest figures however show that by 2005, the North accounts for 59% of the overall waterfowls population, while the South accounts for 41% of the total waterfowls population. Regarding the chicken population, 56% is found in the North and 44% in the South by 2005. As shown by the

[9] MARD, 2005
[10] Nguyen Dang Vang, Le Viet Ly, 2000 and Quac, 1990 in Nguyen Thi Kim Dong, 2005
[11] World Bank, 2005

following figure, ducks are mainly kept in the two deltas, viz. the Mekong River Delta and the Red River Delta.

Figure 2: region wise evolution of the overall poultry population (chicken and ducks) in Vietnam since 2003 (in 10.000 heads)



Source: MARD, 2005

By the year 2005, the vast majority of ducks (57%) were found in the two deltas (Red River and Mekong delta), as shown by the following table.

Table 1: relative geographic distribution of the overall duck population in Vietnam in 2005

Region	Proportion of duck population
Red River Delta	28%
Northeast Region	12%
Northwest Region	3%
North Central Coast	16%
South Central Coast	6%
Central Highlands	2%
Southeast	4%
Mekong River Delta	29%

Source; MARD 2005

2.3 Holding pattern

It is estimated that 70% of the total 12 millions households that the country counts[12] own chickens (22 heads on average), while the average number of ducks per household has not been assessed. It is further estimated that 95% of the ducks in the Mekong Delta are kept on small-scale basis[13].

[12] Nguyen Dang Vang and Le Viet Ly (2000)

2.4 Breeds

There are various chicken, duck and other fowl breeds in Vietnam. Chicken, as well as duck breeds are usually divided into three categories, viz. meat, eggs or dual purpose breeds and two sub-categories, viz. improved and local breeds.

Both meat and egg duck breeds can be of local or improved strains. Local duck breeds are often kept for dual-purpose, while improved breeds are mostly bred for single purpose (meat or eggs). A detailed and exhaustive list of duck breeds, their purpose and comparative advantages is given by Carlen and Lansfors' report on duck husbandry in southern Vietnam[14]. They are:

Table 2: major local and improved duck breeds in Vietnam

	Dual purpose	**Single purpose**	
	Meat & eggs	**Meat**	**Eggs**
Local	Common local duck: *Vit Co* (North) *Vit Tau* (South)	*Ta* or *Bau* duck	*n.a.*
		De and *Trau* (Muscovy ducks)	
Improved-Local	Pekin duck	Cherry Valley	Khaki Campbell
Improved	*Nong Nghiep*	Supermeat	CV 2000
	Tiep	French Muscovy	

Sources: Carlen and Lansfors (2002), Nguyen Dang Vang and Le Viet Ly (2000)

Local breeds

Local breeds are usually not described in details. According to Duong Thanh Liem[15], four main strains of local breeds have been identified:

- *Tau Co* (white feathers)
- *Tau Phen* (yellow-grey feathers)
- *Tau Ran* (striped feathers)
- *Tau O* (black feathers)

The name of the local breeds may change from place to place. Beside the general *Vit Co* and *Vit Tau*, local breeds may include local strains such as *Quy* duck (from Quy Chau in Nghe An), *Ben* ducks (Hoa Binh), *Moc* ducks (Binh Dinh), *Ky Lua* (Lang Son)[16], *Hang Phan Thiet* (central Vietnam), *Co Lun, Sen* and Muscovy ducks (South Vietnam)[17].
Specificities of these duck breeds are unknown.

[13] Nguyen Thi Kim Dong (2005)
[14] Carlen and Lanfors (2002)
[15] Duong Thanh Liem (2001)
[16] Delquigny et al. (2005)
[17] Duong Thanh Liem (2001)

"Improved" breeds

A non exhaustive list of the most common improved duck breeds is given below, they are:

- **Nong Nhiep** ducks are crosses between a Supermeat or Chery Valley drake and a Common or Tiep duck female
- **Tiep ducks** originate from previous Czechoslovakia, it is nowadays frequently crossed with other breeds
- **Pekin** originate from China and are very widespread all over the world. In Vietnam it is widely crossed with local and other breeds. According to an expert, Pekin duck has been widely used in Vietnam and has "degenerated" from its original meat purpose to a dual purpose widely cross-bred breed[18]
- **Cherry Valley** is an English breed, it is also crossed with other breeds, both local dual purpose or improved meat breeds
- **Supermeat** duck is an English breed commonly used in the Mekong delta for crossbreeding. It is particularly appropriate for intensive meat production
- **Khaki Campbell** is a breed originating from Thailand. It is considered as a top egg layer
- **CV 2000** is an improved egg breed from England. It is not considered as very suitable for Vietnamese conditions, as it is not disease resistant and expensive

Remark: in order to avoid confusion, common local breed hereby means local duck breeds (excluding improved imported breeds, as well as Muscovy ducks). Certain experts name common ducks all ducks which are not Muscovy ducks, but include local, as well as improved breeds[19].

It is usually assumed that common ducks (*Anas platyrhynchos*) (local and improved) make up 80% of the total duck population, while Muscovy ducks (*Cairina moschata*) make out 20%[20] of the population.

Table 3: estimated proportion of "improved" and local poultry breeds in Vietnam

	"improved" breeds	**local breeds**
Hens and chickens	30% (among it 15% for edible egg production and 85% for meat production)	70%
Meat poultry	35%	65%
Ducks	40%	60%

Sources: USDA (2005) and World Bank (2005)

2.5 Duck production systems

2.5.1 Classification of duck raising system

Duck production systems vary according to agro-ecological zones[21]. Traditional systems usually follow a seasonal pattern, farmers buying ducklings after the rainy season and fattening them to be ready for various annual events (New Year's Festival[22], Tet Trung Nguyen in the seventh lunar month...).

[18] Bui Xuan Men (undated)
[19] Bui Xuan Men (undated)
[20] Bui Xuan Men (undated), Carlsen and Lansfors (2002), Nguyen Thi Kim Dong (2005)
[21] Nguyen Thim Kim Dong (2005)
[22] Duong Thanh Liem (2001)

Duck production systems can be categorized according to various criteria, viz. spatial, economic or technical. Most of the time, categories are made by combining various criteria.

Differentiation according to several criteria

Duck production systems are usually differentiated into three systems combining spatial (free ranging, semi-confined and confined), as well as economic criteria (low scale, semi-commercial, commercial).

In their study of duck production systems in the Mekong Delta, Carlen and Lansfors (2002) noticed that duck systems in the Mekong Delta considerably vary depending on their location (rural, urban and peri-urban). They differentiate three main systems as follows:

- Scavenging systems: scavenging, free ranging within the farm and the village (garden, home or village pond); daily herding in rice-fields, dikes, rivers, canals and tidal areas (beyond the farm); seasonal transhumant supervised ranging (beyond the locality)
- Integrated duck production systems: rice-fish-duck; fish-duck-pigs (or other domestic species)
- Confined systems: semi-commercial and commercial farms (meat and egg production); duck-fish combination in enclosures or floating cage in ponds/canals/rivers

According to the two authors, duck husbandry systems are divided into sub-systems according to local conditions. Scavenging systems can be either full scavenging or semi-scavenging, where ducks are confined at night in enclosures or pens. According to the experts, ducks in the Mekong Delta are mostly raised on small-scaled farms.
They also remind that duck husbandry systems have been evolving according to policy driven measures (forbidding ducks to swim in canals) and structural changes within rural areas (introduction of short crops rice varieties, rapid urbanisation of certain areas in the South etc.).

Differentiation according to economic criteria

Another classification has been proposed by the FAO and other agencies, differentiating systems according to economic criteria. Over the past years, poultry production units have been given numbered levels according to their production scale[23]. The levels are:

1. industrial integrated system with broilers, layers and breeder farms, potentially for exportation
2. medium commercial poultry production system (broilers/layers/ducks)
3. medium to small commercial poultry production system (broilers/layers)
4. village or backyard production in mixed farming system (ducks, pigs, etc.)

Differentiation according to utilization criteria

Another interesting differentiation is made according to utilization criteria. It provides the following duck husbandry systems[24]:

- ”Harvested rice – running duck ” system: scavenging system to pick fallen paddy rice after harvesting
- ”Rice – duck pest control” system: insect catching, weeding, muddying after rice transplanting
- ”River and coast band collector” system: scavenging system to pick tiny fish, shrimps, oysters etc... at low tide
- Fish – duck pond system
- Backyard duck raising system

[23] Macleod et al. (2005)
[24] Duong Tu Liem (2001)

2.5.2 Description of duck raising systems

Scavenging system

The **free ranging-scavenging** duck husbandry system mainly concerns small, rural farms. Ducks mingle with chickens and other species (porcine, bovine, caprine and human) all year round. They mainly stay within the farm premises, but may roam around the village. Although the performances under these conditions are generally below the intensive production systems, the utilization of low or no-cost feed can compensate the disadvantage of lower performances. Detailed data on the number of farms keeping ducks in this way are not available, but it is assumed that it is the great majority.

The **daily supervised scavenging** system exhibits larger duck flocks, up to thousands of heads, mainly raised for egg production. Local breeds are reputed to be better scavengers than "improved" breeds as they exhibit a smaller body size and more active foraging capacity. Scavenging ducks in rice fields ("Duck-cum-rice production") can forage on cheap, otherwise wasted material, estimated at 250 kg/ha. The ducks are driven into the rice fields during the day and back to pens or sheds near the households at night.

This system is closely linked to rice seasons in Vietnam. In fact, ducks do not scavenge in rice field during the pre-planting period because they cannot forage food. Such a system is commonly found around large water bodies and rice fields in low lying water areas such as the Red River and Mekong deltas.

Daily supervised scavenging is carried out over period of the rice production cycle[25]:

- Integration with the growing rice. Ducklings are driven into rice fields, 20 days after rice transplantation and until the start of flowering. Their smaller body size allows them to avoid harming rice plants[26]. At the start of the rice flowering, the ducks are driven out of the rice fields to canal, ditches, lakes, swamps to forage in water. This system is also used to control pest.
- Pest control system, especially of Golden Apple Snail (GAS). In the Mekong delta, in case of heavy GAS infestation, recommendations are made to herd ducks in paddy fields prior to transplanting rice, as well as 30 to 45 days after transplanting in order to clear the field from snails and their eggs[27]. Ducks were even recognized as the only way to naturally control GAS at adult stage, besides human intervention (hand picking), while at a younger stage of the GAS, rats, fish, snakes and ants can also control its spreading[28]. However, ducks do not feed on GAS eggs or very large hard-shelled GAS[29].
- Integration with rice harvesting period. This is mainly for older ducks. During the day, the ducks are herded in paddy fields for scavenging on weeds, crop residues, snails and fresh-water crustaceans and are brought home in the late afternoon. An expert mentions a sub-system of this system, as being post-harvest meat duck production. According to her observations, farmers buy ducklings 3 to 4 weeks before harvesting rice and, after harvesting, released into the harvested field. Ducks reared under this system are then sold at 2-3 months age for meat. This system seems to have become particularly vulnerable to crop intensification and the introduction of rice varieties with shorter cycle[30]. It was widely encountered in the Mekong delta, while, according to an anonymous expert, rice-duck

[25] A.G. Cagauan (undated)
[26] Bui Xuan Men (undated)
[27] Duong Ngoc Cuong (2002)
[28] Duong Ngoc Cuong (2002)
[29] Nguyen Huu Huan and Ravindra (2002)
[30] Bui Xuan Men (undated)

system was introduced to North Vietnam in 1994 by a Japanese scientist. According to this expert, letting ducks entering the rice fields during the whole vegetation period was not allowed in the past. Ducks could be kept in rice fields only before planting or after the harvest.[31]

The rice seasons in Vietnam vary from one region to another and even from one district to another within a province. In fact, there is different type of rice cultivated, and for each type, there are some long period and short period rice species. More over, the organization of the rice production is often integrated with a crop and/or fish rotation during the year that can change from one district to another.

The table below shows a general picture of the rice production in Vietnam per region. This picture shall enable to assess the period of the year in which ducks are more likely to be present in rice fields

Table 4: seasonal calendar of rice and duck production according to the region

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Red River delta												
Ducklings												
Adult ducks												
North East												
Ducklings												
Adult ducks												
North West												
Ducklings												
Adult ducks												
North Central coast												
Ducklings												
Adult ducks												
South Central coast												
Ducklings												
Adult ducks												
South East												
Ducklings												
Adult ducks												
Mekong River delta												
Ducklings												
Adult ducks												

Source: IFPRI, 2000

The **seasonal transhumant duck system** is often referred to as "Moving Ducks. These ducks often belong to poor farmers who move their animals around. The flock size may vary from about

[31] http://www.asahi-net.or.jp/

ten to a few hundreds. Ducks often move over long distances, sometimes from province to province. The transhumant system also comprises flocks which are kept on river dikes and moved according to the seasonal water level of the river.

Integrated duck production system ("Fish-cum-duck integration")

The aim of such system is to exploit synergies of both fish and ducks exploitation by using one another's wastes and sharing of scarce space. The advantage of this integrated system is the almost closed nutrient cycle. Duck droppings, as well as feed waste allow plankton growth and directly feed fish.

This raising system is a fixed system and strictly confined (ducks cannot move around). It is widely spread in Asia and has been extensively analyzed and described by experts[32].

Such systems can be found in combination with tilapia in the Mekong delta, but also in combination with carp species on northern rivers (or ponds). Ducks can also be kept in net or bamboo enclosures on rivers and channels banks.

In case of rice-fish-duck integration, rice benefits both from duck and fish excreta. Rice-fish-duck integration research is practiced on Cam Binh duck farm[33].

The pond can be periodically (1 to 2 years) drained, the dikes eroded by ducks repaired, and the pond bottom leveled. The mud is then utilized as fertilizer[34]. Even though this technique is part of the integrated system, it hasn't been documented in Vietnam except from informal interviews with farmers.

Confined system

The **confined production system** mainly concerns larger state, foreign or private semi-commercial or commercial farms. Ducks are kept confined for meat or egg production and are fed mostly on industrial feed.

2.6 Feeding of ducks

Feed and feeding regime for ducks vary according to duck breeds and purpose, management system, on farm feed types and availability, as well as the overall farm economy. Under extensive systems ducks are let feeding on resources available in the countryside (insects, gastropods, weeds, fallen rice grains), as well as on kitchen waste and crop residues (broken rice, rice polishing and bran, maize)[35]. Under semi-commercial systems the diet is complemented with crop residues (rice bran, cooked cassava), by-products of the fishery industry (fish meal, shrimps waste) and agro-industrial by-products (soybean waste, groundnut cake, brewery wastes) or even complete or compounded industrial feed. Under commercial systems, the diet mostly consists of industrial feed, completed with various naturally available feeds.

It shall be mentioned that numerous research trials have been conducted on the use of valuable alternative resources available in Vietnam such as duckweed (*lemna minor*)[36], azolla (*azolla pinnata*) and molasses[37].

[32] Csavas (undated), Devendra (undated), Vincke (undated), Mukherjee et al. (undated)
[33] Le Hong Man (undated)
[34] Heinz Pingel (2005)
[35] Bui Xuan Men and Vuong Van Su (1990)
[36] Bui Xuan Men, Ogle and Preston (1998)
[37] Bui Xuan Men and Vuong Van Su (1990)

2.7 Duck products

Eggs

Duck eggs are widely produced in Vietnam for immediate consumption as "normal" boiled eggs, as well as for incubated boiled eggs, called *trung vit lon*, widely consumed as a treat, especially by pregnant women.

The price of duck eggs usually ranges between 1'200 and 1'300 VND/egg. According to the USDA, prices are slightly higher in southern Vietnam with a price of 1'300 -1'400 VND/egg[38]. Duck eggs are usually cheaper than chicken eggs by 100 VND per egg.

Meat

In 2002 Vietnam was reported to have 60 millions heads of ducks (5.6% of the world's flock) and to produce 73'800 tons of meat (2.4% of the world's production)[39].

"Improved" ducks produced under industrial way are produced into 3 cycles per year, while local ducks are produced in two cycles per year[40].

Though no specific detailed data is available on duck meat production and consumption in the country, it seems that duck meat consumption is lower in the northern part of the country due to different food habits than in the South. People in the northern part seem to be more influenced by Taoist nutritional habits categorising food into hot and cold. Duck meat is considered as cold food and is not eaten at certain dates of the lunar calendar[41]. Its consumption is usually higher in summer than in winter.

Meat of local ducks is reputed to be better than imported ducks'. It exhibits lower fat, a thinner skin, a better taste, lower cholesterol content and few to no antibiotic residues (due to the rarity of medical treatment)[42].

Ducklings

Ducklings are produced by three main sources:

- State-owned farms under MARD with grand-parent or parent stock
- Private small-scaled or large-scaled hatcheries
- Own laying ducks producing eggs hatched by hens or by the traditional method using rice husk[43]

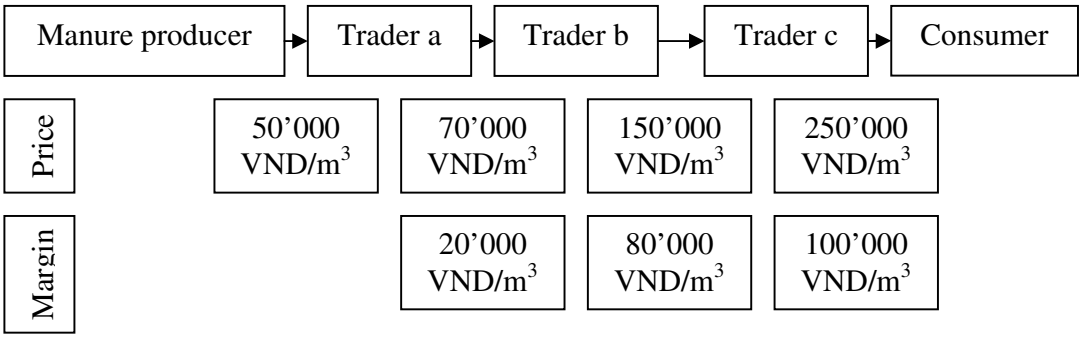
Farms with parental stock under MARD management were estimated to produce 19'000 ducklings per year in 2004, against 21'000 heads of chicks[44]. It is estimated that 80% of the production of industrial day old chicks is ensured by the private sector: CP, Cargill, Japfa and southern companies. In the case of ducklings, the proportion of day-old ducklings produced by the private sector has not been assessed.

[38] USDA (2005)
[39] CEI (2004)
[40] World Bank (2005)
[41] Le Ba Lich Do Kim Tuyen (2000)
[42] Duong Thanh Liem (2001)
[43] Tran Thanh Van (undated)
[44] USDA (2004)

Manure and Feathers

Manure and feathers are often ignored by-products of animal production in general and duck production in particular. Such by-products however play a certain role in the farm economy and farming system, moreover their trade is a potential risk of disease spreading.

Very few quantitative data are available on animal manure trade in Vietnam. However, it is well known that this is widely used as fertilizer throughout Asia in general and Vietnam in particular (up to 82 t/ha/year around Ho Chi Minh City for eggplant production)[45]. An example of manure trade in Tan Lac district of Hoa Binh province has been depicted as follows[46]:



The authors of the study report that pig and poultry manure is brought from Ha Tay province to sugarcane and watermelon cultivation areas in Hoa Binh's province.

Similarly, trade of feathers is not documented, although it may play a certain role in disease dissemination. According to Caddwell, duck feathers used to be the fourth largest commodity for export from South Vietnam in the sixties.[47] Duck feathers are nowadays still an export commodity, as reported by a website document stating that in 2003, 26'500 kg of feathers were exported from Vietnam to the USA (valued at 38'900 USD).

The previous year, 2'500 kg had been exported to Canada. According to this report, as the feathers were processed, they were not a risk to disease transmission[48].

2.8 Economic importance of duck husbandry

2.8.1 Marketing of ducks

Markets

There are numerous markets throughout Vietnam. Three main categories have been described:

- Type 1: markets with more than 400 traders, planned and built to be permanent, located in the important commercial centres of cities and provinces.
- Type 2: markets with more than 200 traders, covered or at least half-covered, located in centres of economic exchange.

[45] Nguyen Tri Khiem et. Al. (undated)
[46] Bourgeois Luthi et al. (2006)
[47] http://www.militaryliving.com/vietnam2/vietnamch9.htm
[48] http://www.aphis.usda.gov/vs/ceah/cei/taf/iw_2004_files/foreign/hpai_vietnam_011204_files/ai_vietnam_0104.htm

- Type 3: markets with less than 200 trading points, not covered, aiming to cover the demand of the people at commune level. Those markets are also called wet markets. The retail food sector in Vietnam has until recently been characterized almost exclusively by numerous wet markets, corner grocery and sundry shops and temporary stalls that are ubiquitous in Vietnamese cities and towns.

The table below shows the repartition of markets in Vietnam. The type 3 markets are still encountered every where in Vietnam. Those rural markets usually represent the primarily exchange place for agricultural products. Those markets are held according to the demand. It can be every 3 to 5 days, or even once a week in the upland area, or every day in the deltas. Poultry are often sold alive, especially in remote area where the conditions of conservation of the product are not adequate (no refrigerator).

Table 5: size of markets places in Vietnam in 2000

Size of the markets	Total	Cities		Countryside	
	Number of markets	Number of markets	Percentage	Number of markets	Percentage
Total	8213	1959	24 %	6254	76 %
Type 1	1380	555	28 %	825	13 %
Type 2	981	244	12 %	737	12 %
Type 3	5852	1160	59 %	4692	75 %

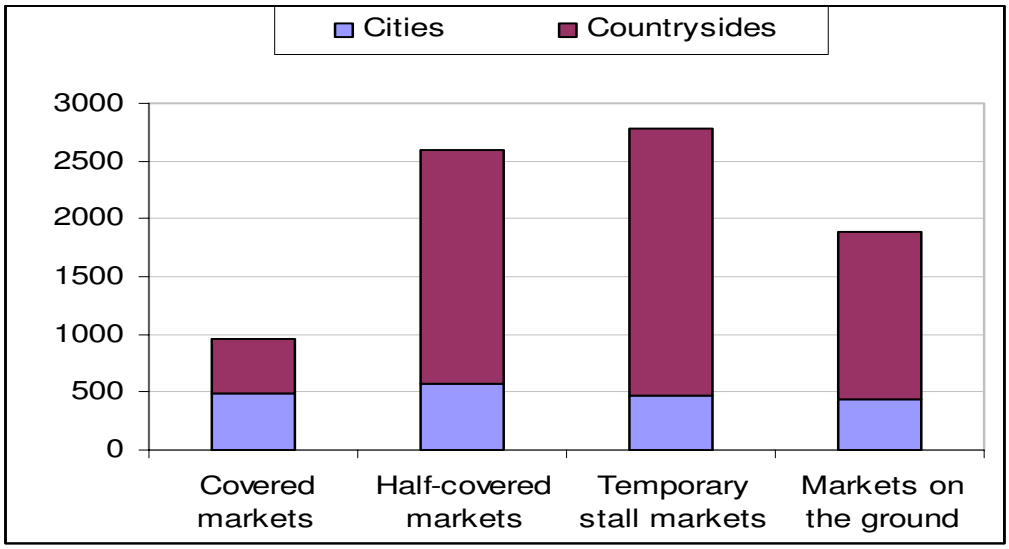
Source : General Statistic Office, 2002

Markets can be further categorised according to their position along the marketing chain:

- Wholesale markets: they are often found in the suburb of large cities, such as Long Bien market, Hanoi's largest poultry wholesale market.
  Such markets provide traders, retailers and institutional customers with large amounts of animals and meat
- Retail markets: such markets are found in rural and urban areas, irrespectively of their size, infrastructure and status they provide customers daily, bi-weekly or weekly with poultry products (live animals, meat, eggs). They usually trade smaller quantities than wholesale markets

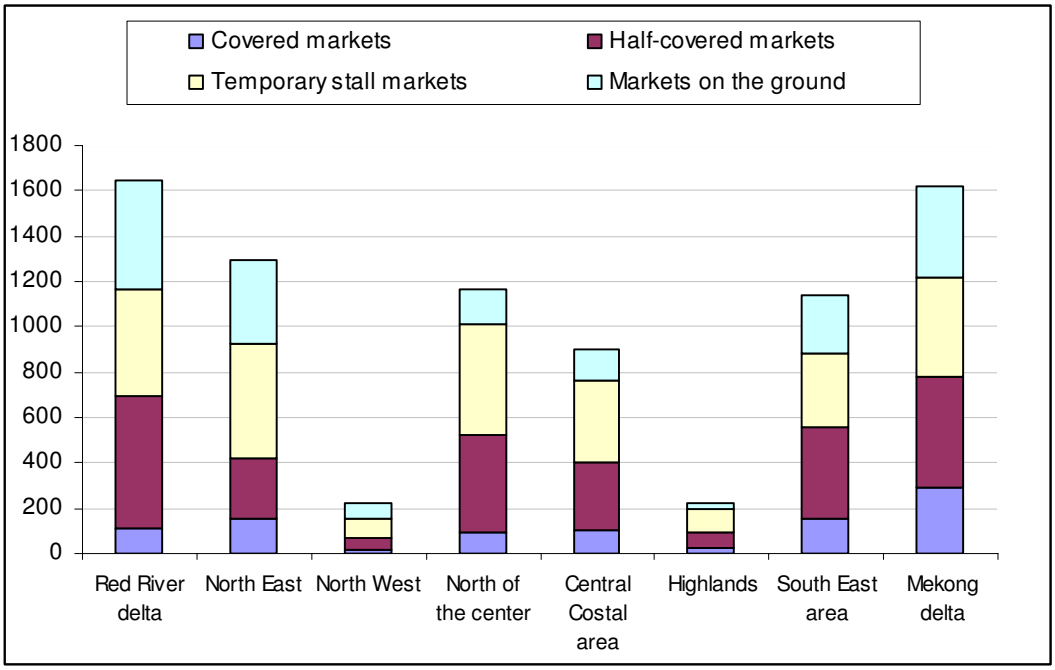
Market conditions are often very poor. In Vietnam, only 11.6% of the markets are totally covered, 31.5% are half-covered, 33.8% are made of temporary stalls and 23% are held on the ground. Those proportions are very different from one region to another, linked mostly to the urbanisation grade of those regions.

Figure 3: number of each type of Markets according to their location



Source: General Statistic Office, 2002

Figure 4: repartition of each type of market per region



Source: General Statistic Office, 2002

Supermarkets

Besides such markets, Vietnam has seen the very fast development of supermarkets since the 1990. The number of supermarkets increased by 17% per annum between 2000 and 2004 in HCMC and by 14% in Hanoi. By June 2004, Hanoi counted 55 supermarkets (and 9 trade

centres), while HCMC showed 71 supermarkets in 2005.[49] No data could be found on the proportion of duck produced in the country and commercialised through this segment of the retail chain. It is assumed to be negligible so far.

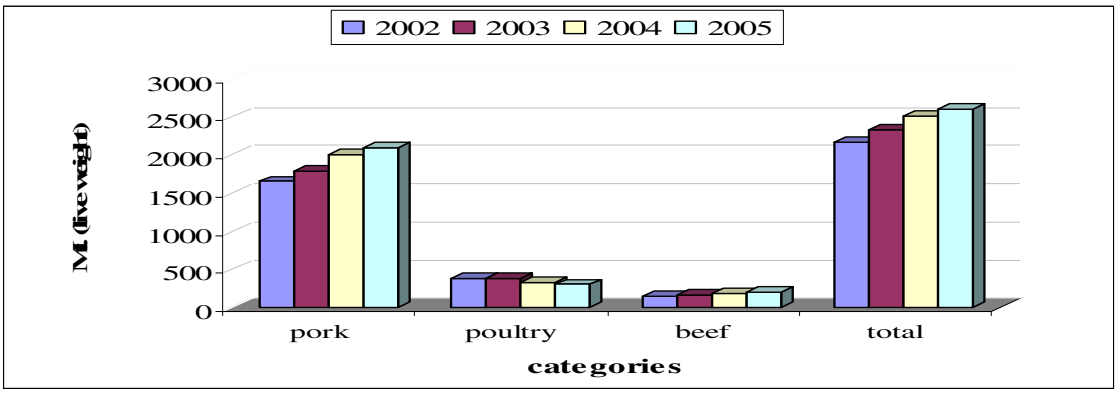
2.8.2 Consumption habits

Evolution of poultry consumption

The poultry sector plays a crucial role in the local economy of the country and greatly contributes to the nutritional balance of both rural and urban households. By 2001, the average per capita per annum consumption of poultry meat was 4.22 kg, against 14.63 kg pork and 10.52 kg seafood.[50]

To date, the egg consumption approaches 60 eggs per head per year and the poultry meat consumption is still estimated to be 4 kg per head per year (13.8% of the total meat consumption), as shown by the figure below.

Figure 5: overall meat consumption (in Mt. per year) in Vietnam



Source: USDA (2005)

The poultry sector annual growth rate was 7.64% between 1990 and 2003[51]. The pre-AI target of the Government was to produce 400 millions poultry heads by 2010.
No detailed data on the relative economic importance of duck production could be retrieved, as very few economic figures exist on duck production systems.

Qualitative aspects

In Vietnam poultry is usually commercialised live on wholesale and retail markets, until it reaches consumers. Buying live poultry on markets, bringing it alive home for slaughter or having it slaughtered and prepared *de visu* is a strong habit and is part of the Vietnamese culture. Buying live poultry is a warranty of quality and freshness. Such habits are found on rural, as well as on urban markets.

Because of Avian Flu, those consumption habits are changing[52]. People trust more and more the poultry sold in supermarkets than the one of the markets; they get more and more afraid of eating some parts of the poultry like the liver or the blood, at it is considered highly infectious; they tend

[49] Moustier P. (2006)
[50] Quirke et al. (2003)
[51] MARD (2005)
[52] Fournier T (2005)

to buy more and more dead poultry; they better cook the poultry and some of them change their food habits, consuming more beef or pork meat during the crisis.

2.9 Institutional framework

The duck production sector is placed under the aegis of the National Institute of Animal Husbandry (NIAH) and the Vietnam National Livestock Corporation for breeding and research aspects, as well as various state, semi-private and private breeding farms for production aspects.

The most relevant breeding duck farms in Vietnam are[53]:

- Dai Xuyen Duck Research Centre, Ha Tay (Only ducks, 8'000 to 10'000 ducks of various strains)
- Southern Livestock Research and Advanced Technology Transfer Centre (VIGOVA), Ben Cat, Binh Duong (South) (grandparent duck strains)
- Thuy Phuong Poultry Research Centre, Hanoi (Chicken, Muscovy ducks, geese and pigeons)
- Cam Binh Poultry Breeding Company, Hai Duong province (both duck and chicken breeding stock)

Beside these state-owned central breeding farms, there were, in December 2003, 15 provincial poultry farms (from which Cao Phong farm in Hoa Binh province, Binh Gia farm in Lang Son province and Tuy Phuoc farm in Binh Dinh province[54] produce ducks), 10 companies under control of foreign investments and 80 private own farms.[55]

2.10 National policies/decrees/resolutions/decisions

Government decisions and decrees directly or indirectly related to duck husbandry have been issued mostly since the first HPAI outbreak. However provincial authorities may issue decrees or decisions on ducks relating to their own territory. This has apparently been the case in the Mekong Delta, where certain provinces have banned duck scavenging systems *in order to protect irrigation systems and prevent water pollution and disease transmission*[56]. Such a measure has led farmers to apply confinement systems and thus to give complementary feed to the ducks.

Since the first HPAI outbreak, numerous governmental decisions and decrees have been issued. A non exhaustive list of important decisions is given in annex 2.

The main decision concerning waterfowls is **Circular No. 84/2005/TT-BNN of December 23, 2005 of the MARD**, guiding the reorganization of the raising of water birds for prevention and control of avian influenza (H5N1) epidemic. This circular prolongs measures on egg hatching promulgated under Decision No. 321/BNN-NN dated February, 4th 2005 of MARD and announcement No. 1844/BNN-VP dated April, 29th 2005. [57] Hatching of water fowls has been temporarily banned until February 2007, in order to reduce the number of poultry species at risk.

Another important legal document is the **Circular No. 85/2005/TT-BNN of December 23, 2005 of the MARD** on quarantine of products (meat and eggs) from poultry[58].

[53] M. Dat, personnal communication (March, 2006)
[54] Delquigny et al. (2004)
[55] Hoang Kim Giao (undated)
[56] Nguyen Thi Kim Dong (2005)
[57] Công Báo No. 23-24 (16-01-2006)
[58] Công Báo No. 23-24 (16-01-2006)

3 History of HPAI outbreaks in Vietnam

3.1 Historical background

The presence of the highly pathogenic strain (H5N1) of the Avian Influenza has been suspected in Vietnam in June 2003, with first known outbreaks in Vinh Phuc and Ha Noi provinces in the North. So far three main waves of reported outbreaks have been affecting the country:

First wave (December 2003-March 2004)

Between December 2003 and March 2004, 57 of 64 provinces were affected and 58.66 millions birds were destroyed (52% chicken, 23% water fowls and 25% quails). The case of Vietnam was reported to the OIE on January 8th, 2004. At the end of this wave, 57 provinces, 382 districts and 2592 communes have been infected.

Second wave (April 2004-November 2004)

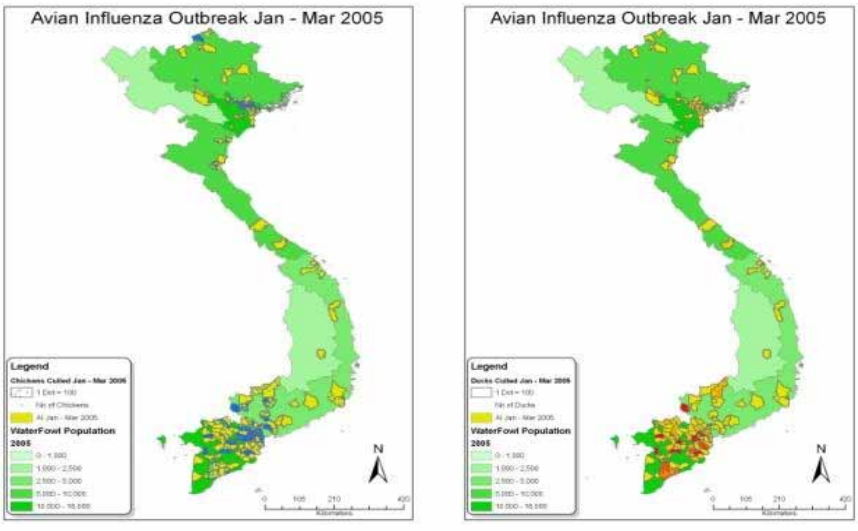
The second episode of HPAI was characterised by a much smaller extent with 80.080 heads of domestic poultry culled (70% chicken, 10% water fowls and 25% quails), thus representing less than 1% of the first outbreak's scope in terms of poultry heads culled. During this phase, the epizooty remained largely confined to the southern part of the country.

Third wave (December 2004-September 2005)

The third wave affected 2'158'526 heads of poultry (22% chicken, 38% ducks and 39% quails) within 186 districts of 36 provinces. It affected mainly small-scaled farms. At the end of this wave, 36 provinces and 186 districts have been infected.

The extent of this wave is visible in the following maps, indicating overall outbreaks (yellow), outbreaks in chicken (blue spots) and ducks (red spots). The green shades are the concentration of ducks per region (also see annex 3).

Figure 6: HPAI outbreaks in 2003-2004 per region and poultry category: chicken (left map) and ducks (right map)



Fourth wave (October 2005-January 2006)

The fourth outbreak occurred between October 1st and December 15th, 2005, mainly in the Northern region of Vietnam.

This outbreak spread in 89 districts of 25 provinces, leading to the death of 3'972'763 heads of poultry (34% chickens, 54% of ducks and 12% of other birds).

The control measures undertaken by the Vietnamese government (preventive culling around the main cities, stopping the commercialisation of live birds, serological monitoring of ducks, cleaning of the markets, vaccination) have helped to limit the spread of HPAI throughout the country. In addition to these control measures, the brutal drop in consumption demand probably contributed to the drop in commercialisation.

3.2 Estimated impact of HPAI in Vietnam

The presence of HPAI in Vietnam has resulted in death cases and mass preventive slaughtering of poultry, as shown by the following table.

Table 6: number of died or culled poultry during AI outbreaks

	1st wave Dec 2003-March 2004		2nd wave Apr 2004-Nov 2004		3rd wave Dec 2004-Aug 2005	
Chicken	30'400'000	52%	55'999	66%	475'841	22%
Ducks	**13'500'000**	**23%**	**8'132**	**10%**	**831'656**	**39%**
Quails	14'760'000	25%	19'947	24%	851'029	39%
Total	58'660'000		84'078		2'158'526	

Source: USDA (2005)

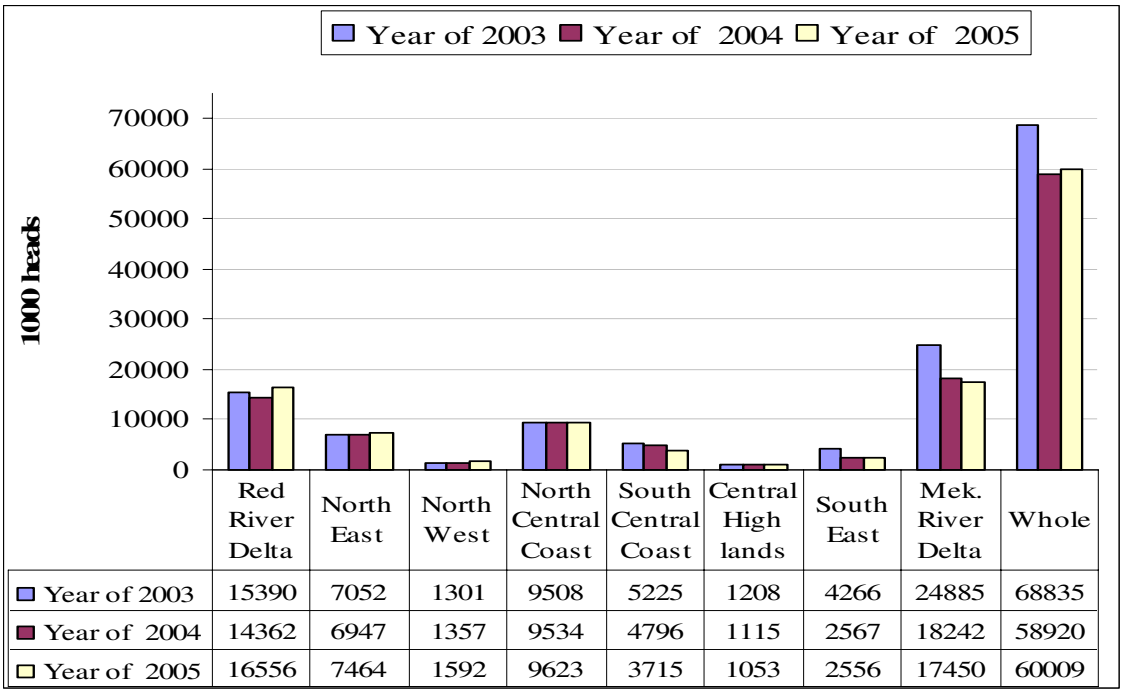
During the first and second wave, chicken have been more heavily affected by slaughtering than other poultry species, followed by quails and finally ducks. During the third wave however, ducks have paid a higher tribute than chicken.

Beside death cases and slaughtering, the poultry population was "naturally" controlled by a significant drop of the consumption of poultry products. According to a study on consumption behaviour of poultry products consumers, a vast majority of the people interviewed in Hanoi (94%) stopped eating poultry products during the first outbreaks (90% of them because of fear and 74% because of recommendations). The study highlighted the fact that mostly rich people (74% of the rich) stopped eating poultry, against 27% of the poor people.[59]

The economic impact of the HPAI outbreaks is estimated to range between 0.3% and 0.5% of the country's GDP[60]. The consequence of HPAI on the overall duck population and its regional distribution is highlighted by the following figure.

[59] Fournier (2005)
[60] World Bank in MacLeod et al. (2005)

Figure 7: evolution of the duck population in the eight regions of Vietnam since the HPAI outbreaks



	Red River Delta	North East	North West	North Central Coast	South Central Coast	Central High lands	South East	Mek. River Delta	Whole
Year of 2003	15390	7052	1301	9508	5225	1208	4266	24885	68835
Year of 2004	14362	6947	1357	9534	4796	1115	2567	18242	58920
Year of 2005	16556	7464	1592	9623	3715	1053	2556	17450	60009

Source: MARD, 2005

The duck population has been drastically reduced from 68 millions down to 58 millions heads between 2003 and 2005. The change has been much more drastic in both deltas, than in other areas.

Between 2004 and 2006, the direct impact of HPAI (number of poultry affected by the disease) is reducing. However, the indirect impact (through drops and instability of consumers demand) on poultry production may be increasing, although this assumption has not yet been asserted by any long term study conducted in Vietnam so far. The end-of-2005 epidemic had a very limited sanitary impact, while the economic impact was probably one of the highest since 2004. Indeed, the brutal drop in consumer demand was such that many producers were unable to sell healthy poultry.

3.3 Potential role of ducks in the spread of HPAI

Ducks are often mentioned as potential silent ("healthy") carriers of the virus[61]. This assertion has been verified by a team of the Centre for Disease Control and Prevention (CDC) in Atlanta, which investigated the presence of various AI viruses on live bird markets in Hanoi in 2001. The CDC team found out that, apart from various AI viruses, endemic to the region such as H9N2, H7N7 etc., the highly pathogenic AI virus H5N1 was present in live, healthy geese and ducks, but not in live chickens. This finding highlights the fact that H5N1 HPAI virus was circulating in Vietnam prior to the massive "first" outbreak of 2003. The CDC had already highlighted the fact

[61] Gilbert and Slingenbergh (2004)

that the H5N1 strain was circulating in southern China in 1999. Thanks to the results obtained from the Hanoi live bird markets, as well as its previous findings elsewhere in the region, the CDC was able to assert that ducks and other waterfowls (geese) were silent, healthy carriers of the HPAI strain[62].

This suspicion has been reinforced in when 71% of ducks tested in the Mekong delta were found positive for H5N1[63].

However, the CDC was also able to assert with certitude that the H5N1 strain found in healthy ducks and geese on live bird markets in Hanoi, was genetically, antigenically and pathologically different from the H5N1 strain causing the epidemic in 2003-2004 and thus could not be assessed as its "*immediate progenitor*".

So far, further epidemiological evidence still lack to assert with certitude that ducks convey the virus without succumbing. Evidence also lack to assert that the viral charge found in healthy ducks is sufficient to efficiently contaminate other poultry species.

[62] Nguyen C. Doan et al. (2004)
[63] USDA (2005)

4 Duck production systems in northern Vietnam: case studies in 4 provinces

4.1 Methodology of the field study

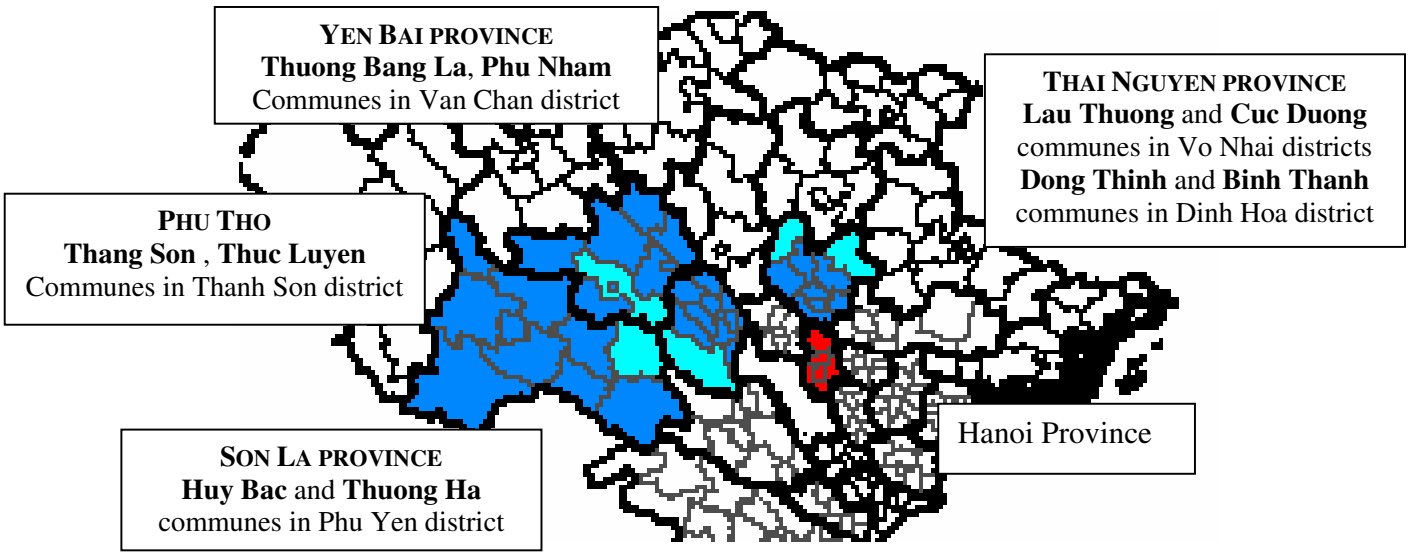
The present study bases on three main sources of information:

1. secondary data from documents obtained through literature research
2. primary and secondary data obtained from interviews with various stakeholders of duck husbandry (State farms, governmental and private stakeholders at provincial, district and communal level)
3. primary data from a field survey and from focus group meetings with relevant stakeholders

It was carried out between December 2005 and March 2006 in selected communes of Thai Nguyen, Son La, Phu Tho and Yen Bai provinces, 4 Northern provinces of Vietnam (see map below), where AVSF has been implementing projects.

Within these provinces, 5 districts and 10 communes (2 in each district) have been selected.

Figure 8: location of field survey in northern Vietnam



Location of the survey (Dark blue = Provinces; light blue = Districts)

The communes were chosen in function of spatial criteria:

- Communes near the main district town (3 communes: Huy Bac, Thang Son and Phu Nham)
- Communes near one of the main district roads, at a distance between 15 and 25 km of the main district town (5 communes: Thuong Ha, Thuc Luyen, Thuong Bang La, Lau Thuong and Dong Thinh)
- Communes without easy access to the main road and poor access to services (2 communes: Cuc Duong and Binh Thanh)

A total of 146 farmers were interviewed twice, at one month interval. Their number and geographic distribution is shown by the following table.

Table 7: number of farmers interviewed per selected commune in each selected district of the 4 selected provinces

Provinces	Districts	Communes	Number of villages	Number of questionnaires
Thai Nguyen	Dinh Hoa	Binh Thang	7	15
		Dong Thinh	7	15
	Vo Nhai	Lau Tuong	4	15
		Cuc Duong	5	15
Son La	Phu Yen	Huy Bac	6	15
		Tuong Ha	6	14
Phu Tho	Thanh Son	Thang Son	5	17
		Thuc Luyen	7	15
Yen Bai	Van Chan	Phu Nham	4	12
		Thuong Bang La	5	13

The field survey has been conducted in two steps:

1. Description of the production system at farm level

The first part of the survey bases on interviews with selected poultry producers at village level. The interviews are based on a questionnaire (see annex 4). This part of the survey has been divided into three steps:

- **Step 1: Testing of the questionnaire**

The questionnaire has been tested twice:

- First testing: the questionnaire has been tested a first time by the team leader on 4 medium sized ducks farms in Thai Nguyen province in November 2005. This step has allowed the author to adapt the questionnaire accordingly and to assess the time needed to complete one interview
- Second testing: the questionnaire has been translated into Vietnamese and has been tested a second time by two Vietnamese veterinary trainees

- **Step 2: Identification and selection of farms**

Farms have been selected based on discussions with the paravets of each concerned commune and their description of poultry production practices in the commune. Each production practice has been proportionally represented in the sampling.
The objective was to interview 30 farmers in each district, thus bringing the total number of questionnaires to 150 and allowing basic statistical analysis of the data.

- **Step 3: Interviews at farm level**

Every farmer has been met twice at one to two months interval. This has allowed gathering rather accurate data on activities over a 2 months period within the farm (animal census, mortality, supply, sales…).

The questionnaire used for the first interview is divided in 9 parts:

- Part 1: characterization of the production stakeholders (ethnic background, family size…)
- Part 2: description of the farm production
- Part 3: animal census
- Part 4: main activities in the farm in the last month
- Part 5: investments
- Part 6: farm management practices
- Part 7: other poultry products
- Part 8: feed management
- Part 9: diseases management

This will give us some quantitative data, on the proportion of farms of each group applying thoses raising technique. As far as the condition permit it (ni > 5 or …), we will apply a Chi2 test to compare the repartition of the use of one technique between each sub-system. And then to assess if there is any statistical significant difference between each sub-system .

2. ***Description of the poultry industry within the commune and district***

This part of the survey bases on interviews with relevant stakeholders at district, commune and village level. Its aim is to:

→ Describe and assess the relevance of the animal production within the concerned districts

→ Cense and assess the importance of the different production stakeholders: public and private stakeholders (vets, paravets, vet and food shops, extension workers, farms…)

→ Describe the market and its organization from production to consumer: hatcheries, big farms, middlemen, traders, market places, private and institutional consumers…

→ Assess the implementation of AI control measures within those districts

This has been achieved through:

- **Focus Group Meetings** at commune level with relevant stakeholders
- **Meetings with relevant district stakeholders**: the District Vet Station (DVS), Representative from mass organizations (Women's Union) of districts where the survey has been implemented.

During the focus group meeting the three following participatory methods have been used:

- Seasonal calendar, with emphasis on rice and duck production
- Market chain analysis of ducks and their products (from producers to consumers)
- Historical matrix: description of the changes in farm management due to AI and farmer's plans in the future to locally control AI

Mainly the two first tools have been applied, while the historical matrix has been used only in one case as some communes were not affected by HPAI.

Due to time[64] and budgetary constraints[65], focus group meetings could be held in two out of the selected 10 communes. In the third commune (Thuong Ha), the focus group meeting could not be held, as information was not passed on in time by the Chairman of the People's Committee and duck stakeholders could not be gathered on this day.

[64] For each focus meeting, between 1 and 2 days per commune are needed, including travel time and depending on the location. Covering all communes would have implied an additional 15 to 20 days for focus group meetings only

[65] The overall budget to cover the whole study is 8'000 USD (including fees of two expatriate consultants, travel costs, running costs of 8 students, accommodation, material and workshop costs)

Table 8: schedule of the field survey

Time	Activity
Beginning of November 2005	Drafting of the questionnaire
November 11th	Testing of questionnaire No.1 in Thai Nguyen province Review of questionnaire No.1
November 21st-25th	Testing No.1 in 4 communes in 2 district of the 4 concerned provinces by 8 students
November 28th-December 2nd	Assessment of the first phase, drafting of questionnaire No.2
December 9th	Submission of final methodology and questionnaire to FAO
December 2005-January 2006	Survey with questionnaire No.1 and No.2 in all concerned provinces
January 23rd-25th	Stephen Swan's mission to Vietnam, final discussion and approval of the methodology by the FAO Hanoi and Stephen Swan
January 28th to February 10th	Tet (New Year) break
January to February	Data analysis of questionnaires
February 27th and 28th	Focus group meeting in Cuc Duong and Dong Thinh communes
March 6th and 7th	Field trip to Thuong Ha commune in Son La province, interview with stakeholders
March 9th to March 15th	Drafting of report
March 15th	Submission of draft final report
March 31st, 2006	Submission of final report

4.2 Results of the field study

The present study is articulated around the classification presented under chapter 3.

Based on spatial criteria (risk of spreading diseases), as well as economic criteria (importance of duck production in the farm), the study has further highlighted **three sub-systems of the semi-confined system**. They are:

- **The self sufficiency oriented sub-system** corresponding to all small farms which do not sell their poultry product, but keep them for the household consumption
- **The intermediate sub-system groups farms with mixed management practices:** self consumption and sale, as well as intermediate number of ducks (less than 100)
- **The semi-commercial sub-system** counts all farms with more than 100 heads, and commercializing their products

4.2.1 Description of the surveyed households

The overall average size of the household is 3.4 adults. One fifth of the households (21.2%) interviewed do not have children yet. In the other families, the number of children varies from 1 to 4 with an average of 1.8 children per family.

Geographical distribution

The proportion of the systems is given by the following table and their geographic distribution is highlighted by the following figure.

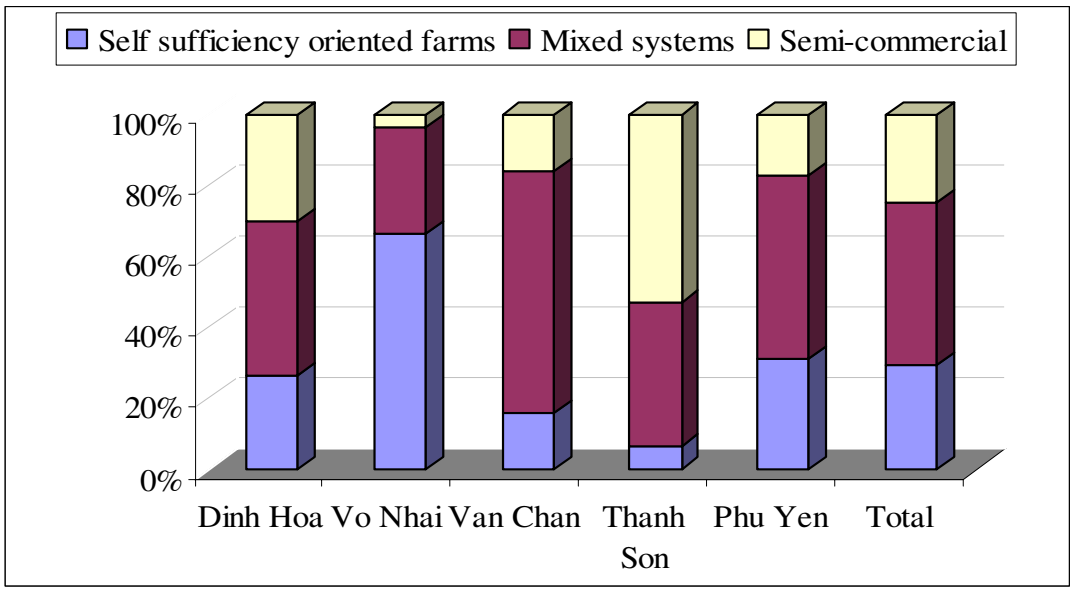
Table 9: number and proportion of farmers interviewed per sub-system under semi-confined main production system

	No. of farms	Proportion
Self sufficiency oriented	43	29.5%
Intermediate	67	45.8%
Semi-commercial	36	24.7%
TOTAL	**146**	**100%**

Mixed systems make up a higher proportion than self-sufficiency oriented or semi-commercial systems, with res. 46%, 29% and 25%.

The geographical distribution of the sub-systems is by far not homogenous. This fact is mainly due to the location of the commune, its infrastructure and market access. Remote communes with poorer road network, such as Cuc Duong commune in Vo Nhai tend to be more self-sufficiency oriented than other communes.

Figure 9: geographic repartition of farms according to the 3 duck production sub-systems



The geographical distribution of each sub-system is presented in the figure below. The differences in the geographical repartition of each sub-system are statistically significant ($p = 2.4.10^{-7}$; ddl = 6). The self sufficient sub-system is significantly more represented in Thai Nguyen province; the semi-industrial one is significantly more represented in Phu Tho province.

Ethnic group

Out of 146 farmers interviewed, 144 gave information on their ethnic background. The majority of farmers interviewed are Tay (35.3%), followed by Muong (26.6%), Kinh (24.5%), Black Thai (13.7%) and Nung (2.9%). The proportion of the different ethnic groups varies according to the different regions. Thai Nguyen hosts more Tay and Kinh, while Black Thai and Muong are found mostly in Son La.

Table 10: repartition of ethnic group by sub-system

	Tay	Muong	Kinh	Other Ethnic Minority
Self sufficient	20	9	9	5
Intermediate	20	10	18	17
Semi commercial	10	18	7	1

When applied to the distribution of each sub-system among various ethnic groups, the chi2 test shows statistically highly significant differences ($p = 5.8.10^{-4}$; ddl = 6). Semi-commercial practices tend to be more adopted by Muong farmers. However, such result needs to be tackled carefully because of the geographical repartition of ethnic groups in Vietnam and of the different sub-systems in the studied area. Thai Nguyen exhibits more self-sufficient farms and simultaneously a higher proportion of Tay.

Income classification

As the criteria defining income classification vary from one province to another, thus rendering comparison difficult, it was decided to classify farmers based on their own perception of income classification.

Out of 146 interviewees, 140 accepted to communicate their perception of their own income classification. A minority of farmers (12 out of 140, 8.6%) consider themselves as poor. The vast majority of farmers (93 farmers, 66.4%) consider their income as average, while 35 persons (25.0%) think they are well off.

The income classification by sub-system and by district following the self-estimation of poverty is shown by the following table. Most of the farmers (between 58% and 73%) classify themselves as "average". The main differences between the three sub-systems can be seen within the semi-commercial sub-system which exhibits a larger proportion of "rich" farmers. This outcome is most probably linked to the fact that semi-commercial production is more demanding in initial capital for investment and thus is more likely to be adopted by richer farmers. However, a Chi2 test applied to those results does not exhibit any significant difference in the income classification between the 3 sub-systems or between each province.

More over, it does not mean that the income classification is the same between self-sufficient and semi-commercial farms. In fact, this data is highly linked to the economic situation of the selected villages regarding the average household income.

Table 11: self estimated income classification by sub-system

	Poor	**Average**	**Rich**
	% farmers	% farmers	% farmers
Self sufficient	9.8	73.2	17.0
Intermediate	7.6	66.7	25.7
Semi commercial	9.1	57.6	33.3

Table 12: self estimated income classification by district

	Poor	**Average**	**Rich**
	% farmers	% farmers	% farmers
Dinh Hoa	0	57.1	42.9
Vo Nhai	17.2	72.4	10.4
Phu Yen	7.1	67.9	25.0
Thanh Son	12.9	51.6	35.5
Van Chan	4.2	87.5	8.3

The majority of farmers interviewed classify their income as average. The data presented in the tables differ from official ones, mainly because the farmers compared themselves to their neighbors and because 7 communes out of 10 are richer than the average communes of the surveyed district.

The official latest statistics on poverty incidence in the studied communes and district is given in the table below.

Table 13: incidence of poverty in the studied districts

		Incidence of poverty		Incidence of rural poverty	Incidence of urban poverty
		District	Commune	District	District
Dinh Hoa	Binh Thang	52.6%	65.4%	55.1%	18.0%
	Dong Thinh		47.8%		
Vo Nhai	Lau Tuong	60.3%	41.3%	62.6%	18.2%
	Cuc Duong		64.0%		
Phu Yen	Huy Bac	69.7%	66.5%	72.6%	25.5%
	Tuong Ha		75.7%		
Thanh Son	Thang Son	62.3%	20.3%	73.8%	11.9%
	Thuc Luyen		46.9%		
Van Chan	Phu Nham	67.6%	64.0%	65.7%	20.3%
	Thuong Bang La		59.8%		

Source: IFPRI, 1999

The figures are likely to have changed over the last 7 years. However, they show large differences within a district. Figures on regional poverty need to be taken in consideration, while envisaging new policies on duck production and possible shifts towards new production techniques.

Income of the surveyed farms is provided by farm activities, but to a non negligible extent by off-farm activities.

Approximately one fourth of the 146 households (26.4%) of the households have at least one person working out of the farm. People working outside the farm work exclusively in non farming activities (factory, further studies etc.). Only one of the 35 people working or studying outside is working on another farm.

Out of the 35 people working or studying off-farm, 19 usually come back home at least once a week. On an average, they travel 16 km from their house to the place where they work or study. The remaining 16 persons come back home once a month or less.

4.2.2 Farming activities and economic ranking

Crops

Income from farming activities mainly originate from crops (rice). Only 3.4% of the interviewed farmers do not produce rice. For the other ones, the total surface for rice cultivation varies between 0.5 and 40 *sao* (1 *sao* = 360 m^2), with an average of 7 *sao*.

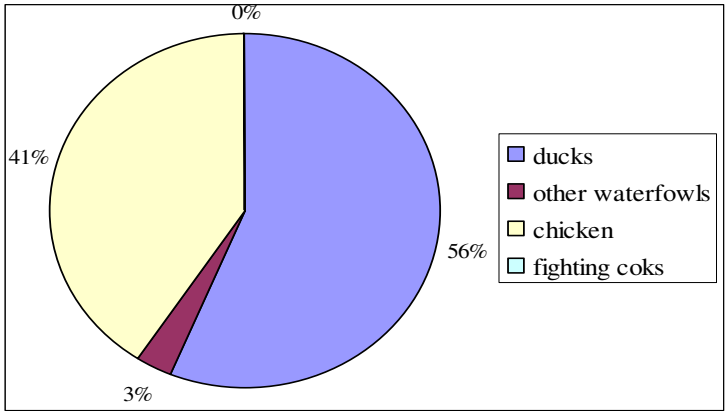
The average seasonal rice production (one crops) is estimated at 180 kg per *sao* (5'000 kg per ha).

Non staple crops are maize, potatoes, cassava, tea and fruit. A large majority of farmers (93.4%) have other crops than rice. The surface for non staple crops varies between 1 and 55 *sao*.

Animal husbandry

All households interviewed keep ducks. Duck outnumber chicken, thus indicating the degree of specialization of the farms. Other poultry include other waterfowls (geese), as well as fighting cocks (see figure below and annex 5).

Figure 10: proportion (%) of various poultry species within the overall poultry flock of interviewed farmers



The largest non poultry domestic animal population is given by pigs both for fattening (532 heads) and for reproduction (51), followed by dogs (337), cattle and buffaloes (228) and goats (149).

Out of 146 farms, more than half (63,9%) practice fish farming.

4.2.3 Labour input

Two third of interviewed farmers mention that the family member taking care of poultry change almost everyday. A very small amount of farmers (1.4%) pay for external help in poultry production and simultaneously for all kind of work within the farm. There are not any significant differences between the 3 sub-systems.

The working time devoted to duck production greatly varies between 15 minutes to 10 hours a day (herding), as shown in the table below.

Table 14: daily working time devoted to duck production per sub-system (N = 129)

	Less than 1 hour a day	**From 1 to 3 hours a day**	**More than 3 hours a day**
Self sufficient	31 (79.5%)	8 (20.5%)	0
Intermediate	42 (70.0%)	13 (21.7%)	5 (8.3%)
Semi commercial	6 (20.0%)	11 (36.7%)	13 (43.3%)

The difference between each sub-system appears highly significant ($p = 5.0.10^{-8}$; ddl = 4). That is to say that the more farms are specialized in one production, the more the farmers spend some time for this activity.

4.2.4 Economic importance of duck production

The survey shows that duck husbandry plays an important economic role for the farmers interviewed. A majority of interviewed farmers (N=107, 75.9%) rank duck production among the three, economically speaking, most significant productions within the farm. One fourth of the farmers (N=25, 23.4%) mention duck production as the branch generating the highest income on the farm.
For 47 farmers (43.9%) duck production is the economically second most important production on the farm and 35 (32.7%) said that duck production is the third most relevant production on the farm. The details per district are given in the following table.

Table 15: ranking of duck production according to economic importance within the farm's economy by surveyed district

	1st production	2nd production	3rd production	TOTAL
	% farmers	% farmers	% farmers	% farmers
Dinh Hoa	13.0%	60.9%	26.1%	76.7%
Vo Nhai	10.8%	57.1%	32.1%	93.3%
Van Chan	30.0%	35.0%	35.0%	87.0%
Phu Yen	6.7%	26.7%	66.6%	55.6%
Thanh Son	57.1%	28.6%	14.3%	67.7%
AVERAGE	23.4%	43.9%	32.7%	100%

The table above shows high variations between the regions. Duck production is to a large extent classified as second most important economic production of the farm, except in Phu Yen, where it is mainly classified as third economically most important production of the farm and in Thanh Son, where it is ranked as first production branch.

The table below presents the results according to each sub-system. The differences appear highly significant ($p = 1.3.10^{-7}$; ddl = 6). In fact, the more the production is developed within the farm, the more income generating it is. However, if we cross those results with the geographical distribution of each sub-system, we can highlight some weird aspects that are difficult to explain with the present survey:

- 2/3 of interviewed farmers in Vo Nhai, Thai Nguyen belong to the self-sufficient sub-system and 93.3% of the interviewed farmers rank their duck production among the three most important production of their farm.
- Thanh Son is the district with the higher proportion of semi-commercial farms and thus, only 2/3 of the farmer consider the duck production as economically valuable

Table 16: duck production ranking within the farm by sub-system (N = 141)

	1st rank	2nd rank	3rd rank	Not ranked
Self sufficient	0	19	14	9
Intermediate	6	21	19	19
Semi commercial	17	9	2	6

4.2.5 Investment capital

Duck shed

Out of 146 farmers interviewed, 135 farmers answered the question related to building costs for duck production. A small number of farmers do not have any building for ducks (10 farmers, 7.4%). Another small number (5 farmers, 3.7%) does not remember how much they spend for their building. A large proportion (56 farmers, 40%) built their shed by themselves and did not pay anything. The investment capital significantly differs from one sub-system to another ($p = 3.7.10^{-4}$; ddl = 4) and is highly linked to the professionnalization of the duck production.

Table 17: investment capital according to by sub-system (N = 135)

	No investment	Less than 1 million*	More than 1 million*
Self sufficient	27	13	2
Intermediate	25	30	7
Semi commercial	14	6	11

*: 1 USD = 15.950 VND

A large majority of existing sheds (64.8%) have been built less than 3 years ago. This outcome is imputed to the fact that most of the farmers rebuilt animal pens every 2-3 years, as they are built with damageable locally available material (bamboo).

Origin of the capital

Capital invested in the shed originates mostly from the household's own savings (65.0% of the households), followed by the bank (16.3% of the households), the family (13.8% of the households), moneylenders (4.1% of the households) or credit issued by the Women's Union (0.8% of the households).

Table 18: investment capital according to by sub-system (N = 135)

	Loan from banks, lenders, Women's Union	Loan from the family, without interest rate
Self sufficient	3	24
Intermediate	5	56
Semi commercial	18	18

The semi-commercial farmers more often call up capital from private organization (Bank, lenders, Women's Union) than from their saving or their family ($p = 2.4.10^{-6}$; ddl = 2). This is probably to be linked to the easier access to loan for those farmers

4.3 Duck husbandry systems

4.3.1 Poultry holding pattern

The following figure shows that the more intensive the production tends to be, the higher the average number of poultry per farm is.

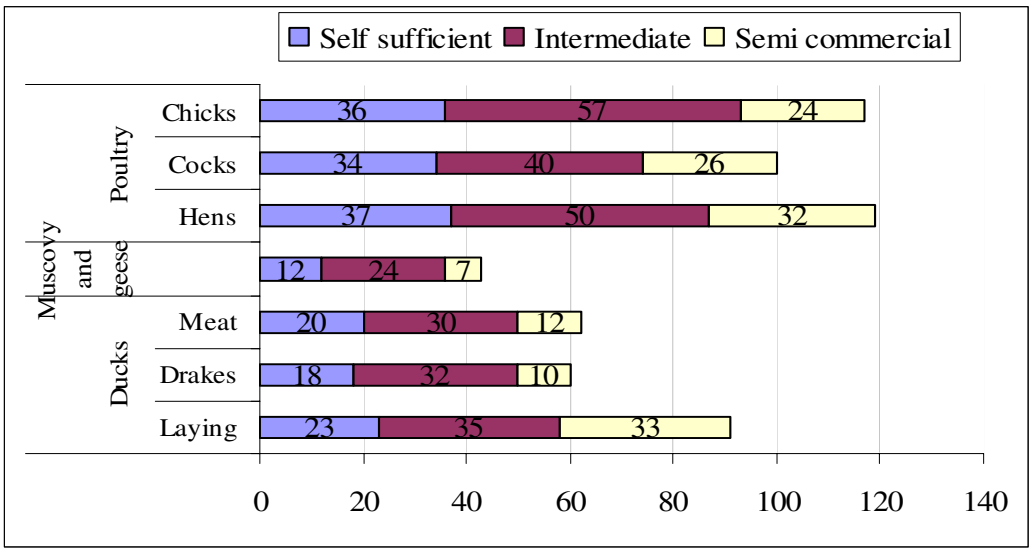
The number of ducks raised per farm was one of the main criteria to categorize the different farms into the three sub systems. The table below presents the herd holding pattern per sub-system. The semi-commercial farms exhibit a higher average number of poultry whatever the category of poultry we are referring to.

Table 19: herd holding pattern (No. of heads per farm) per sub-system under semi-confined main production system and per poultry category

	Ducks			Muscovy and geese	Poultry		
	Laying	Drakes	Meat		Hens	Cocks	Chicks
	No of heads (No farms)	No of heads (No farms)	No of heads (No farms)	No of heads (No farms)	No of heads (No farms)	No of heads (No farms)	No of heads (No farms)
Self sufficient	5 (23)	1,9 (18)	13,2 (20)	9,9 (12)	5,9 (37)	2,8 (34)	24,6 (36)
Intermediate	18,9 (35)	2,0 (32)	28,2 (30)	17,9 (24)	10,2 (50)	3,3 (40)	24,3 (57)
Semi commercial	200,3 (33)	19,9 (10)	56,8 (12)	24,4 (7)	19,6 (32)	3,4 (26)	78,3 (24)

Semi-commercial laying duck farms have a much higher average holding than semi-commercial meat duck farms (200 heads against 57 heads). Meat oriented self-sufficiency and intermediate farms tend to have higher average holding than the same categories of farms with laying ducks.
The number of farms per sub-system varies according to the poultry species produced. In the survey sample, the intermediate sub-systems exhibits, without exception, the largest number of farms, as illustrated by the following figure. The semi-commercial sub-system shows the lowest number of farms, with the exception of laying ducks.

Figure 11: number of farms per sub-system under semi-confined main production system, per poultry category



4.3.2 Ducks holding pattern

Duck breeds as well as their provenance vary according to the production sub-systems, as shown by the figure below.

Table 20: duck breeds and origin of duckling supply per sub-system under semi-confined main production system

	Main breeds	Type of supply	Middleman / Market	Hatchery / farm	No answer
Self sufficient	Vit Bau, Muscovy, Ha Lan	• Ready to hatch eggs (40.5%) • Ducklings (59.5%)	43,6%	53.8%	2.6%
Intermediate	Vit Bau, Bau Canh Trung, Muscovy	• Ready to hatch eggs (21.6%) • Ducklings (78.4%)	51.7%	43.5%	4.8%
Semi commercial	Sieu Trung, Ha Lan, Sieu Co Co	• Ducklings (91.7%) • Ready to lay female (8.3%)	30.4%	65.2%	4.3%

The ready to hatch eggs are usually brooded by hens or Muscovy ducks, a practice which implies low input (no electricity and labour). The number of farms buying ready to hatch eggs or ready to lay female ducks are a minority. Most of the farms buy ducklings, either from a middleman or at the market. Semi-commercial systems tend to buy ducklings directly from hatcheries, but the difference in the type of supply does not appear statistically significant between each sub-system. Only one of the self-sufficient farm hatches own eggs.

4.3.3 Other domestic animals holding pattern

The total domestic holding pattern per sub-system is illustrated by the following table.

Table 21: domestic animal holding pattern per sub-system under semi-confined main production system

	Pigs		Ruminants	Dogs	Fish
	Sows	Fattening			
Self sufficient	1,2 *(9 farms)*	3,9 *(32 farms)*	3,4 *(25 farms)*	2,2 *(33 farms)*	20 farms (80% integrated with duck production)
Intermediate	1,8 *(13 farms)*	4,1 *(56 farms)*	3,7 *(39 farms)*	2,9 *(58 farms)*	43 farms (86,0% integrated with duck production)
Semi commercial	1,1 *(16 farms)*	6,4 *(28 farms)*	6.8 *(22 farms)*	2,9 *(32 farms)*	53 farms (96,3% integrated with duck production)

The higher the intensification is, the higher the holding pattern tends to be. However the average number of other animal species per farm tends to be average with less than 2 heads of sows,

between 4 and 6 heads of fattening pigs, 3 and 7 heads of large ruminants and less than 3 heads of meat dogs.

The only statistically significant difference between each sub system is that a higher proportion of semi-commercial farms raise at least one sow ($p = 0.03$; ddl = 2).

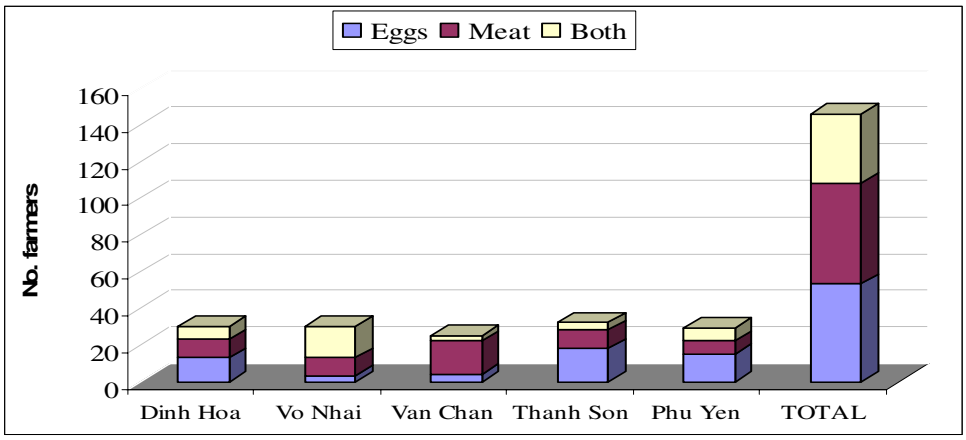
Out of 146 farms, 116 (79%) practice fish farming, out of which, 104 (89.6%) combine fish and duck production. This practice is significantly more important for the semi-commercial farms ($p = 5.7.10^{-10}$ ddl = 2). This particularity needs to be taken in consideration while tackling the duck issue. Any intervention on duck production will ultimately lead to changes within the fish production. Breeds and origin of ducks

It also has to be noticed that out of 146 farmed surveyed, only three self-sufficient and one intermediate farm do not have any other animals on the farm (2.7%) and four self-sufficient, six intermediate and three semi-commercial farms (8.9%) have only one other type of animal (either pigs or dogs).

4.3.4 Specialisation of the production

Investigation on the production purpose with the duck herd show that an almost equal number of farmers keep ducks specifically for meat (38%) **or** eggs (36%), while farmers using dual-purpose ducks account for 26% of all interviewed farmers (see figure below and annex 6).

Figure 12: number of farmers keeping ducks for eggs, meat or both purposes per district



The degree of specialization differs between sub-systems, as shown by the following table.

Table 22: proportion of farms (%) keeping ducks for single-purpose (meat or eggs) or dual purpose (N_{tot}=146) per sub-system under semi-confined main production system

	Duck production purpose		
	Egg production	**Meat production**	**Both**
	% farms	% farms	% farms
Self sufficient	11,7	48,8	39,5
Intermediate	32,8	46,3	20,9
Semi commercial	72,2	8,3	19,4

The statistical analysis of those differences shows that they are highly significant ($p = 3.7.10^{-7}$; ddl = 4):

- Farmers practicing self-sufficient oriented duck husbandry mostly keep ducks for dual purpose, and very few of them raise ducks for eggs exclusively (app. 12%).
- Farmers at intermediate level seem to focus more on specialized production as meat (46%), followed by egg production (33%) than self-sufficiency oriented farm..
- This assertion is also verified for farmers practicing semi-commercial duck husbandry, which are clearly specialized towards egg production. For a minority of these farmers, meat duck has been chosen. Roughly one fifth of semi-commercial farmers use ducks for both eggs and meat production.

4.3.5 Infrastructure

The survey has shown that most of the farmers use confinement at night. The existing infrastructure for confinement of ducks and their adoption level by farmers is given by the table below.

Table 23: proportion of farms (%) (N_{tot}=146) with different infrastructure per sub-system under semi-confined main production system

	Building for the night	**Park**	**Well fenced park**
	% farms	% farms	% farms
Self sufficient	90,7	51,2	7,3
Intermediate	91,0	37,9	12,1
Semi commercial	94,4	42,9	14,3

A large majority of farms under all 3 sub-systems have a building for the night to confine their ducks. Between 38% and 51% of all farms have a park, which does however not allow a strict confinement. For each sub-system, a high proportion of farms have free roaming ducks.

Only a small proportion of farmers have a "well fenced park" enabling them to strictly confine ducks. The higher the specialization grade, the higher the proportion of farms with strict confinement infrastructure ($p = 9.0.10^{-3}$; ddl = 4).

4.3.6 Use of water bodies

Ducks, as waterfowls, are largely kept in a way making use of existing natural (rivers, streams, lakes) or man-made (ponds, dams, canals, inundated rice fields) water resources. Discussing this practice with farmers, it appears that it is for zootechnical reasons. In fact, it is known that under extensive condition, ducks need water to reproduce[66]. This has to be considered when dealing with the modification of duck management practices.

The proportion of farms making use of these resources is given in the table below.

[66] L'aviculture française (1988)

Table 24: proportion of farms (%) (N_{tot}=146) using available water resources per sub-system under semi-confined main production system

	No	Pond	Rice field	River / Stream	At least 2 different locations
	% farms	% farms	% farms	% farms	% farms
Self sufficient	7,1	26,2	42,9	11,9	11,9
Intermediate	6,0	38,8	25,4	6,0	23,8
Semi commercial	0	41,6	8,3	11,1	36,1

Very few farmers do not make use of any water resources. The proportion ranges from 0% to 7%. The use of water bodies is significantly different from on sub-system to another ($p = 0.01$; ddl = 6). However, the required conditions are hardly respected. As the degree of signification is not so importance, we cannot assert the following impression but they are very likely to be true:

- Self-sufficiency oriented farms make a large use of rice fields. They do not tend so much to use ponds or multiple locations.
- Intermediate farms tend to use ponds first, followed by rice fields. They also tend to use multiple locations (rice fields, ponds and / or rivers).
- Semi-commercial farms largely use ponds. They do not tend to solely use any other water body. However one third of the farms use different locations, making large use of rice fields after harvest.

It has to be mentioned that farmers herding ducks in rice fields prevent their animals from mingling with ducks from other herds.

4.3.7 Inter species interaction

Ducks are in frequent contact with other poultry species, as well as other domestic animal species. Contacts with other species occur on the farm and village premises, on the rice fields, as well as during specific activities such as brooding of ready to hatch duck eggs by hens, a common traditional practice. The proportion of farms per sub-system applying practices implying more or less close contact with other species is given in the following table. All those results appear statistically different between each sub-system: semi-commercial farmers look significantly more after their ducks during the day ($p = 9.0.10^{-6}$; ddl = 2); use significantly less the brooding practice of ready to hatch eggs by other species ($p = 7.7.10^{-7}$; ddl = 2); and limit significantly more the contact between animals of different species ($p = 2.1.10^{-4}$; ddl = 2). However, we have already noticed that semi-commercial farmers also tend to have significant chickens, hens or other water fowl flocks. That is to say that they tend to limit the contact between their ducks and foreign ducks, but there are contacts between their ducks and other poultry species within the farm.

Table 25: proportion of farms (%) managing their ducks according to various per sub-system under semi-confined main production system

	Self sufficient	Intermediate	Semi commercial
Looking after ducks during the day	3.4%	8.3%	40.6%
Brooding ready to hatch eggs by other poultry species	40.5%	20.9%	5.6%
Mixing ducks with other poultry species	68.3%	38.8%	22.9%

Ducks are usually allowed to go out of the farm from 3 to 90 days old, with a median value of 13 days age. Ducks usually stay in the direct neighborhood within the farm premises (maximum 350 m). There is neither rent, nor fees to pay for letting ducks scavenge in the rice fields, neither to other farmers, nor to the commune. The ducks stay between 6 to 12 hours per day in the rice fields, at the pond or the river.

Ducks come back to the farm once or twice a day, on their own. Almost all of them are enclosed at night. The higher the specialization is, the higher is the proportion of farms herding their ducks during daytime (40,6% of semi-commercial farmers, 8,3% of the middle size farm and 3,4% of the scavenging farms).

The proportion of farmers using a hen to brood duck eggs is much higher under self-sufficiency oriented systems (40.5%), than with intermediate farmers (20.9%) and semi-commercial farmers (5.6%). In the case of egg production farms, eggs are collected daily, without differences between the sub systems.

The self-sufficiency oriented system is inclined to have more opportunities for ducks to mingle with other poultry or domestic animal species. However, as this sub-system is mostly confined to village or commune premises (see following chapter), the danger to spread diseases is not so high.

4.3.8 Marketing of poultry products

The field survey investigated the marketing pattern of duck products. The results are given by the following table.

Table 26: proportion of farms (%) (N_{tot}=146) using available marketing channels per sub-system under semi-confined main production system

	No sale	**Market**	**Middleman**	**Customers / shops / incubators**	**2 different locations**
	% farms	% farms	% farms	% farms	% farms
Self sufficient	100	0	0	0	0
Intermediate	1.5	28.6	17.5	77.8	25.4
Semi-commercial	0	23.1	46.2	61.5	30.8

In the survey sample, self-sufficiency oriented farms exclusively keep their products and do not sell them. Farms of intermediate level largely sell their products directly to retailers (shops) or to end consumers (customers and hatcheries).

Semi-commercial oriented farms mostly make use of retailers and end consumers, as well as middlemen. It shall be noted that the higher the specialization grade is, the more complicated the marketing constellation becomes (various stakeholders and marketing steps are involved).

However, no statistical difference between semi-commercial and intermediate sub-system appear ($p = 0.61$; ddl = 2). Meanwhile, the result of the statistical test is not significant enough to totally reject the possibility of a link. This could be further investigate.

4.3.9 Use of duck husbandry by-products

Duck husbandry generates by-products such as feathers, egg shells, old or even dead animals. The way farmers dispose off these by-products is given by the following table.

Table 27: proportion of farms (%) (N_{tot}=146) disposing off by-products of duck production per sub-system under semi-confined main production system

	Selling feathers	Old animals		Dead animals			
		Sell or give	Eat	Sell or give	Eat	Burn or burry	Throw or feed animals
	% farms	% farms	% farms	% farms	% farms	% farms	% farms
Self sufficient	39.5	10.7	89.3	0	5.1	76.9	17.9
Intermediate	43.3	67.4	32.6	0	7.9	81.0	11.1
Semi commercial	66.7	77.8	22.2	0	5.7	85.7	8.6

The higher the specialization level is, the more farmers tend to sell by-products such as feathers ($p = 3.8.10^{-2}$; ddl = 2) or old animals ($p = 2.2.10^{-7}$; ddl = 2). Self-sufficient oriented farms tend to keep by-products for themselves.

On the disposal of dead animals: none of the farmers report selling any dead animal and a small minority in each sub-system report eating them. Self-sufficiency oriented farms have a higher tendency to throw away or feed dead animals than intermediate or semi-commercial farms. All categories tend to dispose them off by applying rather bio-secured measures such as burning or burying.

The vast majority of farmers throw eggshells. Only a few of them (17 farmers, 11.6%), normally represented in each sub-system, use the eggshell as a feed supplement.

4.3.10 Waste management

The survey further investigated the use of manure and its disposal. The results are given by the following table.

Table 28: proportion of farms (%) (N_{tot}=146) using duck manure, treating and storing it per sub-system under semi-confined main production system

	Use of manure			Storage of manure		
	Used	Well treated (quick lime)	Dry only	Ground	Poultry shed or pig sty	Plastic bag
	% farms	% farms	% farms	% farms	% farms	% farms
Self sufficient	97.7	11.9% of 97.7%	7.1% of 97.7%	43.9	56.1	0
Intermediate	91.0	26.2% of 91%	14.8% of 91%	34.4	60.7	4.9
Semi-commercial	91.7	15.1% of 91.7%	3.0% of 91.7%	50	40.6	8.3

A vast majority of farms under all sub-systems use duck manure produced in the shed or the enclosure. The proportion seems higher for self-sufficiency oriented farms than others, but as the conditions requested for statistical tests were not fulfilled, it is not possible to say whether the differences between each sub-systems were significant or not. The proportion of households treating or improving manure is however low in both self-sufficient and semi-commercial units, while it is twice higher with intermediate units.

Treating manure is done in two ways, by disinfecting (adding quick lime) and by improving physical quality of the manure (adding hashes or rice husk to reduce the humidity level). Intermediate farmers tend to improve physical quality of the manure, while semi-commercial units tend to make more use of quick lime. As below, the conditions of statistical tests were not fulfilled.

Manure is stored either on the ground outside, or in the poultry shed or the pigs' sty or in plastic bags. Storing in plastic bags is rather unusual, while storing in poultry shed or pig sty is very frequent (between 40% and 60% of the farmers). Comparing the storing practices (storing on the ground outside vs inside) of different sub-systems, it appears that significant differences exist ($p = 4.7.10^{-3}$; ddl = 2): semi-commercial farmers tend to use both storing practices; intermediate farmers usually store manure in poultry shed or pig sty and self-sufficient farmers let the manure outside.

4.3.11 Feeding management

Only 28.6% of self-sufficient farmers feed their ducks with industrial food. For 75% of them, this is only during the youth period. The proportion of farmers giving industrial feed raises to 44.8% under the intermediate sub-system, for 50% of them, this is only during the first month of life. For farmers under semi-commercial management, this proportion is much higher with 94.4%. Such farmers feed industrial feed during the whole production cycle.

Table 29: feeding management practices (Ntot=145) per sub-system

	Industrial feed	**Kitchen wastes, farm by-product**
Self sufficient	12 (40.0%)	30 (60.0%)
Intermediate	37 (55.2%)	30 (44.8%)
Semi commercial	34 (94.4%)	2 (5.6%)

The feeding management practices appear significantly different between each sub-system ($p = 3.1.10^{-8}$; ddl = 3): the semi-commercial farmers usually buy some industrial feed, whereas very few inputs exist for the self-sufficient farms.

4.3.12 Disease management

Ducks are recurrently affected by various diseases and other health problems (poisoning by polluted water, pesticides etc.). Farmers usually apply preventive medicine (vaccination), as well as curative treatments (deworming, antibiotics). It is worth mentioning that farmers often use antibiotics as a preventive measure.

Table 30: proportion of farms (%) (N_{tot}=146) treating their ducks at least once, per type of treatment per sub-system under semi-confined main production system

	Deworming	**Vaccination**	**Vitamins**	**Antibiotics**
	% farms	% farms	% farms	% farms
Self sufficient	7.1	9.5	2.4	17.1
Intermediate	16.7	15.2	4.5	34.9
Semi commercial	52.9	31.8	44.4	72.7

Whatever the type of treatment considered, the differences between each sub-system in the application of systematic treatment appear significant. The use of para veterinarians services is also significantly different between the sub-systems (p = 8.9.10-4; ddl = 2).

A large majority of self-sufficiency oriented farmers tend to let their ducks without preventive or curative treatment. Only 2.3% of the self-sufficient farmers call the paravet in case of problems.

A larger proportion of intermediate farmers use antibiotics, followed by deworming and vaccination. Only 6.0% of the intermediate farmers call the paravet in case of problems. Semi-commercial duck farmers make a large use of preventive and curative treatments. A large majority (three fourth) use antibiotics, followed by deworming and vitamins.

Semi-commercial farmers raise their ducks with greater care than self-sufficient farmers. However, only one third of the semi-commercial farmers vaccine ducks. Only one fourth of semi-commercial farmers (25.7%) are accustomed to call paravets, in case of problem.

This shows that farmers largely count on their "own knowledge" or resources to treat ducks.

4.4 Modification of duck production practices during AI outbreaks

Consequence of AI outbreaks on farm management

The impact of the HPAI outbreak within the country on duck farming practices of the survey sample was investigated. The findings are given in the following table.

As the conditions for applying statistical tests were not fulfilled, the following results must be considered as qualitative ones only.

Table 31: proportion of farms (%) (N_{tot}=146) changing their duck's raising practices because of Avian Flu, per sub-system under semi-confined main production system

	Self sufficient	**Intermediate**	**Semi commercial**	**TOTAL**
	% farms	% farms	% farms	% farms
Do not change anything	88.1	65.7	63.6	71.8
Stop industrial feeding and let the ducks free	2.4	9.0	12.1	7.7
Stop the commercialization	0	14.9	3.0	5.6
Wait before buying a new flock	4.8	0	3.0	2.1
Keep the ducks enclosed	2.4	4.5	0	2.8
Sell all ducks	0	1.5	0	0.7
Cull all the ducks	2.4	4.5	3.0	3.5
Want to switch their activity to other animal production	2.4	22.4	8.3	7.7

It appears that a vast majority of farmers did not change anything to their traditional or usual duck husbandry practices after HPAI outbreaks. However, among the one who reported changing something, the semi-commercial and intermediate farmers where the more represented (p = 0.04; ddl = 2). Unfortunately, those changes are often link to current legislation (stop the

commercialization of animals or eggs), or to worst or inadapted management practices (let the duck scavenge, slaughtering, stop the production)

The proportion is particularly high with self-sufficient farmers (88%). One generally immediate consequence of HPAI outbreak was the drop in the consumption of meat and eggs and consequently a drop in the commercialization of these products. A positive consequence is the reduced movement of duck products and live ducks. An adverse consequence is the release of ducks for scavenging in order to spare on expensive, commercial feed. This measure was more adopted by semi-commercial farmers (12%) than others. Culling of ducks was not largely applied.

Few farmers seem to envisage abandoning their activity (7.7% on an average). The proportion is however higher with intermediate farmers than others.

Specific consequences of vaccination on duck farming practices

During this survey, many farmers mention the implementation of vaccination in their farm and its consequences on their production.

The main problem was the adverse effect of vaccination on duck health: mortality and morbidity were very often mentioned, especially in intermediate and self-sufficient farms. This is not surprising knowing that those ducks are very likely to have parasitic infection and nutriment deficiencies. The efficacy of the vaccination in those farms is then questionable.

Furthermore, another adverse effect of the vaccination mentioned by farmers could possibly increase the risk of HPAI virus spreading.

Indeed, most of the egg production farms, even the semi-commercial ones, said that vaccination induced a decrease in the daily number of laid eggs. As a consequence, farmers decided to artificially induce moulting of their female ducks, by stopping feeding them with industrial feed and letting them scavenge to feed themselves.

Such a measure has on one hand a positive effect as it contributes to reduce movements of products (stop the commercialization of eggs); but on another hand, it also increases the number of ducks in the fields.

4.5 Illustration of 3 sub-systems of the semi-confined main system

The field survey highlights the fact that in the studied areas of Northern Vietnam, the main duck production system is semi-confined. Ducks are confined at night in a pen or an enclosure and most of the time released during the day to more or less freely scavenge backyard, in the village premises, through rice fields and along water bodies.

The survey further highlights three sub-systems, based on economic criteria, viz. self-sufficiency oriented, intermediate and semi-commercial. Commercial duck production systems are known to exist in Northern Vietnam, but were not encountered in the communes visited.

The semi-confined systems and its three sub-systems were assessed at individual household level. However the same classification can apply to villages or even communes considered as one production entity. This step is illustrated by the three following cases studies, based on focus group meetings held at commune level in 2 communes (Cuc Duong and Dong Thinh), as well as one field visit, without focus group meeting (Thuong Ha commune).

4.5.1 Self-sufficiency oriented production entity: Cuc Duong Commune, Vo Nhai district, Thai Nguyen Province

Cuc Duong is a mountainous commune situated in Vo Nhai district in Thai Nguyen province, at 30 km distance from Thai Nguyen city and 10 km from Dinh Ca, Vo Nhai's district centre.

Though Cuc Duong is situated not far away from the main road connecting Thai Nguyen city to Lang Son in the East, the commune is naturally closed by Karst Mountains all around. The commune premises are accessible by a single narrow black-topped road.

Cuc Duong has a population of 2'218 people distributed in 453 households over 5 villages (Tan Son, Truong Son, Nam Son, Binh Son and Mo Tri). The commune's area is 37.71 km^2.

The overall **poultry population** is 12'092 heads, among them 250 ducks (2%).

Farmers do not mention any specific **duck breed**, most of them are local common ducks (*Vit Lang* and *Vit Bau*). Muscovy ducks are available as well.

The focus group meeting organized with commune authorities and duck farmers showed the following **seasonality of duck production** in the commune.

Table 32: seasonal calendar of duck production in Cuc Duong commune, Vo Nhai district, Thai Nguyen province

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainy season												
Planting rice												
Weeding												
Duck herding in rice field												
Harvesting												
Stocking with fish fingelings												
Sale of fish												
Stocking with ducklings												
Sale of ducks												
Highest diseases prevalence												
Peak consumption of duck meat												

Activities related to duck production are concentrated over the rainy season. Ducklings are purchased or produced in March-April so that their size allows them to enter the rice fields when the rice plants are still small. Ducklings are bought from 3 middlemen or self produced.

Ducks are however not purposely kept for weeding rice fields. Golden Apple Snails have not spread up to Cuc Duong, other pests such as caterpillar are eaten by ducks. However as the duck density is low, pesticides are sprayed against major pests. **Feed** is not purchased, ducks are extra fed with kitchen waste and ducklings are fed with cooked rice.

Movements of ducks are restricted only when they are still too small to roam around, as well as at night when ducks are confined in their shed. Otherwise ducks are left more or less free and come back by themselves when they are hungry.

Ducks are to a large extent kept under VAC combination system. The fish pond is occasionally cleaned (maximum once a year) and the mud kept for the garden and orchard. If the pond is fed by a running water source, it does not need cleaning. Fish species are various carp types, used for self consumption and sale.

The **disease prevalence** is high, particularly over the first days of the ducklings and during the rainy season. Over the years, there have been recurrent episodes of a disease, whose main symptom is sudden death in the afternoon, without clinical signs prior to the death. This disease affects all age categories, though young ducks are more heavily affected.

The **stakeholder** analysis (see figure below) revealed that the commune counts only one larger duck producer, who owns 100 heads. Apart from him, farmers do not have specialised duck breeding activities. The number of stakeholders of duck production is therefore low and their type rather homogenous (low scaled, confined to commune premises).

External inputs are negligible, they are mainly medicine (unknown type) from the feed shops. Commercial feed is hardly used. The main input are ducklings or young ducks (laying type) bought for 15'000 per kg LW for further raising.

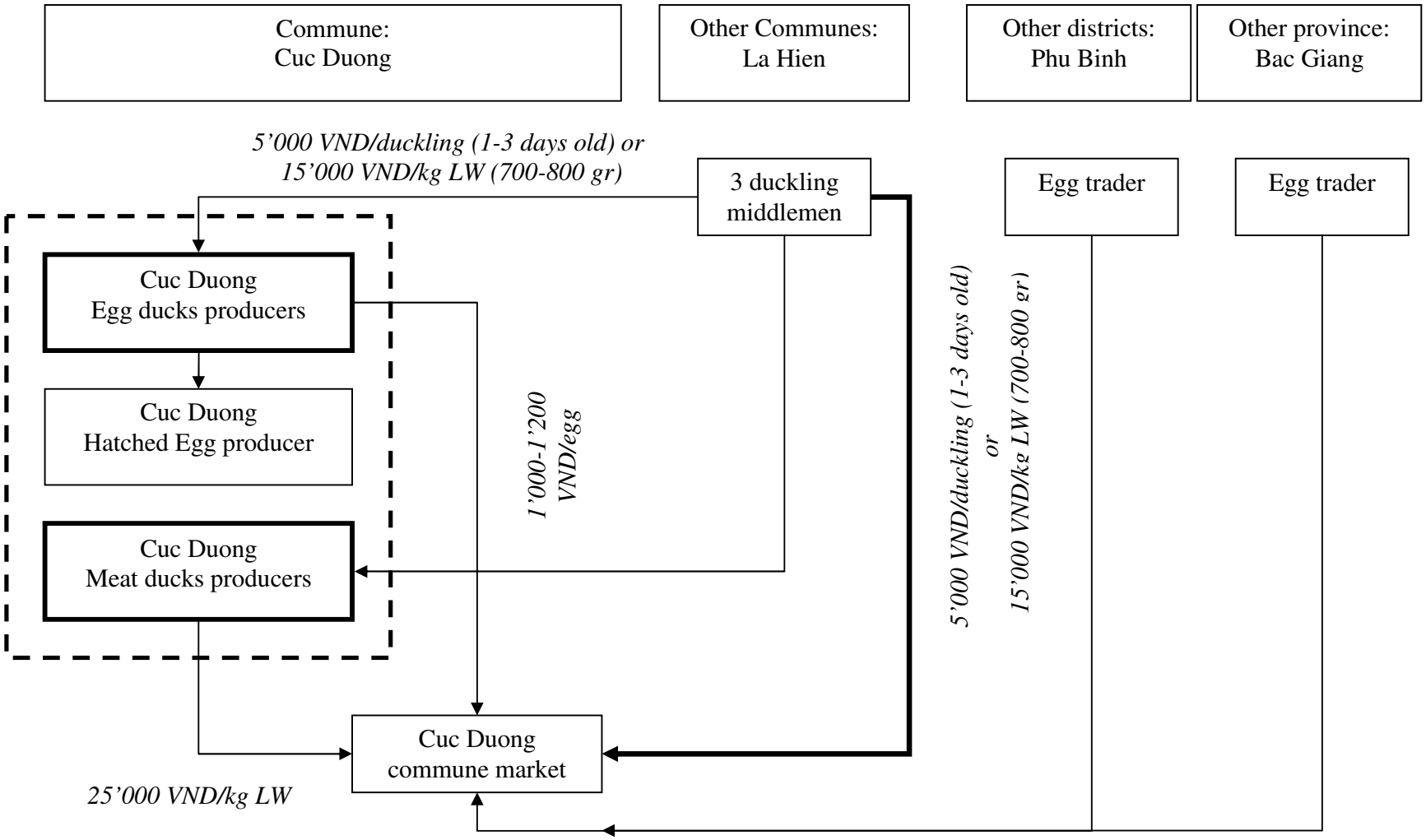
Products of duck husbandry are eggs, meat and ducklings. Ducklings are mainly self-produced eggs hatched on the farm by a hen because female ducks are known not to brood eggs.

The **use of products** is largely characterized by self-consumption. Products (eggs, incubated eggs and meat) are occasionally sold on the local commune market (every day on small-scale and every 5 days at larger scale). Fresh eggs are sold for 1'000 to 1'200 VND/piece and meat for 25'000 VND per kg LW at 2.5 kg. Feathers and shells are not used but thrown away.

There is no specific **consumption seasonality** of products. Duck meat is highly prized and preferred to chicken meat.

The historical matrix on HPAI incidence showed that the largest duck farmer (100 heads) has sold his ducks in December last year and has not taken up production yet, like every year (the production cycle starts in March). Vaccination has been carried out by commune authorities.

Figure 13: stakeholders of duck production and marketing of duck products in Cuc Duong commune, Vo Nhai district, Thai Nguyen province


Commune:
Cuc Duong
Other Communes:
La Hien
Other districts:
Phu Binh
Other province:
Bac Giang
5'000 VND/duckling (1-3 days old) or
15'000 VND/kg LW (700-800 gr)
3 duckling middlemen
Egg trader
Egg trader
Cuc Duong
Egg ducks producers
Cuc Duong
Hatched Egg producer
Cuc Duong
Meat ducks producers
1'000-1'200 VND/egg
5'000 VND/duckling (1-3 days old)
or
15'000 VND/kg LW (700-800 gr)
Cuc Duong
commune market
25'000 VND/kg LW

Cuc Duong commune can be considered as a self-sufficiency oriented production unit and a relatively closed market.

Considering the danger of spreading diseases, the main threats are the two egg traders from Phu Binh district and from Bac Giang province, as well as the three duckling traders from La Hien neighbouring commune. These stakeholders are the main potential carriers of threats. This potential threat is increased by the fact that these middlemen go around farms to sell ducklings directly in case they have not sold all their ducklings on the market. The risk to spread the disease out of the commune area is lower than the risk of getting contaminated, as products are mainly self-consumed.

However a clear identification of main stakeholders and poultry movements shall enable to take up adequate measures to prevent bird flu from spreading (make farmers aware of risk posed by external stakeholders).

Summary:
an entity (village, commune) oriented towards self-sufficiency is characterised by:

- low scaled duck activities
- few stakeholders
- a relatively closed market
- low duck movements
- a large utilisation of existing local feed (post-harvest residues, molluscs, crustaceans) and natural resources (water bodies)
- a recurrent disease prevalence in the rainy season
- products largely self-consumed or sold on local markets

Duckling movement is probably the highest external risk factor, which can be reasonably well addressed, if stakeholders are properly identified and users made aware of the risks.

4.5.2 Intermediate production entity: Dong Thinh Commune, Dinh Hoa district, Thai Nguyen Province

Dong Thinh is a mountainous commune situated in Dinh Hoa district in Thai Nguyen province, at 50 km distance from Thai Nguyen city and 10 km from Cho Chu, Dinh Hoa's district centre.

Dong Thinh is situated not far away from the road connecting Dinh Hoa to Cho Don (Bac Kan province) and other districts of Thai Nguyen (Phu Luong).

Though considered as remote, the commune's territory is more open than other areas, the topography is characterized by ranges of mountains in the background and a large flat land area.

The commune centre is accessible from the main district black-topped road by a single narrow earthen road.

Dong Thinh has a population of 4'100 people distributed in 960 households over 22 villages. The commune's area is 1'279 ha.

The overall **poultry population** is 19'070 heads, among them 2'070 ducks (11%). Some geese can also be found, but their number seems to be rather low.

Farmers do not mention any specific **duck breed**, most of them are local common ducks (*Sieu Co* or *Bao Linh* breed) kept either for meat or egg production.

The **seasonality of duck production** in the commune is the following.

Table 33: seasonal calendar of duck production in Dong Thinh commune, Dinh Hoa district, Thai Nguyen province

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainy season												
Planting rice												
Weeding												
Duck herding in rice field												
Harvesting												
Cleaning the pond												
Stocking the pond with fish seedlings												
Stocking with ducklings												
Sale of ducks												
Highest diseases prevalence												
Peak consumption of duck meat												

Activities related to duck production are concentrated over the rainy season. Ducklings are purchased or produced in February after Tet. 2 days old ducklings are bought from hatcheries in neighboring communes (mainly Binh Yen) at a price of 2'600 VND/head or self produced. They are kept 3 years in case of laying ducks and 3 or 4 months in case of meat ducks (in two batches, one for each rice season).

Laying ducks are changed every 3 years (in two batches at 6 months interval), so that there is no interruption in the egg production.

Ducks are not purposely kept for weeding rice fields.

Feed is not purchased, ducks are extra fed with kitchen waste and ducklings are fed with cooked rice.

Movements of ducks are restricted only at night when they are confined against theft and predators. Otherwise ducks are left scavenging on post-harvest waste in rice fields after the two rice harvests for about one month (June/July and November/December). During the post-harvest scavenging period, ducks are herded in order to prevent the flocks from mingling. Ducks are brought to water bodies daily and brought back in the evening.

Ducks from other communes (Bao Cuong, Dinh Bien, Bao Linh and Phuc Chu) are also herded in rice fields of Dong Thinh commune. Herding is practiced in order to avoid any mingling of animals from different flocks. If other flocks approach, the herders try to chase them away.

One farmer marks his animals with a colored cross on the tail in order to recognize them. He does it for ducklings, which are not herded.

Ducks are to a large extent kept under VAC combination system. Fish species are various carp types, used for self consumption and sale. Ducks feed on snails etc. available in the pond.

The **disease prevalence** has always been high over the years. There have been recurrent episodes of a disease, whose main symptom is paralysis.

External inputs are negligible, they are mainly medicine (unknown type) from the commune or district feed shops. Commercial feed is hardly used. The main inputs are ducklings bought from hatcheries for further raising.

Products of duck husbandry are eggs and meat. Feathers are a by-product which seems to be of a relative importance, as traders come as far as neighboring districts and provinces to collect them.

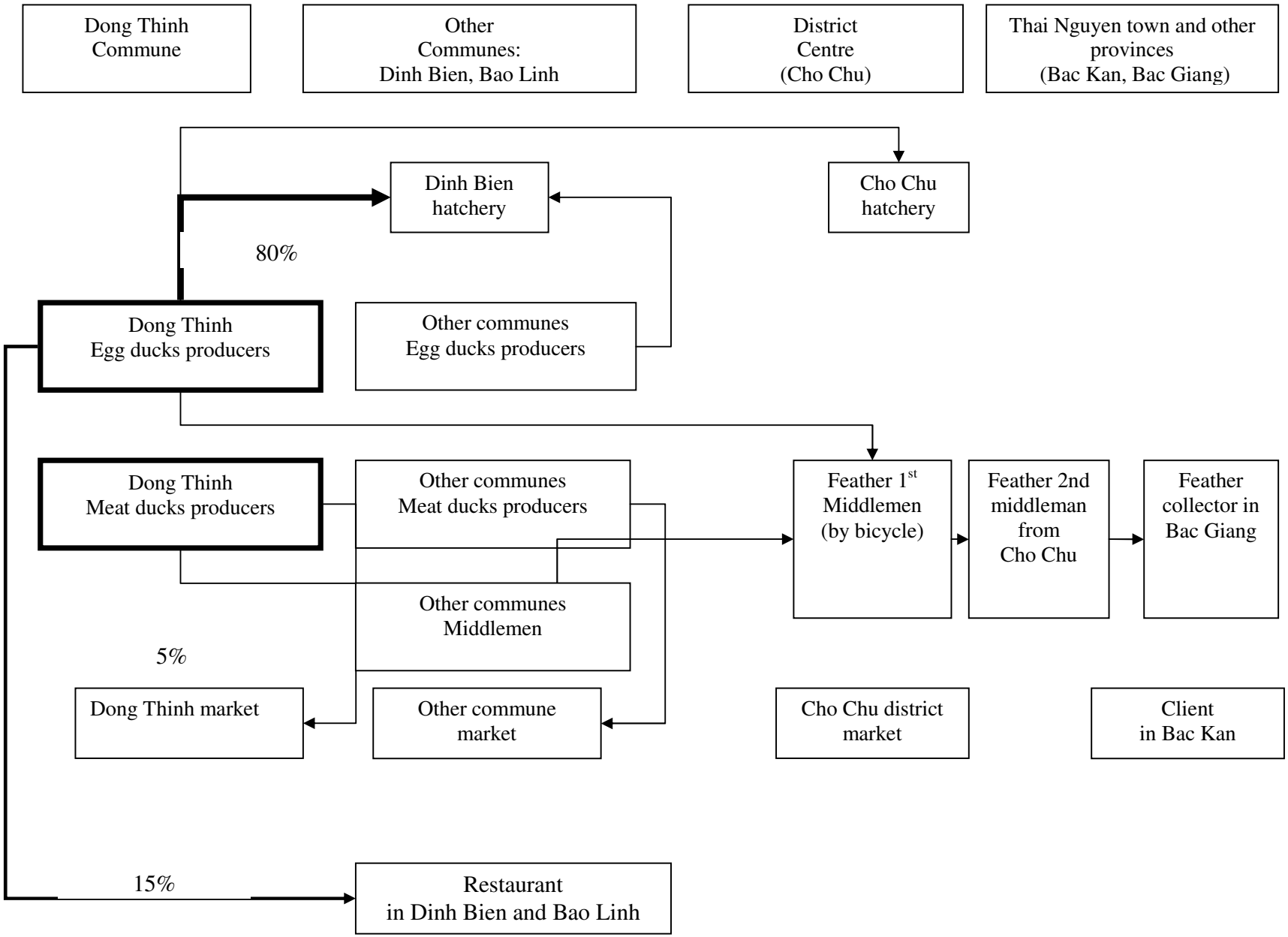
The **use of products** depends on the production scale. Products (eggs, incubated eggs and meat) are occasionally sold on the local commune market (every day on small-scale and every 5 days at larger scale). Eggs are sold for 1'200 to 1'500 VND/piece to hatcheries and meat for 17'000 VND per kg LW.

Feathers are sold at 20'000 VND/kg when the duck farmer has a certain quantity. Egg shells are thrown away.

There is a specific **consumption seasonality** of products. Duck meat is mostly consumed for festivals (Tet Nguyen Dan in January, Tet Thanh Minh in March and another festival in August).

The **stakeholder** analysis (see figure below) revealed that the commune counts numerous stakeholders, as shown by the following figure.

Figure 14: stakeholders of duck production and marketing of duck products in Dong Thinh commune, Dinh Hoa, Thai Nguyen province


Dong Thinh Commune
Other Communes: Dinh Bien, Bao Linh
District Centre (Cho Chu)
Thai Nguyen town and other provinces (Bac Kan, Bac Giang)
Dinh Bien hatchery
Cho Chu hatchery
80%
Dong Thinh Egg ducks producers
Other communes Egg ducks producers
Dong Thinh Meat ducks producers
Other communes Meat ducks producers
Feather 1st Middlemen (by bicycle)
Feather 2nd middleman from Cho Chu
Feather collector in Bac Giang
Other communes Middlemen
5%
Dong Thinh market
Other commune market
Cho Chu district market
Client in Bac Kan
15%
Restaurant in Dinh Bien and Bao Linh

M. …, egg duck producer
Su Nghe Village, Dong Thinh commune, Dinh Hoa district, Thai Nguyen Province

M. Huan, 28 years old, married with 2 children, has taken over the farm from his parents 3 years ago. His family has always been practicing duck husbandry.

He has 14 *sao* of land (4600 m^2) for rice cultivation, a tea tree nursery and 1 *mau* (3600 m^2) of ponds stocked with carp and tilapia seedlings.

He has 250 ducks for egg production, which can swim on the pond or rest on the shore.

On **infrastructure**: ducks are enclosed for the night in bamboo sheds. Rice husk is spread once a weak as litter. The ponds are fed by a running water source. The water level of the pond is lowered in order to catch fish seedlings for sale.

On **feeding**: ducks are fed thrice a day with industrial feed at a quantity of 17 kg per day for 100 ducks.

On **disease prevention**: ducks are vaccinated against pasteurellosis every 6 months by injection. Vaccine against HPAI has been done in November-December by the paravet.

On **products**: eggs are collected every morning from the nests and sold mainly to a private hatchery (80%), to the market for consumption (5%), as well as to dealers from other provinces (15%) (Bac Kan). He sells his eggs himself and does not want middle-men to come to his farm in order to prevent diseases. He tries to sell all eggs, he is even ready to lower the price at the end of the day, in order to come home empty-handed.

On **the future of his production**: in an attempt to diversify his production, M. Huan bought 3 pigs for fattening and one boar, for 1.5 million VND at 6 months age from Tuyen Quang province, which is used to inseminate sows in the neighbourhood. He fears HPAI outbreaks and takes prevention measures by himself to prevent his farm from being contaminated. He does not allow duckling traders to come on his farm, which is naturally well protected from intruders (in a small valley behind the forest).

M….., duck eggs hatchery owner
Dong Thinh commune, Dinh Hoa district, Thai Nguyen Province

On **infrastructure**: the hatchery consists of two cabinets, bulb-heated at a constant 37ºC and one room with thick cotton blankets covering the ground. The first cabinet has a capacity of 6'000 eggs, while the second cabinet can contain up to 13'000 eggs. Humidity is kept constant (not measured) thanks to a large bowl filled with water placed on the ground. Electricity is the highest cost factor after the cost of purchased eggs.

On **supply**: eggs originate from 4 farms of Dong Thinh and Dinh Bien communes of Dinh Hoa district, within a radius of 5 km. Each farm brings between 300 and 500 eggs every 4 days. Eggs are transported by motorbike in carton boxes and are protected with straw.

On the **hatching process**: after a maximum waiting period of 4 days (stored in baskets under the bed), eggs are grouped by 40 pieces in nets, and placed in the smallest heated cabinet. Nets are moved 4 times a day until day 16 of incubation. Whenever new eggs arrive, the nets are placed on the two first layers and older eggs are placed further up.

Eggs are candled with a lamp at day 5 for fertilisation and at day 16 for embryo development

On day 16 after the lamp check, nets are moved to the bigger heated cabinet, until day 22. Between day 22 and day 28, eggs are spread on the blanket and covered by two layers of blankets until hatching. During this period, eggs placed on the side are periodically (4 times a day) moved towards the middle in order to keep a constant temperature.

On **products**: it is estimated that 90% of the eggs are fertilised and 70% of the eggs reach final hatching. Discarded eggs are either commercialised, self consumed, fed to dogs, fish, pigs and ducks or thrown away.

Ducklings are to a large extent sold on regional markets and private farms (Cho Chu, Phu Binh, Dong Thinh, Dinh Yen and Binh Thang) within a radius of 10 km. A small amount is directly sold on the farm. 2-days old ducklings are sold at 2'700 VND/head. On day 2 they are fed a small amount of cooked rice.

A small amount of incubated eggs, with dead embryos, is also sold at 16 days for direct consumption, at a price of 1'500 VND/egg.

On **seasonality**: February and March are the months with the highest supply of eggs

On **disease prevention**: no specific measures have been undertaken regarding HPAI prevention. In February 2004, the egg supply has stopped for 1 month due to a drop of the duckling demand. This year, nothing has changed

The historical matrix on HPAI incidence showed that Dong Thinh commune was not affected by HPAI. The neighbouring commune (Trung Luong) was affected in February 2004. As a preventive measure, poultry of neighbouring farms were culled and the premises were disinfected.

Farmers fear HPAI but did not change anything to their management practices.

Vaccination has been carried out by commune authorities between the 19th and 26th of October 2005 and 17th to 25th November 2005. The impact of HPAI was however felt by farmers as they could not sell products for 2 months, following a drastic drop of poultry products consumption.

Farmers have sold their ducks last December and have not taken up production yet, as it is too early in the season.

Dong Thinh commune can be considered as an intermediate production entity, combining self-sufficiency oriented farms, as well as specialised semi-commercial oriented farms. The commune taken as an entity is a relatively open market with numerous stakeholders involved, scattered in other communes, districts and even provinces.

Considering the danger of diseases spreading, the main threats are the hatcheries from neighbouring communes, as well as the middlemen gathering feathers and buying meat. Their existence is known, however nobody seem to really know who they are and where they come from (further stakeholders analysis would be needed in other communes). These stakeholders are the main potential carriers of threats.

The complexity of the system makes issues related to HPAI prevention more complicated to address.

Summary: an entity (village, commune) of intermediate level is characterised by:

- the simultaneous presence of self-sufficiency oriented farms, as well as semi-commercial farms
- duck activities on various scales (small and large)
- utilisation of existing local feed (post-harvest residues, molluscs, crustaceans) and natural resources (water bodies), parallel to utilisation of commercial feed
- high disease prevalence, especially in self-sufficiency oriented farms
- high rate of marketed products
- numerous duck movements
- high number of various stakeholders
- wide geographic distribution of stakeholders within the commune, in other communes, other districts and even other provinces
- large and intricate marketing system

Movement of ducklings is probably the highest external risk factor, which is more difficult to address, as in the self-sufficiency entity, as duckling producers are more scattered and numerous. Some farmers are already reasonably aware of bio-security and naturally adapted to them (prior to HPAI outbreaks). This entity seems to react more quickly to natural drops of the consumption in case of HPAI outbreak (consumption drops immediately and subsequently production as well)

4.5.3 Intermediate production entity with migratory characteristics: Thuong Ha Commune, Phu Yen district, Son La Province

Thuong Ha is a mountainous commune situated in Phu Yen district in Son La province, at 250 km distance from Son La main's town.

Thuong Ha is situated on a black-topped district road connecting both Phu Yen and Moc Chau districts.

The commune's topography is characterized by ranges of mountains in the background, a narrow flat land area and the presence of a very large water body, the Song Da forming one of the upper branches of Hoa Binh's reservoir.

Dong Thinh has a population of 2'924 people distributed in 619 households. The commune's area is 1'937 ha.

The current overall **poultry population** is currently 18'530 heads, among them 2'070 ducks (11.2%).

The limited time left for the study and the non availability of farmers busy with rice transplanting prevented the team from carrying out a focus group meeting. However the field trip and a few interviews with relevant stakeholders showed particular aspects related to duck husbandry, particularly relevant within the HPAI context. The most relevant aspect encountered is the presence of migratory duck flocks as illustrated by the following text box.

Duck flocks migrating
according to the water level of the Song Da river

Thuong Ha commune has migratory duck flocks belonging to fishing households on the Song Da river. The fishing families originate from two communes of one district in Phu Tho, Son La's neighboring province in the South.

The families, (16, among them between 4 and 9 have ducks according to different sources) move with their fishing rafts according to the seasonal water level of the Song Da river and the Hoa Binh reservoir. During the flood season (September to December), they come as high as Thuong Tuong commune. Ducks are kept on cages on the boat at night and released during the day to swim on the river and graze on the shore and fields.

The historical matrix showed that Thuong Ha commune was affected by HPAI.

According to the District veterinary services, the commune was not part of the vaccination scheme (only 12 communes out of 27 were targeted, the vaccinated communes are reported to be covered at 91% by vaccination), as it was not considered as a commune at risk. Communes with high poultry movements, high poultry density and easy access to the road were identified as communes at risk.

Thuong Ha commune was affected by an HPAI outbreak in November 2005. First suspicious cases were reported on November 22nd, 2005 and ducks were collected for epidemiological checks. On November 29th, it was decided to slaughter all ducks (4'500 heads) from the commune.

It is reported that a fisherman spread the disease in Thuong Tuong commune first and then in Thuong Ha, as they moved down to the commune with their ducks at night, by fear of getting their flocks slaughtered in Thuong Tuong.

In 2005 Thuong Ha will be part of the vaccination scheme.

An interview with a duck farmer gives an insight of duck husbandry practices prior to the HPAI outbreak.

Ms. …, Muong duck farmer
Thuong Ha commune, Phu Yen district, Son La province

Ms. Duon is a Muong farmer, whose stilt house is on the lake shore.

She used to keep 480 laying ducks prior to the HPAI outbreak in December 2005. It was her first batch of production, that she had taken up in May 2005. Ducklings were purchased at 2-3 days age by her husband from a hatchery in Hoang Xa in Phu Tho province. Her husband knows well the migrating fishing families originating from this commune, who recommended this hatchery to buy ducklings.

She lost approximately 280 ducks from diseases at young age.

Duck used to be confined overnight under her stilt house, protected by a bamboo fence and a net. Duck were released in the morning to the river, all year round.

The ducks were fed with rice bran and maize when young and with commercial feed and paddy rice when bigger.

Eggs are sold to shops along the road to Van Hien commune. Her husband goes 2-3 times a week by motorbike to sell up to 600 eggs at a price of 1'000 VND/egg. Neighbors also used to get eggs from her.

Feathers are sold to scrap collectors who come every day to the commune to collect scrap iron, paper and other recyclable waste. The collectors have a central collecting point in Phu Yen district and dispatch their ware to Son Tay district.

In October 2005, ducks started dying unexpectedly. The first dead animals were eaten.

However, with the increasing number of death cases (15 per night), the family became worried and searched advice from the PARAVETS. Ducks were treated with a medicine, without results. Later he advised to cull all remaining ducks and bury them in the garden.

It is unclear if she got compensation payment for the culled ducks or not. According to the Chairwoman of the Women's Union of the commune, the farmer got compensated with 3'400'000 VND (17'000 VND/head).

Ms. Duon does not know, if she will take up again duck production. In the meantime, she bought 5 cattle (2 cows, 2 calves and 1 yearling) from H'mong people.

5 Discussion

Methodology Constraints

- **Enrol other poultry species in the study and assess their role**

This study did not focus on chicken or other poultry (quails, geese, pigeons) production, although duck farmers keep more or less large amounts of chicken or other poultry beside ducks.

Although chicken are considered as highly sensitive to HPAI and are consequently viewed as immediate indicators of HPAI outbreak, it would have been interesting to assess their possible "silent" role in the spread of AI, especially through their commercialization and their raising practices. Indeed, chicken are rarely fenced and never herded and hence could be more susceptible than ducks to spread the disease from one farm to another.

- **Emphasis on HPAI striken areas**

Secondly, this survey did not focus on areas heavily affected by HPAI outbreaks. This constraint, imposed by the fact that AVSF is working in mountainous provinces and districts, has been discussed during the setting-up of the survey methodology.

The present study therefore gives clear pictures of the role that ducks could potentially play, it however cannot give an affirmative statement on the role that ducks played. This can only be done through post outbreak detailed investigation.

The present study attempts a step towards assessing the possible link of duck presence and HPAI outbreaks by presenting maps drawn on the January/February 2005 HPAI episode in Vietnam. The maps tend to show that HPAI outbreaks are linked with a high human and poultry population density and a high number of communications roads. Those conclusions are consistent with the finding of the National Institute for Veterinary Research, which listed as main risk factors the animal and animal product movement and the delayed diagnosis.[67]

These first findings shall remind experts to be particularly cautious when linking high incidence of HPAI in ducks with small-scaled, scavenging duck production. The first raw results highlighted by the maps mentioned above, tend to show the opposite.

- **Questionable results and the role of potential distorting parameters**

Some results obtained through questionnaires are certainly questionable and need to be interpreted cautiously. For instance, data related to the disposal of dead animals are most likely to be unreliable, as it is known from informal interviews with farmers that they often eat dead animals and even sell them. Therefore the percentage of sold, given or eaten dead animals is certainly under estimated, respectively the percentage of farmers claiming to burn or bury dead animals is probably over estimated.

Farmers know that such practices are not politically correct and often fear that they could be denounced.

Restructuring Poultry Production

This has been widely discussed by international experts and Vietnamese government. The "solution" found is to organize poultry production in a more industrialized way and to incite farmers to move toward linear or vertical market integration.

The present survey highlights in a qualitative way some elements which have to be carefully considered before further striving towards this direction.

[67] T.D. Nguyen et al. (undated)

- **Specialization of the production**

One main issue pointed at by experts for more than 2 years, owing to the threat of a possible human influnenza pandemic, is related to close contact of animals of different species within farm premises. As highlighted by this report the vast majority of farmers are not specialized: most of them simultaneously raise different poultry, as well as other animal species (at least dogs and/or pigs). The same observation is true for crops, farmers tend to maintain a wide array of crops on their farm, in order to cope with self-consumption needs, cash and own labour resources. Diversification is a common way to secure the household income and to be able to face with market fluctuations, animal or crop diseases, natural disaster… Therefore, without political or technical guidance, farmers are not likely to take the risk of a mono-production system.

Moreover, prior to "upgrading" farms from sector 4 to sector 3 and sector 3 to sector 2, specific prevailing conditions of the farms have to be taken into consideration in order to increase chances of achievement. Indeed, farmers already convinced by duck production are more likely to upgrade their management practices. Basically, such farmers are the ones already belonging to the semi-commercial sub-system: they spend significantly more time for their ducks, their initial investment is significantly higher, their economical interest in duck production has been assessed and they have access to credit. Encouraging self-sufficient farmers to improve their duck husbandry practices is more difficult, as they do not have the same required initial conditions.

- **Localisation of the poultry production area**

The present survey tends to show that some of the studied provinces are already moving towards a specialisation process. In fact, Phu Tho province presents a significant higher proportion of semi-commercial farms. It is not possible to assess why farmers specifically invested in duck husbandry, but regional discrepancies are a point which needs to be considered when looking for the more appropriate location or even "reallocation" of poultry husbandry.

In fact, it is high time to listen to farmers' motivation and justification before choosing which area is more appropriate to develop one activity. This can be a technical motivation (presence of specialized and skilled paravet, easy access to good quality products), a marketing motivation (presence of a slaughterhouse, reliable and regular market opportunities), a provincial orientation (loans, low taxes),…

- **Reducing of small-scaled, scavenging duck systems**

Such a decision evoked by legal texts and official plans has to be taken only with the conviction that small-scaled production units play a major role in AI spread in Vietnam. So far nothing ensures that this option would be of any strong positive effect in Vietnam.

The present study points out that in northern uplands of Vietnam, such production units are located mostly, in villages and communes with little interactions with other villages and communes. In fact, the main interaction with other duck production units in other villages and communes is the supply of ducklings or eggs. It is basically one of the only ways, how the disease can propagate in the village premises (through poultry movements). It is however unlikely that self-sufficient farmers further spread the disease or contaminate other communes outside their premises through poultry movements.

In the present study, the farms managed under semi-confined systems are mostly owned by households, classifying their income as "average" to low. Such a finding shows the importance of simple, low scale, nevertheless rather secure poultry production for poorer segments of the rural population in Vietnam. The reduction of small-scale duck (or chicken) production systems would have major consequences on poverty issues in Vietnam, especially for the self-sufficient and intermediate farms. This fact corroborates the point of view expressed by Carlen and Lansfors (2002). These authors were able to assess that measures to stop duck scavenging in rice-fields in the Mekong Delta would have ravaging consequences on rural households. Such households could not afford to confine their ducks and feed them with purchased feed, not speaking about concentrate, too expensive for their revenue scale.

Furthermore, the reduction of small-scaled systems would have major economic consequences, not only on the overall poultry production, but also on rice and fish productivity, as these productions are part of the duck/fish and rice/duck integration in the studied area.

The intermediate and semi-commercial sub-systems of the semi-confined duck system represent an important market for duck breeding farms and animal feed companies that will surely pay a high tribute in case small producers would be targeted for reduction.

The survey has shown that upland communes have no or limited access to "industrial poultry" products and completely rely on small-scaled, intermediate and semi-commercial units to supply the market. A suppression of these traditional production units would have major consequences on the protein supply of millions of Vietnamese people.

Table 34: expected target on volume of poultry from 2004 to 2010

	Expected No of heads in 2010	2004/2010
Total No of poultry (x 1000)	360-380	+ 56.5 - 65.2 %
- Chickens	280	+ 69.7 %
x Commercial	150	+ 130.8 %
x Scavenging	130	+ 30 %
- Ducks	80 - 100	+ 23.1 - 53.8 %

Source: Hoang Kim Giao (2004)

Moreover, it seems that such a decision would hit more heavily some provinces or districts than other. In fact, the highly significant differences between surveyed districts in terms of repartition of the three sub-systems tend to show that some districts are already moving toward a more commercial raising system.

Finally, we can also fear environmental consequences of such a decision as ducks are often raised on rice fields for pest control, especially in the Southern part of Vietnam.

Production management practices

Some experts have officially formulated that "significant measures have to be implemented with sector 3 farms"[68].

- **General comments on the at-risk management practices**

It is very difficult to rank the 3 sub-systems in terms of risk of HPAI spreading. In fact, all of them present some management practices at low risk and others at high risk. It could be envisaged to focus on the adoption of alternative management practices based on the experiences of Vietnamese farmers.

Table 35: risk assessment per sub-system

	Low risk	High risk
Self sufficient	•Small number of animals •Little animal movement •Meat production •Remote area	•Use of rice fields •Ducklings purchased from middlemen or from the market •Waste management •No interests for this production
Semi commercial	•Use of ponds •Direct duck supply to hatcheries or farms	•Large flocks •Mixing of species •Important movement of animals, animal

[68] Macleod et al. (2005)

	•Higher proportion of confined ducks •Professionalization of the production	by-products and stakeholders •Use of rivers and streams •Egg production

By considering the production unit as the village and not only as the household, self-sufficiency oriented farms in remote areas illustrate one of the most biosecure production system in Vietnam, as highlighted by "Cuc Duong commune case study". As a matter of fact, the major animal movements within such a system are small trade of ducklings from the lowland to the commune, but not the opposite, as very few products leave the village. With the exception of human movement, such areas are not likely to infect other communes or villages.

Although the semi-commercial system appears to be much more bio-secure than the two other systems, there are still major aspects which need to be tackled in order to improve poultry production management within this system:

- Positive aspects of this system are the greater extent of confinement, the larger use of veterinary products and paravet service.
- Negative aspects are the problematic waste management (manure stored in pig sty or chicken pens), the large use of rivers and streams, as well as rice fields. These aspects create potentially important risks for the spread of the HPAI virus.

Indeed semi-commercial farms are specialized enough to have adopted practices allowing them to act on a large scale and involve various stakeholders. However they are not specialized enough in order to move towards linear market integration, not speaking about vertical market integration.

Semi-commercial farms exhibit large chicken flocks, which are a potential source of cross contamination, as they are more likely to scavenge around the farm without surveillance.

Similarly some farmers throw away or even feed animals with dead poultry, both risky practices, respectively increasing the risk of HPAI virus spreading and enhancing the risk of recombination. The same problem may occur when duck manure is mixed with pig manure inside the pig sty.

This study has highlighted that semi-commercial sub-system often specialized in egg production and keep large flocks, whereas self-sufficient and intermediate farms have a mix production or are specialized in meat production. The raising period for egg production is much longer (2 to 3 years) than for meat (few months). The latter production system exhibits a more important turn-over.

Under such circumstances, the type of production could have an effect on the presence of HPAI. In fact, as ducks are suspected to be a reservoir of the virus, the longer they live, the higher is the risk of mutation to a highly pathogenic strain of AI.

Moreover, meat production units can be considered less at risk for AI spreading because of the existence of period without animals in the farm. In fact, the focus group meetings have shown that the cycle of meat duck production usually starts in February and ends 2 to 5 months later. Two cycles per year may be practiced. Between those periods, the absence of sensible species on the farm can stop the virus cycle or minimize its spreading locally.

- **Use of water bodies**

The large and complex use of different natural feeding grounds such as ponds (closed and safe), rice fields (open and theoretically unsafe, but supervised by herding and spatially and temporally limited) and running water bodies (open, unsafe and not supervised) is a further risk within the HPAI context.

In view of the field outcome, it appears that running water bodies should be given more emphasis than rice fields in the discussion and in legal texts.

Natural and man-made water bodies play a pivotal spatial and technical role in duck production in Vietnam. These are probably one of the most problematic characteristics, when talking about HPAI risk in the region.

Contradictory information on the use of running water has been highlighted by the present study. Some provinces in southern Vietnam have forbidden since years the use of rivers and streams for duck raising for bio-security and hygiene reasons, while a recent Decision has promulgated in December 2005 the interdiction for ducks to roam free in rice fields and to scavenge, but encourages the use of running water sources (river, streams, channels)[69].

There are 3 main water bodies used in Northern Vietnam:

- The ponds with duck-fish integrated system. Although the ponds are most of the time not very well fenced and allow ducks to escape, it appears to be the safest water body used because the water cannot circulate and neither can the virus (at least not through the water). The only damper which needs to be addressed here is related to the regular cleaning (once a year, mostly during the dry season) and the use of mud to fertilize rice fields and orchards.
- The rice fields is always pictured as the riskiest management practice, as it obviously shows large number of ducks (wherever travelling through the countryside, ducks can be seen scavenging in rice fields). However, when left alone, ducks most often stay nearby the farm. When scavenging in the fields, they are herded and supervised and usually do not mingle with other flocks. In that sense, the risk of contamination from one flock to another is represented by an indirect transmission through the persistence of the virus in faeces in rice fields.
- The rivers and the streams are, according to the present survey, the worst water resource to be used because of running water and the easy contamination risk. Ducks kept on running water bodies are also very difficult to keep under surveillance, being by the owner (except if he fishes at the same time and follows his flock on a raft) and by authorities, when it comes to migratory water system.

- **Markets and middlemen**

So far, no specific study seems to have been undertaken on the specific role of middlemen and markets as a source of AI spreading in Vietnam, although they are assumed to play a major role. As mentioned previously in the report, the Centre for Disease Control in Atlanta had identified the presence of the H5N1 in live healthy geese in 2001 on live bird markets in Hanoi[70]. Live animal markets, also called wet markets, have been pinpointed to be major places for HPAI virus spreading. According to Webster (2004), live poultry markets have been identified as the source of contamination by the H5N1 virus which infected 18 people and killed 6 of them in Hong Kong in 1997.

Special care should be taken to quantify the risk that markets, but specifically middle-men represent in term of AI spreading.

Markets are places of periodically high poultry concentration originating from different locations, with various stakeholders. Middle-men are particularly at risk as they transport animals daily from one farm to another. The study currently carried out by the FAO and Agrifood Consulting on marketing chain analysis with emphasis on live bird markets shall help shed light on this matter.

[69] Cong Bao No. 23-24 (16-01-2006)
[70] Nguyen D. C .et al. (2004)

6 Conclusions

The present study, although limited in terms of budget and time, has enabled to obtain a detailed picture of relevant systems and sub-systems of duck husbandry prevailing in selected areas of northern Vietnam. The study highlights the complexity of the duck husbandry sector, both on the production and marketing side. It shows the importance of agro-ecological specificities prevailing in a given location and their impact on the evolvement of duck husbandry sub-systems within a same main system.

One main production system is largely encountered in mountainous areas, viz. the semi-confined system. This main system implies a confinement of ducks at night and their release during the day to scavenge on farm and village premises, in rice fields and on various natural and home-made water bodies, according to a seasonal pattern. The study further highlights three sub-systems, defined according to economic criteria.

Self-sufficiency oriented duck husbandry systems are relatively easy to control, as they are characterised by a general low profile: low density of activities, low marketing of products and relatively closed production and marketing cycle. Emphasis should be put on further awareness of HPAI and its mode of transmission, as well as simple, common-sensed practices such as keeping middle-men away from farm premises, buying products only from known production units (hatcheries from the neighbourhood) etc.

Intermediate levels are already more difficult to control, as they operate on a larger scale, imply more stakeholders, often scattered and beyond control (far away places). In this regard, middle-man for ducklings, but also eggs, meat and feathers may pose the greatest threat in terms of disease spreading, especially if they come from other locations, often other communes, districts or even provinces.

Semi-commercial oriented units show a higher degree of specialization in many regards, but still perform under a system implying many stakeholders, as they have not yet moved towards more linear market integration, not speaking about vertical integration of the market. In that regard, semi-commercial systems also still pose a major threat to disease dissemination. However, their production mode could be improved and controlled in a better way than intermediate levels. Possibly also because they have a higher interest in improving their production basis, in regards to the economic importance of duck production within their farm economy.

Risky management practices

The present study has highlighted certain risky practices in the context of HPAI. They are listed in the following table by sub-system.

Table 36: risk assessment per sub-system

	Self-sufficient	Intermediate	Semi-commercial
Member of the family working outside the farm, with poultry	+	+	+
Raising other poultry species	+	++	+++
Raising other animals	+	+	++
Mixing ducks with other poultry species	+++	++	+
Absence of building for the night	++	+	+
Absence of fenced park	+++	++	++
Use of rice fields	+++	++	+
Use of rivers and streams	++	+	++
Ready to hatch eggs brood by other poultry species	+++	++	+

Let the ducks scavenge alone	+++	+++	+
Duckling supply with middlemen or market	++	+++	+
Selling ducks or eggs at middleman	0	++	+++
Selling feathers	+	++	+++
Throwing dead animals or feeding other animals of the farm	++	+	+
Selling or giving dead animals	0	0	0
Using the manure with no treatment or inappropriate treatment	++	+	++
Lack of appropriate care to ducks	+++	++	+

The table shows that all systems more or less have risky practices, irrespectively of their production scale. Some practices are more relevant under certain sub-systems (+++), while others are less relevant (+).

Although numerous risky practices still exist, it has to be mentioned that in spite of such practices, no or relatively few outbreaks were reported in the studied areas.

Adoption of new practices by farmers in the HPAI context

As the study was carried out in areas not severely hit by the epizooty, farmers did not change much their practices. Only few of them want to switch from their duck production to other productions.

Farmers fear the epizooty, however they are used to recurrent disease episodes which periodically decimate their flocks. Reactions of farmers on sudden death cases of ducks show that they do not seem to be aware of the necessity to report cases.

Ducks as silent carriers

A study carried out in 2004 in Ret village (Kha Cuu commune, Thanh Son district, Phu Tho province) showed that the mortality rate of Muscovy ducks on a farm was 90%, higher than with hens and broiler chickens (84%)[71]. The morbidity was 70% with ducks and between 68% for broilers and 77% for hens. This study as well as indications from the field, among others interviews in Thuong Ha commune, indicate that ducks nowadays are sensitive to HPAI. In view of the high mortality of ducks under the recent outbreaks and the lack of continuous, recent and systematic epidemiology tests, no definite conclusion may be drawn on the role of ducks in HPAI silent spread. A project drawn by the Royal Veterinary and Agricultural University and the National Institute for Veterinary Research is planed to undertake such an investigation in Vietnam in 2006.

Addressing the current duck production and marketing constraints in the context of recurrent HPAI outbreaks is crucial and urgent. However, any attempt to use drastic measures to shift from traditional practices towards more “modern” practices shall be carefully assessed. Focusing the attention on self-sufficiency, small-scaled oriented sub-systems would be an error with devastating consequences on the rural population, both in economic and direct food security terms.

One key solution to determine the role of ducks as well as the role of other factors (chicken, wild birds, human beings…) is the conduct of simple but detailed on-farm investigation immediately after each outbreak.

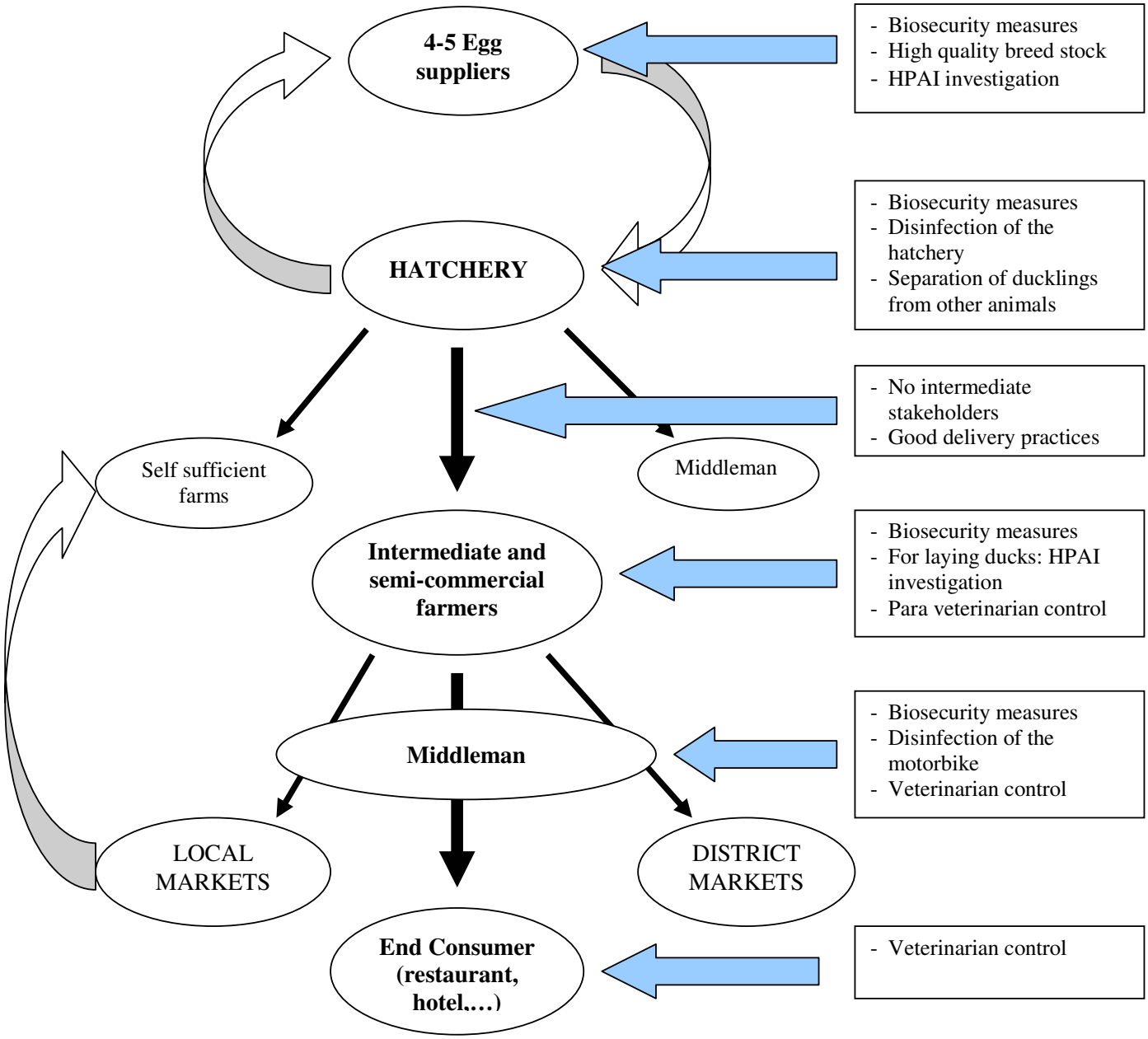
[71] Delquigny et al. (2005)

7 Recommendations

Pilot projects

- ***Monitor and support groups of farmers in duck production***

As it is suspected that an upland area is infected through the transportation of animals from the lowlands to the uplands, it could be interesting to support the implementation of hatcheries to supply the local markets.



Farmers who shall be supported would belong to the intermediate or semi-commercial semi-confined systems. They are more likely to play a role in the local spread of HPAI and to accept to work and

improve their raising practices, owing to the economic importance of this production and to their daily working time devoted to duck production.

Working with all the stakeholders along the local market chain (hatchery, the farms selling eggs and the ones buying ducklings, middlemen, consumers) could rapidly increase the quality of products, sustain the project, increase the confidence of consumers in poultry product, and bring more benefit to the farmers...

In each farm, special emphasis should be put on:

- proper waste management including disposal of dead animals and the risks induced by mixing poultry waste with pig's
- limiting the interactions between poultry and other animals, especially dogs that can spread the disease out of the farm and pigs that could recombine the virus
- correctly fencing building/park/pond
- using water bodies in an appropriate way
- applying basic biosecurity measures

The self-sufficient farmers will be indirect beneficiaries by buying higher quality duckling from the hatchery, limiting the risk of getting infected and buying good quality poultry at local market if necessary.

- ***Improving investigation of clinical outbreaks***

One of the difficulties to deal with Avian Flu is its high contagiousness, allowing a very rapid spreading.

The improvement of good management practices on a farm is one way to limit the spread of the disease. Another one is to investigate the outbreak, upstream and downstream to cense all suspected farms, predict its spread and take adequate measures.

This can be considered as a task of Public Veterinary Services, as long as they understand the efficiency of such an investigation. The goal of this project would be to write a manual on basic epidemiology and the way to investigate outbreaks and to disseminate it at district level.

Additional studies

To better understand the occurrence of AI outbreaks, several other studies could be undertaken:

- Similar study on chicken raising under scavenging production. This study could be undertaken to assess the chicken/duck/pig interactions
- Survey on HPAI outbreaks, similar to the one undertaken in Thailand. This survey could quantify the link between HPAI outbreaks and the main roads in an area.
- Marketing chain analysis with emphasis on live birds markets and middlemen.
- Analytic epidemiology survey. In fact, the relative importance of the listed bad practices is still difficult to determine. Being able to rank those practices in terms of risk factor would certainly be useful for Vet Services to implement an adapted program to deal with Avian Flu.

Policies for the control of poultry production units

It could be interesting to limit access of the market to "professional" farmers, namely registered farmers, who could be allowed to sell their products and could be easily contacted in case of AI outbreaks.

The legislation on middlemen activities should also be more deeply studied and adequate measures taken, such as systematically issuing permits and reinforcing their control.

Moreover, the migratory system should be further studied to be able to propose some measures to undertake how to tackle their high risk practices.

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Annex 1

TERMS OF AGREEMENT

1. Background

Duck production systems in Asia

FAO has been working on the socio-economic impact (TCP/RAS/3010), epidemiology and ecology of Avian Influenza (AI). Initial results (Gilbert et al.,2004[72] and Gilbert and Slingenbergh, 2004[73]) and reported in the proceedings of Regional Workshop October 14-15, 2004 in Thailand, strongly suggest that ducks have an important role as silent carriers and conveyers of H5N1(the Highly Pathogenic strain of AI (HPAI) while domestic ducks can get infected as well.

In terms of numbers, ducks represent 10 - 15 percent of poultry in the village and backyard farming systems. Gilbert and Slingenbergh (2004) report the figure to be 13 percent for Thailand, whereas ducks account for a disproportionate 28 percent of the H5N1 outbreaks in that country.

The duck production systems in Vietnam can be divided into three broad systems:

- Ducks keep by the majority of the small rural farms and that mix with the chicken and other animals throughout the year. Reliable data on the exact number of farms that keep ducks in this manner are not available.
- Commercial duck systems with larger flocks that may run into thousands of birds. These systems are commonly found around large water bodies and rice paddies in low lying water areas such as the Mekong Delta.
- The third is a free-range duck system that is often referred to as “moving ducks”. These ducks belong to poor farmers who move them around, often over long distances and across provinces to feed them. Flock size can vary from about ten to a few hundred birds. These are quite different to the free-ranging ducks associated with rice production common in Vietnam (as a subgroup of the latest).

The village backyard poultry/duck system are mainly controlled by women, whereas the more specialised and mobile systems involving large numbers of ducks are controlled by men. All these systems have received scant attention either economically, socially or biologically and accurate information is hard to find.

In Indonesia there are several distinct duck production systems such as free range small scale mixed with other poultry species (chicken, quails, etc.), and various type of larger flock of free ranging ducks (Muscovy and Pekin ducks) around water areas and scavenging for feed. Where chicken and ducks were raised together in Indonesia there have been serious outbreaks of HPAI.

Objective of the study

FAO is interested to understand better the role that free-ranging duck systems have in the transmission of HPAI in Asia. To achieve this, AGA will commission a study, initially in Vietnam and Indonesia, which analyses the interaction and overlap (either spatially or temporally) between the free ranging duck production and the other poultry (chicken) production systems and wild water fowl. The study will also identify additional knowledge gaps that will require investigation and make preliminary recommendations on practical husbandry related control measures.

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[72] 1 Highly Pathogenic Avian Influenza in Thailand: a two-scale analysis of second wave outbreaks

[72] 2 Highly Pathogenic Avian Influenza in Thailand: an analysis of the distribution of outbreaks in the 2nd wave, identification of risk factors, and prospects for real-time monitoring

The Non Governmental Organization Agronomes & Vétérinaires Sans Frontières (VSF-CICDA) will cover the field study in Vietnam.

FAO contribution will support the Non Governmental Organization-Agronomes & Vétérinaires Sans Frontières to conduct a field study on major free-range duck systems in Vietnam. Similar study will be undertaken in Indonesia and FAO will recruit an international consultant to coordinate the programme.

2. Terms of Reference

2.1 Activities

An indicative outline of the study report is expected to include four major sections:

1. Description of the main free range duck sectors in Vietnam: numbers of producers and geographical scope of the main duck production systems; duck breeds; comparisons and differences between producers; dynamics (growth/decline in numbers and geographical scope of the main systems; productivity; production economics; constraints and potentials; marketing aspects (seasonality of production and sales, distance to markets, market diversity, numbers and types of buyers and markets etc.); types and source of feed inputs; labour inputs; interaction between duck producers and other farmers (e.g. "rent" for use of fields, contribution of ducks to rice ecology etc.). This work will be done in conjunction with GIS systems and findings from related AGAH work (on spatial location), in particular attention to the spatial overlap between ducks and a) chickens and b) wild waterfowl.
2. Discussion on the possible role of free-ranging duck systems in the transmission an Avian Influenza outbreaks. Determine the link between free-ranging duck systems and rice production cycles and analyze rice and duck production cycles for possible correlation with AI outbreaks in different types of ecosystems. Identify key risk areas in the production systems/cycles (especially those overlaps between duck and chickens) for HPAI transmission, such as: parent stock ranging in rice paddies, hatching of eggs, brooding, fattening, harvest and slaughter. Further gaps in available information and epidemiology will be identified.
3. An assessment of a) the impact of existing AI control measures on these production systems, b) the response from the Governments including legislation, regulation, compensation mechanisms on the different systems, and c) percentage of farmers choosing not to restock or switching to other species. Identification of possible indicators for socially and economically adapted government responses.
4. Review of potential options for these production systems for the future to reduce the risk of HPAI transmission including: isolation (as far as possible) ducks from chicken and other fowl; costs associated with enclosure/isolation practices; alternatives to continuous duck production; development of options for more bio secure duck production including the option to manage large flocks as a bio secure village system, etc; the possibility to "brand" a bio secure duck and secure a premium price.

2.2 Outputs

A comprehensive report will be provided at the end of the study presenting all the results and analysis. This report will review free-range duck farming systems in Vietnam and their possible implications for the spread of the Highly Pathogenic (H5N1) strain of Avian Influenza (HPAI).

2.3 Duration and Timing

The activities will start at signature of the Letter of Agreement and the report will be delivered, at the latest by Mid-March 2006.

Item	***To be completed on:***
Writing and testing the questionnaire	January 5, 2005

A first draft report by beginning of March 2006, as the result of the field study report in English	March 15, 2006
A final report by mid-March 2006, as the final form of the field study report in English	March 30, 2006

2.4 Monitoring and Progress Reporting

VSF-CICDA will provide a mid term progress report by the end of December 2005 as the technical questionnaire tested in the field containing all the points developed in paragraph 2.1.

Electronic copies of the reports in English language will be sent to the FAO-Vietnam and to Ms Guerne Bleich AGAP, FAO headquarters.

By Mid-March 2006, prior to receiving final payment for the service, VSF-CICDA will submit a final audited statement of accounts (or certified as to its correctness by the officer responsible for maintaining it) to the FAO Representation in Vietnam.

3. Inputs to be provided by VSF-CICDA

The NGO VSF-CICDA will provide the detailed input as in paragraph 5 below.

4. Inputs to be provided in kind by FAO

FAO will provide technical and methodological guidance, through the international consultant and AGAP officer, for the questionnaire design, sampling procedures and the implementation of the survey, if required and deemed necessary.

5. Detailed budget

Item	***Cost***
Writing and testing the questionnaire	1 500 US
Implementation of the study in the concerned areas, filling the questionnaires, monitoring the field staff	5 500 US
Writing the final report as the final form of the field study report in English	1 000US
TOTAL	**8 000 US**

6. Monitoring/Certifying Officer

The FAO Representative in Vietnam is designated to monitor the proper implementation of the Agreement and to certify that the terms of the Agreement have been satisfactorily met and that appropriate payments can be made.

Annex 2

Ordinance No. 18/2004/PL-UBTVQH11 dated …of the … on veterinary medicine

Directive No. 22/2004/CT-TTg of June 15, 2004 of the Prime Minister, on continued bird flu prevention and combat and quick restoration and development of poultry production and farming[74]

Decision No. 751/QD-TTg of July 2, 2004 of the …, on replacing the head of the National Steering Committee for bird flu prevention and combat

Directive No. 47/2004/CT-BNN of October 5, 2004 of the MARD, on further enhancing bird flu prevention and control[75]

Decree No.33/2005/ND-CP of March 15th, 2005 detailing the implementation of a number of articles of the Ordinance on Veterinary Medicine[76]

321/BNN-NN, dated 04.02.2005[77]

1844/BNN-VP dated 29/04/2005[78]

Decision No. 26/2005/QD-BNN of May 18th, 2005 publicizing the list of vaccines, bio-preparations, microorganisms and chemicals used in veterinary medicine, which are permitted for circulation in Vietnam[79]

Decision No. 574/QD-TTg of June 24, 2005 of the Prime Minister, on the policy of providing financial supports for control of bird flu[80]

Directive No. 25/2005/CT-TTg of July 12, 2005 of the Prime Minister on bird flu vaccination. With this Directive, the Prime Minister requests concerned ministries, branches and localities, within the scope of their competence, to carry out the programme on bird flu vaccination throughout the country[81]

Decision No. 45/2005/QD-BNN, **of July 25th, 2005** promulgating the list of animal and animal product quarantine objects and the list of animals and animal products subject to quarantine[82]

Decision No. 46/2005/QD-BNN of July 25th, 2005 promulgating a list of objects of veterinary hygiene inspection. A list of subjects liable to veterinary hygiene inspection and a list of subjects liable to veterinary hygiene inspection and compulsory application of veterinary hygiene standards[83]

Decision No. 47/2005/QD-BNN of July 25th, 2005 providing for numbers of animals and weights of animal products subject to quarantine when being transported out of a district and cases exempt from quarantine[84]

Decision No. 48/2005/QD-BNN of July 25th, 2005 providing for samples of slaughter control mark and veterinary hygiene inspection stamp[85]

Decision No. 30/2005/CT-TTg of September 26th, 2005 of the Prime Minister on enhancing the management of cattle and poultry slaughtering for assurance of food safety and[86]

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[74] Công Báo No.31 (26-06-2004)
[75] Công Báo No.17 (23-10-2004)
[76] Công Báo No.18 (21-03-2005)
[77] source under investigation
[78] source under investigation
[79] Công Báo No.19-20 (15-06-2005)
[80] Công Báo No.03-04 (03-07-2005)
[81] Công Báo No.24-25 (22-07-2005)

[82] Công Báo No. 05-06 (04-08-2005)
[83] Công Báo No. 07-08 (06-08-2005)
[84] Công Báo No. 07-08 (06-08-2005)
[85] Công Báo No. 07-08 (06-08-2005)

Decision No. 63/2005/QD-BNN of October 13, 2005 of the MARD, promulgating the Regulation on compulsory vaccination for livestock and poultry[87]

Decision No. 64/2005/QD-BNN of October 13, 2005 of the MARD promulgating a list of diseases which must be declared as epidemics; a list of dangerous animal diseases; and a list of diseases subject to the application of compulsory preventive measures[88]

Directive No. 34/2005/CT-TTg of October 15, 2005 of the Prime Minister, on concentrating efforts on coordinated and efficient implementation of the urgent action plan on bird-flu (H5N1) and human-flu pandemic prevention and control[89]

Directive No. 53-CT/TW of October 28th, 2005 on urgent measures to prevent the avian influenza (H5N1) pandemic[90]

Resolution No. 15/2005/NQ-CP of November 4, 2005 of the Government on urgent measures to prevent the avian influenza epidemic (H5N1) and type-A (H5N1) human influenza pandemic[91]

Circular No. 69/2005/TT-BNN of November 7, 2005 of the MARD, guiding the application of a number of urgent measures to prevent and control the avian influenza (H5N1) epidemic[92]

Decision No. 12/2005/QD-BTNMT of November 9, 2005 of the Ministry of Natural Resources and Environment, promulgating an urgent plan of action for avian influenza epidemic and human influenza pandemic prevention and control[93]

Decision No. 38/2005/QD-BYT of November 24, 2005 of the Ministry of Health, promulgating the plan of action for prevention and control of human influenza pandemic in Vietnam[94]

Decision No. 309/2005/QD-TTg of November 26, 2005 of the Prime Minister, on the provision of financial support for bird flu prevention and control. The Decision replaces Decision No. 574/QD-TTg of June 24th, 2005[95]

Decision No. 3024/2005/QD-BTM of December 7, 2005 of the Ministry of Trade, promulgating the urgent plan of action for prevention and control of the H5N1 avian influenza epidemic and H5N1 type-A human pandemic[96]

Decision No. 1318/QD-TTg of December 13, 2005 of the Prime Minister, on supports for concentrated slaughtering and processing of poultry products[97]

Circular No. 84/2005/TT-BNN of December 23, 2005 of the MARD, guiding the reorganization of the raising of water birds for prevention and control of avian influenza (H5N1) epidemic[98]

Circular No. 85/2005/TT-BNN of December 23, 2005 of the MARD guiding the quarantine in transportation, slaughtering and trading of poultry and poultry products[99]

Decision No.86/2005/QD-BNN- dated 25/12/2005 of the MARD on regulating the quarantine of animals and animal products, as well as regulating veterinary inspections. The Decision annuls the Agriculture and Rural Development Minister's Decision No.609/NN-TY/QD of September 6, 1994[100]

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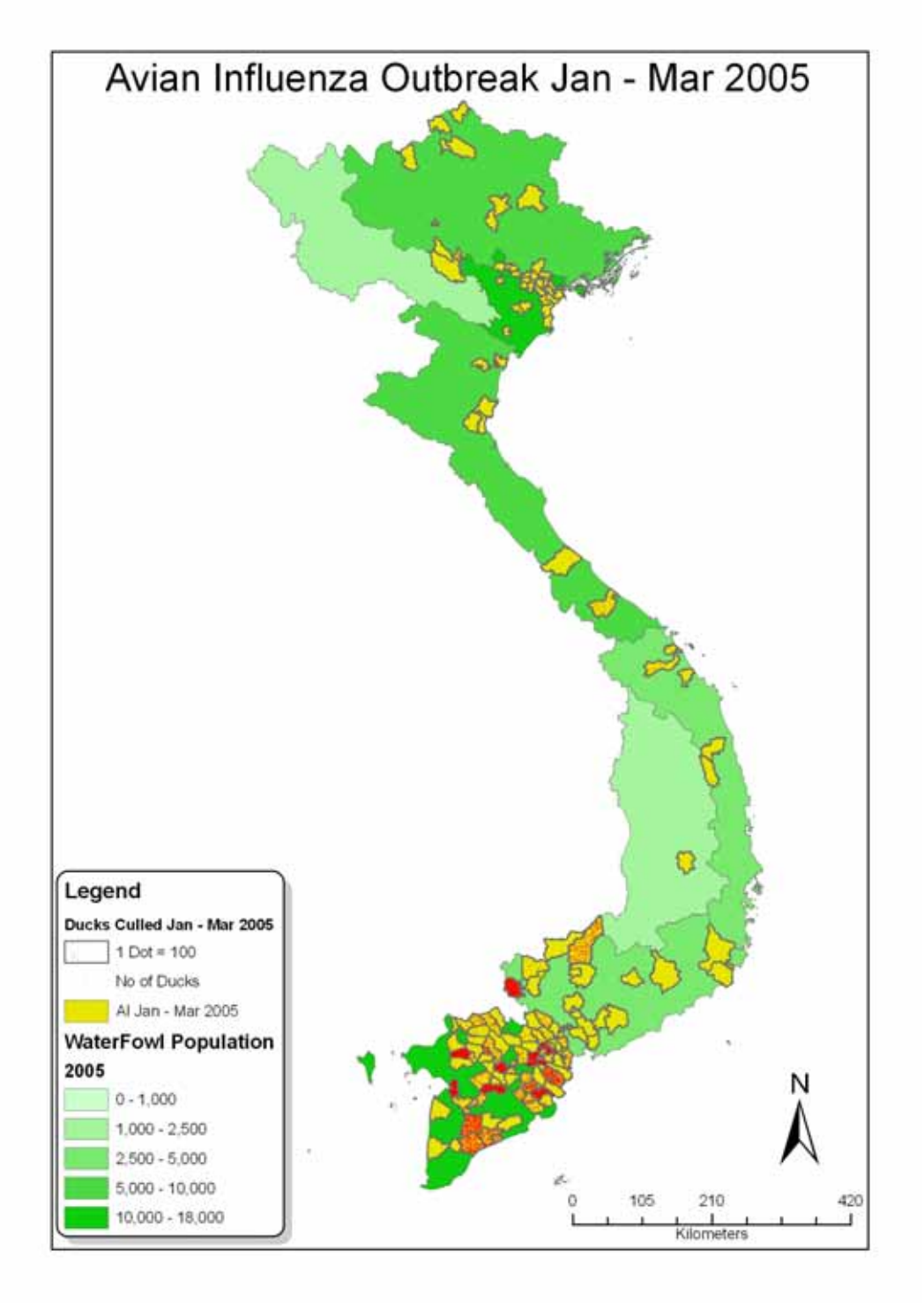
[86] Công Báo No. 07-08 (08-10-2005)
[87] Công Báo No. 37-38 (26-10-2005)
[88] Công Báo No. 37-38 (26-10-2005)
[89] Công Báo No. 31-32 (24-10-2005)
[90] source under investigation
[91] Công Báo No. 10 (09-11-2005)
[92] Công Báo No. 17-18 (16-11-2005)
[93] Công Báo No. 17-18 (16-11-2005)
[94] Công Báo No. 26-27 (21-12-2005)
[95] Công Báo No. 05 (05-12-2005)
[96] Công Báo No. 19-20 (16-12-2005)
[97] Công Báo No. 19-20 (16-12-2005)
[98] Công Báo No. 23-24 (16-01-2006)
[99] Công Báo No. 23-24 (16-01-2006)

Decision No.87/2005/QD-BNN- dated 26/12/2005 of the MARD on the procedure of control on slaughtering animals[101]

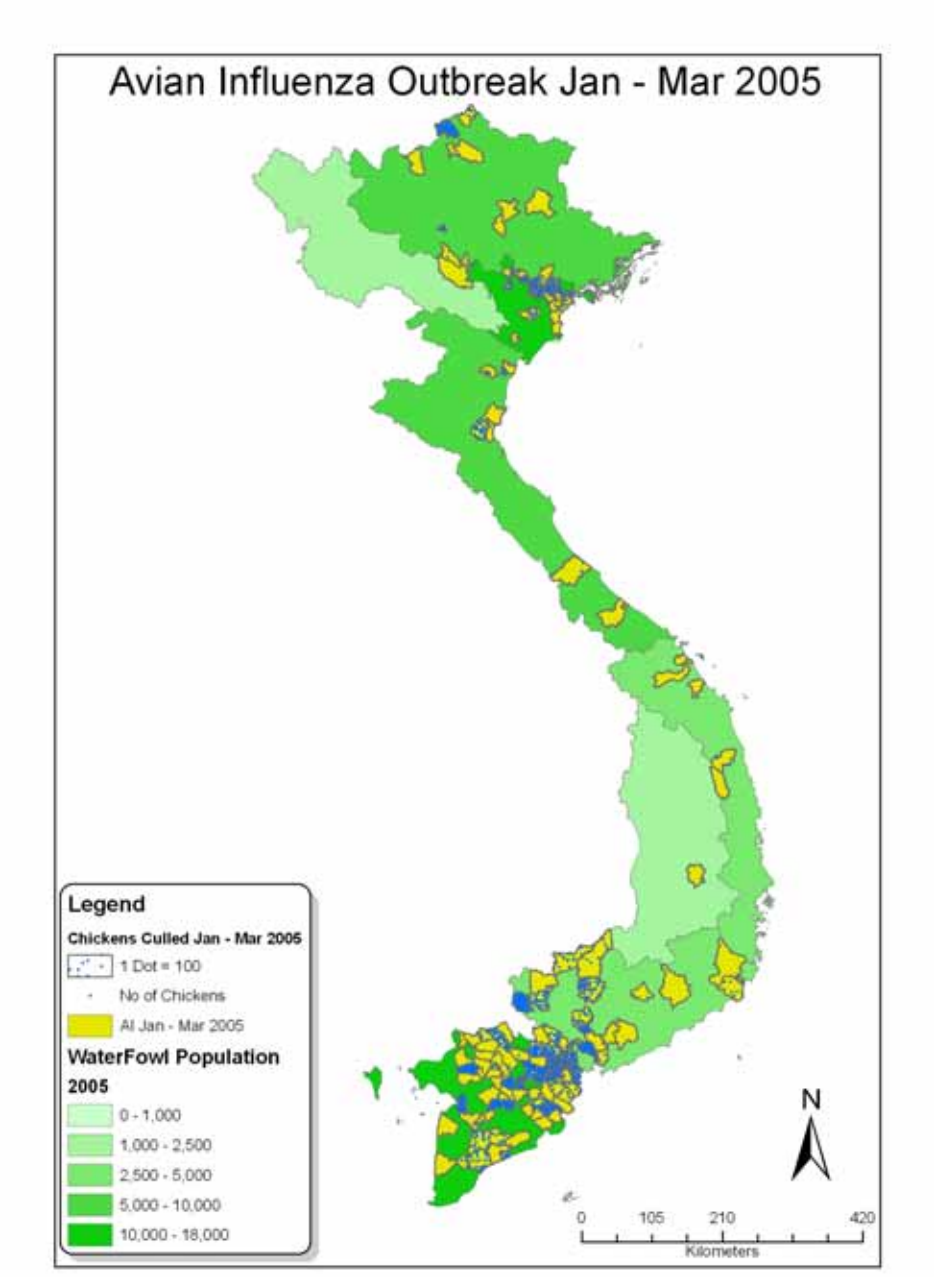
Joint Circular No. 09/2005/TTLT/NHNN-BTC of December 30, 2005 guiding the debt freezing and continued capital lending by credit institutions for poultry farmers who suffer from losses caused by avian influenza epidemic under the Prime Minister's Decision No. 309/2005/QD-TTg of November 26, 2005, on funding supports for avian influenza prevention and control[102]

[100] Công Báo No. (05-01-2006)
[101] Cong Bao No. (05-01-2006)
[102] Công Báo No.19-20 (14-01-2006)

Annex 3a: Nationwide duck population density in 2005 (green shades), overall HPAI outbreaks (yellow) and number of ducks (red spots) culled between January and March 2005



Annex 3b: Nationwide duck population density in 2005 (green shades), overall HPAI outbreaks (yellow) and number of chicken (blue spots) culled between January and March 2005



Annex 4: Questionnaire on duck production in selected communes of Northern provinces

QUESTIONNAIRE DUCK PRODUCTION

Province:	
District:	
Commune:	
Village:	
Name:	
Age:	
Number of adults:	
Number of adult working outside the farm:	
What are they doing?	
How far o they work?	
How often do they come back home?	
Number of children:	
Ethnic:	
Income classification:	

DESCRIPTION OF THE FARM

Person in charge of poultry: _____
Member of the family Employee Change every day

Salary of the person in charge of poultry (VND/day): _____

How much time does it take per day to take care of poultry (food + rice field + …)? _____

Crops productions:

Crops	Surface	Last production
Rice		
Maize		
Potatoes		
Cassava		
Tea		

What production brings you the highest income on the farm? (Ranking)
(e.g.: fish>pigs>rice>horticulture>ducks)
_____
_____

DRAWING OF THE FARM

The drawing much emphasize on the farm, the poultry building, the other animal building, ponds, fences, road, river, rice field, other neighbor farms

Animal Census

	Number last month	During the last month,							Number today
		What increase?			What decrease?				
		Bought	Gift	Birth	Sold	Died	Eaten	Other	
Duck									
• **Laying**									
• **Males**									
• **Meat ducks**									
• **Ducklings**									
• **Muscovy**									
• **Geese**									
Chicken									
• **Pullets**									
• **Cocks**									
• **Meat chickens**									
• **Chickens**									
• **Fighting cocks**									
Other birds									
• **Pigeons**									
• **Quails**									
Fattening pigs									
Sows									
Buffaloes									
Cattle									
Horses									
Goats									
Rabbits									
Dogs									

Do you have freshwater fish production (pond/cage)? Yes No
Is it integrated with duck production (duck/fish pond or duck/fish cage)? Yes No
Do your ducks go to a neighbor's pond? Yes No

Special events in the farm during the last month

From outside to the farm	
Middleman comes to buy animals / eggs	
Middleman comes to sell animals	
Feed supplier	
You buy (nursery) rice seedlings	
Special event in the family (specify)	
The paravet comes to your farm	
• Vaccination of poultry	
• Vaccination of other animals	
• Treat animals against diseases	
From the farm to outside	
You go to the market to buy animals	
You go to the market to sell animals	

Investment Costs

How much did you spend for your building? _____
When was it? _____
How many more year this building will last? _____

How much did you spend in equipment? _____
How many more year this equipment will last? _____

Where did you get the money from?

	Amount	Rate
Bank		
Family		
Own money		
Money lenders		
Other: _____		

Farm Management

- ***Animals***

Did you buy those animals? Yes No

	Female	Male
Breed		
Age when you bought them		
Age today		
Cost		
Where did you buy those ducks (name of middleman / producer)?		
Where did the producer /middleman buy them (farm, commune, district, and province)?		

How long do you usually keep them (months)? _____
What do you do with your animals today? _____

Do you want to change your production in the next few months? Yes No
If yes, what do you want to raise? _____

How many litters do you have today? _____
How old are the ducklings? _____

How many animals do you usually have per batch? _____
How many batch a year? _____
When do you start the batch (month)? _____

- ***Equipment***

Is there a building? Yes No Material:
Is there a park outside? Yes Yes, but ducks can escape No
Do your ducks can go outside the farm? Yes No
Do your ducks go swimming? No Yes in a pond Yes, in rice field
Yes, in the river
How old are your ducks when they go outside the farm the first time? _____
What is the distance between your farm and the place where the ducks spend their day?__
Is it always the same place? Yes No
How many different places do you use? _____
To whom does the rice field belong? _____
How much do you rent the rice field per month? _____
How long a day are ducks kept in the rice field / pond / river? _____
How many times a day do ducks move to the rice field / pond / river? _____
Do you stay with your ducks? Yes No

How often do you usually clean the park?
How often do you clean the park today?

How often do you usually clean the pen?
How often do you clean the park pen?

- ***Production***

Why do you raise ducks? For meat For eggs For both

EGGS

Where do the females lay? In nests in the pen In nests outside
On the ground in the pen On the ground outside
How old are your laying females when they start to lay? _____
How long do your laying females lay (months)? _____
How long is a cycle? _____
Do you remove the eggs every day? Yes No (Frequency: _____)

How many eggs did you produce per week? _____
How many eggs did you consume or give per week? _____
How many eggs did you sell per week? _____
Where do you sell the eggs? Market Middleman Incubator
Customer
What sort of egg do you usually sell? Not hatched Hatched
What is usually the price of one egg? _____
What is the price of one egg today? _____
What do you do with your eggs today? _____

Which poultry brood the eggs? Hens Muscovy ducks Ducks
In average, how many eggs are there per litter? _____
In average, how many eggs hatch per litter? _____
In average, how many ducklings do you have per litter after 2 months? _____

MEAT

At what weight do you sell the animals? _____
At what age do you sell the animals? _____
Where do you sell the animals? Do not sell Market Middleman
Customer Restaurants
If you sell animals to the market, how many animals do you bring? _____
If you sell animals to the market, what do you do with unsold animals? Quarantine
Back to the farm Back to another farm

How many animals do you keep/give per month? _____
What is usually the price of 1 kg of poultry? _____
What is the price of 1 kg of poultry today? _____
What do you do with your ducks today? _____

OTHER PRODUCTION IN THE FARM

- *Old or dead animals*

	Before	Today
What do you do with old animals (eat, burn, sell, throw away, burry…)?		
How much is the cost for old animals (VND/kg or animal)?		
What do you do with dead animals (eat, burn, sell, throw away, burry…)?		
How much is the cost for dead animals (VND/kg or animal)?		
If you burry those animals, do you treat them?		
What product do you use for treatment? (Dilution?)		

- *Manure*

	Before	Today
What do you do with manure (Sell, use, nothing)?		
How often do you take manure for storing (1.Never, 2.Every day, 3.Every week, 4.Every month)?		
How often do you put new straw (1.Never, 2.Every day, 3.Every week, and 4.Every month)?		
Where do you store the manure (1.Outside in contact with the ground, 2.Outside in a plastic bag, 3.On the ground in the pen, 4. In a plastic bag in the pen)?		
Do you treat manure (Yes / No)?		
What product do you use for treatment? (Dilution?)		
When do you sell the manure(1.Every month, 2.Every 2-3 months, 3.Twice a year, 4.Once a year)		
How much does one kg of manure cost?		

- *Feathers and eggshells*

	Before	Today
Do you sell feathers (Yes / No)		
Where do you sell feathers?		
How much do you produce? (Units?)		
Do you treat feathers (washing, drying)?		
What is the unit price?		
Do you sell eggshells (Yes / No)?		
Where do you sell eggshells?		
How much do you produce? (Units?)		
Do you treat eggshells (washing, drying)?		
What is the unit price?		

Feeding management

Do you give industrial food to your ducks? Yes No
Which are the ducks having industrial food? Breeds Meat ducks Egg ducks
What quantity do you give them? _____
When do you give them industrial food (age)? _____
What sort of industrial food do you give them? _____
Is it a concentrate or a complete food? Concentrate Complete
What is the price of 1 kg of industrial food? _____

What else do they eat? Rice bran Cassava Maize Water lily (spinach)
Snails, small fish Kitchen waste Banana stem Paddy
Others: _____

How many meals per day do you give to ducklings? 0 1 2 3 4
How many meals per day do you give to ducks? 0 1 2 3 4

When do the ducks scavenge (months)? _____

Diseases Management

What are the systematic treatments you do?

	Type / Name of the product	**Frequency / Age of animals**	**Cost**
Deworming			
Vaccination			
Vitamines			
Antibiotics			
Disinfection			

- *Main diseases*

What are the main symptoms? Diarrhea Cough Stop eating Stop laying
Death Weakness Neurological symptoms

Which kind of birds do you vaccinate? Breeds Meat ducks Egg ducks
Do you buy products when your ducks have a disease? Yes No

- *Paravets*

Do you call the paravet for duck vaccination? Yes No
Do you call the paravet for duck diseases? Yes No
Where do you buy the products? _____

- *Antibiotics*

How long do you usually treat your ducks? 1 day 2 days 3 days 4 days
If your ducks get better after 2 days, do you stop the treatment? Yes No
Do you give the good dosage? Yes No, increase No, decrease
After a treatment, do you wait before eating or selling your animals? Yes No
How many days? _____
What do you do when the treatment doesn't work?

- You eat the ducks
- You sell the ducks
- You give the ducks
- You feed the pigs
- You feed the fish
- You burry the dead animals
- You change the antibiotic
- You stop using the antibiotic afterward
- Other: _____

Why don't you treat your animals?

- Because you don't have access to any product
- Because the paravet knows nothing about ducks' diseases
- Because it is too expensive to treat
- Because my ducks do not have diseases
- Other: _____

Annex 5: Total heads of domestic animals holding in interviewed households (N_{tot}=146)

	Dinh Hoa	Vo Nhai	Van Chan	Thanh Son	Phu Yen	TOTAL
	No. heads	No. heads	No. heads	No. heads	No. heads	No. heads
Ducks	2019	481	884	647	1080	8015
Other waterfowl	148	470	390	378	323	447
Chickens	1463	1007	910	1088	968	5817
Fighting cocks	3	0	0	2	1	6
Fattening Pigs	65	109	127	128	103	532
Sows	11	12	9	11	8	51
Buffaloes/cattle	35	25	24	56	88	228
Horses	2	0	0	0	5	7
Goats	33	0	0	0	116	149
Dogs	87	62	46	108	34	337
Fish farms	24	14	21	19	14	92

Annex 6: proportion of farmers interviewed keeping ducks for single purpose (meat or eggs) or for dual purpose (both meat and eggs)

	Dinh Hoa	Vo Nhai	Van Chan	Thanh Son	Phu Yen	TOTAL
	% farms	% farms	% farms	% farms	% farms	% farms
Eggs	13	3	4	18	15	**53**
Meat	10	10	18	10	7	**55**
Both	7	17	3	4	7	**38**
TOTAL	30	30	25	32	29	146

Annex 7: geographic repartition of farms according to the 3 duck production sub-systems

	Dinh Hoa	Vo Nhai	Van Chan	Thanh Son	Phu Yen
	% farms	% farms	% farms	% farms	% farms
Self sufficiency oriented farms	8	20	4	2	9
Intermediate systems	13	9	17	13	15
Semi-commercial	9	1	4	17	5

Annex 8: pictures taken during field trips

Middleman selling chicken and ducks on the road between two communes in Dinh Hoa district, Thai Nguyen province on February 28th, 2006

Focus group meeting with duck producers, AHW and commune authorities in Dong Thinh commune, Dinh Hoa district, Thai Nguyen province on February 28th, 2006

Traditional large-sacled brooding of eggs, hatchery in Dinh Yen commune, Dinh Hoa district, Thai Nguyen province on February 28th, 2006

Semi-commercial laying duck production in Dong Thinh commune, Dinh Hoa district, Thai Nguyen province on February 28th, 2006

Self-sufficency oriented, integrated (VAC) duck production in Thuong Ha commune, Phu Yen district, Son La province on March 7th, 2006

Traditional herding of ducks in Thai Nguyen province on February 26th, 2006