Policy Responses to the Threat of Highly Contagious Disease Originating in Domestic Animals:

An Overview of Recent Experience with Avian Influenza

Adam Borelli
Negar Ghobadi
Joachim Otte
Dirk Pfeiffer
David Roland-Holst

October 2005

Acknowledgements

This note presents an overview of historical context related to Highly Pathogenic Avian Influenza. This work is part of the Pro-Poor Livestock Policy Initiative, an FAO administered program to promote the livelihoods of smallholders in developing countries. The authors are consultants, research staff, and other experts in AGA/FAO. Joachim Otte is research director of the PPLPI project at FAO. Dirk Pfeiffer is a Professor at the U.K. Royal College of Veterinary Medicine. David Roland-Holst is the James Irvine Professor of Economics at Mills College and Directory of the Rural Development Research Consortium at the University of California, Berkeley (dwrh@are.berkeley.edu). Adam Borelli and Negar Ghobadi are research assistants at the University of California, Berkeley. The authors would like to thank colleagues at FAO for valuable guidance and input, as well as a variety of official and private researchers for facilitating our research in Thailand and Viet Nam. All opinions expressed below are those of the authors and should not be attributed to their affiliated institutions.

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1. INTRODUCTION

Highly pathogenic avian flu (HPAI) first occurred in Viet Nam and Thailand in late 2003, causing severe mortality in affected flocks. The disease has recurred in 2004 and 2005, and is now considered endemic to the region. Given that the virus has crossed a species barrier and caused human fatalities, concerted efforts are being mustered by national governments and international agencies to control the spread of the disease through a variety of measures, which may ultimately amount to a 'restructuring' of the poultry industry. Control measures could include the prohibition of certain production practices and/or of raising particular poultry species (e.g. scavenging ducks and chickens), which are important for sources of income for a large number of poor rural farming households. Measures put in place to control HPAI may thus have larger impacts on the lives of the rural poor than HPAI itself.

Devising evidence-based responses to animal and human health risks that balance the interests of a wide variety of national and international stakeholders requires thorough analysis of epidemiological and economic information (past and present), development of scenarios of disease spread, their likelihood of occurrence, the identification of critical control points and interventions, and negotiation between stakeholders at national as well as international level.

This paper attempts to provide a brief overview of a possible approach to systematically address the recurring need of national governments and the international community to respond to novel disease threats using the incursion of HPAI into Thailand and Vietnam as cases from which to derive broader lessons.

2. STAKEHOLDERS

2.1 Poultry industry

Thailand is the world's sixth largest producer of poultry meat. However, the industry is small in comparison to the overall economy, and represents just 0.4% of

gross domestic product (GDP)[1]. In Vietnam, the poultry industry represents 0.6% of GDP[2].

These estimates might suggest that in Vietnam, for example, if poultry production fell to zero for a period of six months, lost income would amount to 0.3% of the value of GDP. However, this approach ignores the ability of farmers to substitute resources towards other animals or crops, which would mitigate income losses to some degree[3].

Although Avian Flu threatens the entire poultry industry in affected countries, the burden appears to be skewed towards consumers and specialized? (backyard systems, being diversified, seem relatively resilient to me) small to intermediate? scale producers. For example, in Thailand, big agribusinesses appear better positioned to take advantage of government assistance, in comparison to family-owned farms[4].

2.2 Other agriculture industries

Avian Flu has a sharply negative impact on the demand for poultry products. However, as consumers substitute away from poultry, this increases the demand for other foods, particularly meats such as pork, beef and mutton.

For example, in response to sporadic Avian Flu outbreaks, substitution away from chicken towards pork has been a boon for Vietnam's hog industry, where pork prices rose 15% from 2004 to 2005. During 2004, the industry increased production from 25 million heads to 26 million, and a similar increase is expected for 2005[5].

Industries related to substitute products also stand to benefit, for instance, the hog industry in Vietnam accounts for 60% of total commercial feed demand, and industry expansion may lead to an increase in feed production of around 10%[6].

2.3 Tourism sector

[1] Castillo and Verbiest 2004:2
[2] World Bank 2004:1
[3] World Bank 2004:1
[4] Delforge
[5] Reuters
[6] Reuters

In Thailand and Vietnam, the tourism industries account for roughly 6.0% and 6.7% of GDP respectively[7]. Tourism and related industries, such as airline and hospitality industries, are extremely vulnerable to negative shocks given the elastic nature of demand. Both countries rely heavily on international tourists, who can easily switch destinations or postpone their holiday in response to any kind of adverse event.

2.4 Financial markets

In some ways, the 1997 Asian financial crisis has left Asian financial markets well prepared for the impact of Avian Flu. Investors are much more aware of the risks they face and the returns they should realistically expect.

In an economic ?? sense, Asian governments and central banks also appear better prepared for a crisis of confidence that might hit financial markets. For example, many Asian central banks have massive foreign reserves. For instance, Thailand and Vietnam's foreign reserves stand at USD 48.3 billion and USD 6.5 billion respectively[8].

2.5 Broader economy

Any negative shock to one sector of the economy has secondary effects. For example, layoffs in the tourism industry result in less spending, which in turn impacts negatively on GDP growth. The degree to which the entire economy is affected by a new Avian Flu outbreak depends upon the degree of the outbreak itself and the ensuing national and international responses.

2.6 International community

Repercussions of transboundary diseases beyond the border

[7] Cezayirli 2005:1, Reuters
[8] CIA Factbook

3. SCENARIOS

Some research on the impacts of a possible Avian Flu epidemic focuses on just two distinct hypothetical scenarios – one in which the epidemic remains confined to animals, and one in which it becomes a human epidemic. The key transition being Avian Flu to become communicable from person to person.

3.1 **Scenario 1** - Isolated outbreaks with sporadic transmission to humans

Case study: Avian Flu (H5N1) outbreak in Hong Kong 1997

Human cases: 18 infections, 6 deaths (33% case fatality)
Transmission to humans: Close contact with contaminated birds or bird manure
Livestock: Hong Kong's entire poultry population (1.5 million birds) were destroyed by authorities
Cost: Produce cost of approximately US$13 million

Hong Kong's first fatality occurred in May 1997. In December 1997, the government banned imports of chickens from mainland China, and in January 1998 began a process which resulted in the culling of Hong Kong's entire chicken population of approximately 1.5 million birds. The cost of this culling solely in terms of lost produce is estimated at $13 million, but the move arguably averted a major pandemic[9]. Tourism suffered as a result of the outbreak, but the degree of this downturn is hard to quantify because of the fact that the Asian financial crisis and Hong Kong's handover from Britain to China were overlapping events which also affected tourism.

The major types of economic costs of the Avian Flu outbreak were the trade costs of restricting imports, costs of testing and tighter regulation of poultry products, and the costs from culling birds.

So far, Avian Flu has only been suspected of transferring between humans in a few rare cases, and this is not confirmed. The lack of person to person transmission is an important point, because a lineal extension of the current series of events is likely to see the effects of Avian Flu confined to the poultry industry and related agricultural industries. Without person to person transmission, the tourism industry is likely to be minimally (see BSE) affected.

[9] Davis and Kimbal 2005:

Case study: Netherlands (H1N7) 1 March, 2003

Human: 89 infections, 1 death
Transmission: Contact with poultry, suspicion of limited human to human transmission.
Livestock: 25 to 30 million chickens were destroyed by authorities[10].
Cost: Direct economic costs of €150m[11]. Indirect costs estimated at €500m[12].

One veterinarian who visited an affected farm died two months after becoming ill, 89 other people suffered symptoms. Most people suffered conjunctivitis-like symptoms, with only seven cases of influenza. In three cases, the families of poultry workers became sick with a minor respiratory illness which provides some indication that human to human transmission occurred[13]. Dutch authorities also reported evidence of infection among pigs.

In response to the outbreak, the Dutch government suspended exports and began culling chickens. Other control measures included the use of protective glasses, masks, and treatment with oseltamivir, an antiviral drug[14]. Today, the Dutch poultry population is more than 10% below its peak of 104 million birds in 2003. The outbreak saw meat production fall by 25% and allowed cheap competition, particularly from Brazil, to gain a foothold in European poultry markets[15].

Shortly after the outbreak, the Minister for Agriculture reported on the situation to the Dutch parliament via the following letter: http://www.vetscite.org/publish/items/001102/\

Update: As a result of recent concern over the spread of Avian Flu in wild and domestic bird populations throughout central Asia, on 19 August, 2005 the Dutch government ordered all free range commercial poultry to be housed indoors. The move affects around 5 million of the 90 million chickens farmed in the Netherlands[16].

There are two reasons why the Dutch government appears prepared to take radical preventative measures. Firstly, the Netherlands situation is unique because it has the highest concentration of poultry in the European Union, and is therefore probably more at risk of an Avian Flu outbreak than any other EU country. Secondly, the Netherlands 2003 experience is still fresh in the minds of policy makers.

[10] Knight 2005
[11] Europa 2005
[12] Yahoo
[13] WHO 2003
[14] CIDRAP 2003
[15] Yahoo
[16] Knight 2005

There is some suggestion that the move may have violated EU law, given that EU member states abdicate the right to enact laws relating to animal welfare to the European Commission[17].

3.2 **Scenario 2 -** Low level clustered outbreaks with sporadic human infection

Case study: Bovine Spongiform Encephalopathy (BSE) in Britain 1986

Human cases: 148 vCJD cases in humans, which is ultimately fatal
Transmission to humans: Consumption of tainted bovine neural tissue is linked to Variant Creutzfeld-Jakob's Disease (vCJD) in humans
Livestock: 183,803 BSE cases
Cost: Produce cost of approximately ?? US$ million

BSE is believed to have originated in sheep and transferred to cattle via meat and bone meal used as a high protein feed supplement. Consumption of tainted beef is strongly linked to vCJD in humans – a rare and incurable brain disease which is ultimately fatal.

Although BSE was identified in cattle in 1986, it was not until 1996 that the announcement was made that vCJD in humans was linked to beef consumption. Despite relatively few deaths, the nature of mental decay caused by the disease was shocking. Domestic sales of beef products fell by 40%, and export markets were lost. The price of beef cattle fell by 25%[18]. In terms of public expenditure, the outbreak cost $2.5 billion in the year following the outbreak. In terms of income lost, the crisis cost the British economy roughly $1.5 billion, or 0.1% of GDP. This income loss would have been higher, if it had not been partially offset by rising consumption and prices of substitute meat products. Consumer demand for all bovine related products fell strongly. For example, roughly 30,000 dairy farms failed during the BSE epidemic, despite the fact that milk consumption is not linked to vCJD.

This scenario of low level clustered outbreaks also implies that Avian Flu remains limited to poultry to human transmission. The British BSE outbreak which was recognized in 1986 therefore represents a useful case study, as the disease was not communicable between humans. (How appropriate would the NIPAH outbreak in Malaysia be?)

One lesson from the British BSE epidemic is that the impact on particular sectors, and even within sectors varies considerably. Factors associated with vulnerability to the epidemic include the distribution of compensation payments

[17] Telegraph
[18] Atkinson 2005:1

and the degree of specialization in cattle or beef related commerce[19]. For example, beef producers and abattoirs were provided with compensation payments, but retailers were not. Specialized retailers such as butchers were most affected, but even they had the ability to adjust product mix in order to mitigate turnover losses. Larger businesses appear to have coped with the outbreak more effectively than smaller operations, and this again also appears linked to a more diversified product line.

The British Tourist Authority estimates that the BSE outbreak caused a 10% annual loss of revenue for the tourism industry over ? years. Given the lack of person to person transmission, this is somewhat surprising, and reveals something about the nature of demand for tourism services. Firstly, tourist demand is fickle, and secondly, tourists can be deterred solely by concerns over food safety.

3.3 Scenario 3 - High level local human affliction, i.e. high levels of disability/mortality (local infection clustered across family/farm boundaries)

Case study: Pneumonic Plague in India 1994

Human cases: 2,500 infections, 50 deaths (2% case fatality)
Transmission: Breathing infected respiratory droplets from an animal or human, can also develop from untreated bubonic plague, which is transmitted through flea bites (usually rat fleas).
Livestock: -
Cost: $1.3 billion

Despite being endemic to the subcontinent, the 1994 outbreak of pneumonic plague in Surat, India caused widespread panic. There was a mass exodus of workers from the region, and around 500,000 residents of Surat fled the city within four days of the epidemic being announced. The international community placed several trade and travel restrictions on India and export losses alone amounted to $420 million[20]. Hotel bookings fell by 20% to 60% and airlines lost millions of dollars per week[21]. The combined cost of the two month plague epidemic has been estimated at over $1.3 billion[22].

[19] Atkinson 2005:1
[20] Pallipparimbil
[21] WHO
[22] Davis and Kimball 2005:

Given the likely government response to clustered animal and human infections would be to engage in a program of culling diseased and at risk birds, high levels of disability and mortality are likely to occur only if Avian Flu becomes communicable between humans. Such a scenario represents a turning point, and would have massive ramifications for the tourism industry in particular. Since pneumonic plague can be transmitted between humans, the Surat plague epidemic provides a useful case study.

The Surat outbreak illustrates the problems that can arise as a result of ineffective government responses. Government officials pronounced a plague epidemic before it had been confirmed, and local and international media reports of greatly exaggerated death tolls added to the panic. The government provided misinformation as to how to deal with the disease, and closed many schools, banks, offices and public areas. Around 6,000 cases reported as the plague are thought to have been misdiagnosed. The hysteria surrounding the outbreak caused such an exodus from Surat that the government had to forcefully prevent people from fleeing with military force.

The plague highlighted reliance on migrant labor as an important risk factor for an economy. Diamond cutting is a major industry in Surat, employing roughly 400,000 people – many of which are migrants[23]. Although permanent residents of Surat also fled the plague, migrants were most likely to leave, presumably because they had few ties in the city, and were able to find accommodation with relatives in other areas.

3.4 **Scenario 4 -** National epidemic affecting humans **(**rapidly emergent infection/affliction nationally, including urban areas and compromising domestic transport linkages.)

Case study: Cholera in Peru 1991-95

Human cases: 600,000 infections, 4,500 deaths (0.75% case fatality)
Transmission to humans: Contaminated drinking water and foods, particularly

[23] Diamond

shellfish
Livestock: -
Cost: $1.5 billion

Peru reported the outbreak of a Cholera epidemic to the World Health Organization in February 1991. Shortly after the announcement, Peru's economy began to suffer from trade related costs. Orders of fresh fruit and seafood were cancelled, and in the first quarter of 1991, tourism was down roughly 65% on the corresponding period in 1990[24]. The Peruvian cholera epidemic is thought to have cost over $700 million in tourism and trade losses alone[25].

Although the Peruvian cholera epidemic spread throughout the nation, killing 4,500 people, it does not represent a perfect case study for an Avian Flu outbreak of similar severity. Cholera is not transmitted from person to person. Rather, it is a symptom of poverty. Cholera is caught by ingesting food or water that contains a particular strain of bacteria. Highly risky food types include shellfish, undercooked fish, raw vegetables, or unpeeled fruits, and drinking contaminated water is also a major source of infection. Cholera is seen as a symptom of poverty because it is so easily prevented via filtration and chlorination of the water supply.

However, the Peruvian cholera outbreak does provide some useful information about how national outbreak of Avian Flu might affect South East Asian economies. For example, like the BSE case study, it shows that tourism losses can be substantial even without the threat of person to person transmission.

3.5 **Scenario 5 -** Regional epidemic affecting humans **(r**apidly emergent regional infection/affliction with transboundary linkage)

Case study: Severe Acute Respiratory Syndrome (SARS) 2002-03

Human cases: 8,069 infections, 775 deaths (10% case fatality)
Transmission to humans: Close person to person contact, airborne, touching contaminated surfaces

[24] Davis and Kimball 2005:7
[25] Davis and Kimball, WHO

Livestock:	-
Cost:	Estimates of the economic cost of SARS to the world economy vary widely, from $40 billion to $140 billion[26].

SARS is thought to have been passed from Civet cats to humans in Southern China. The first human case was identified in November 2002, and the last case in this outbreak was recorded in June 2003.

Economic and political consequences of the SARS outbreak were felt around the world, but were concentrated in the Asian countries where the disease originated. In China, the 2003 FIFA Women's World Cup (soccer) was switched from Beijing to the US. The International Indonesian Hockey Federation also cancelled a tournament scheduled for Beijing. Patronage of Chinese restaurants in fell in South East Asia, and even Chinatowns in North America reported a drop in customers[27].

Several SARS cases were reported in Canada, and economic costs were consequently high. In Toronto, restaurant patronage fell by roughly 25%, 800 bus tours were cancelled, cinema audiences fell sharply, and hotels experienced millions of dollars in lost revenue.

The SARS outbreak provides an excellent example of how a highly pathogenic outbreak of Avian Flu might spread around the world from a South East Asian epicenter. In April 2003, the cost of SARS per country was estimated as follows[28]:

1. China: $2.2 billion
2. Hong Kong: $1.7 billion
3. Indonesia: $400 million
4. South Korea: $2 billion
5. Malaysia: $660 million
6. Philippines: $270 million
7. Singapore: $950 million
8. Taiwan: $820 million
9. Thailand: $490 million
10. Vietnam: $111 million
11. Japan: $1.1 billion

In some markets, the impact of SARS on tourism was greater than the impact of the New York terrorist attacks in 2001. SARS also deterred tourism between countries

[26] Straits Times 2003
[27] Wikipedia
[28] Crispin, Fowler, Saywell 2003

that experienced few infections. For example, during early 2003 there was a decline in the number of European visitors to Australia, probably because they were unwilling to travel through Asia en route.

3.6 Scenario 6 – Global pandemic of national or proximate origin (unrestricted global epidemic radiating from a national or neighboring source.

Case study: Spanish Flu (H1N1) 1918-19

Human cases: 500 million people infected, at least 25 million killed (perhaps 50 million or more)
Transmission: Close person to person contact.
Livestock: -
Cost: -

The Spanish Flu was thought to have originated in the US in January 1918 and quickly spread around the world, aided by troop movements during the First World War. The Flu quickly mutated to become highly pathogenic, and in some areas it killed up to one third of those it infected. Local authorities reacted by trying to limit travel and public congregations. One US town even banned shaking hands[29].

It is certain that 25 million deaths and hundreds of millions of seriously ill people must have had a massive negative economic impact on the entire world. In the US, the Spanish Flu caused a wave of business failures across the country and resulted in a short recession[30]. However, the economic and financial ramifications from an Avian Flu pandemic of similar proportions may be far more severe[31]. Since 1918, globalization has seen the world economy become vastly more integrated, and today, international trade makes up a considerable proportion of world GDP[32]. In this regard, the modern economy is arguably much more susceptible to a negative shock.

One particularly sobering aspect of the Spanish Flu outbreak is that it is now believed that the virus originated from birds, transferred to humans and acquired

[29] Wikipedia
[30] New Yorker
[31] Nesbitt
[32] Nesbitt

the capacity of human to human transmission, just as the virus causing the current outbreak of Avian Flu may do[33].

[33] Lovgren

4. REVIEW OF COUNTRY ECONOMIC LITERATURE

4.1. Thailand

The Thailand livestock industry has undergone significant change over the last two decades. The buffalo, cattle, pig and poultry industries have all experienced a transitional stage in recent times that has mirrored the dramatic economic development of Thailand and the South-East Asian region in general. Changing economic, demographic and political conditions have impacted on the traditional structure of the livestock industry in Thailand.

Traditionally the livestock sector in Thailand, as in most of South-East Asia, has been a subsidiary to the subsistence economy with buffaloes and cattle mainly used for draught purposes and pigs and poultry for village consumption. The traditional agricultural societies of the South-East Asian region were predominantly crop-growing societies and only a small livestock component existed to support this crop production.

Despite the orientation of Thai agriculture to crop rather than livestock production, integration of livestock into the whole village production system is an essential feature of Thailand's agricultural sector. Traditionally livestock production is not considered as a distinctive enterprise of the farming system, rather it is an integral part of crop production.

Farmers in villages raise cattle and buffaloes for land preparation, manure production and long-term savings. Native chicken and swine are raised in backyards for home consumption as well as for household savings. In many ways, the stability of the small farm system and the livelihood of the small farmers depends on the complementary role of livestock and cropping, that is on a mixed farming system.

A large portion of Thailand's livestock and poultry are in the hands of small-holders within villages. On average it has been estimated that a Thai farm family raises approximately 1.2 buffalo, 1.0 head of cattle, 0.8 pigs, 17.1 chickens and 3.2

head of other poultry (Khajarern and Khajarern, 1989, pp. 25). As noted, they are generally raised by subsistence farmers to complement and assist in the production of crops and generate additional income. However, while the contribution of additional cash income by livestock to the small farm household has always been essential, (Thummabood and Morathop, 1992) traditionally this contribution has been low when compared to that of crops. It has been estimated that only around 1/5 of agricultural cash income received by villages is contributed by livestock compared to around 4/5 by crops (Khajarern and Khajarern,1989). Furthermore the productivity of village livestock is low when traditional raising systems are used. (Murphy and Tisdell, 1992).

Changes in the Thai diet have had a significant impact on the demand for poultry products in particular. Poultry production has become a highly successful component of the Thai livestock sector. Introduction of modern breeding programs and production methods (applied in the United States) for poultry has been facilitated by large agribusinesses, which first pioneered contract farming methods in Thailand in the early 1970s. These early innovations and a long period of low feed prices and (until very recently) labour costs, were responsible for the real decline in poultry prices. This process has increased the importance of poultry products in Thai diets at the expense of traditional fish. Present consumption of poultry (only meat or incl eggs?) stands at about 6.6 kg per capita per year (Warr, 1993, p. 87).

The recurrent risk of animal disease has consistently posed a serious economic threat at both village and national level in Thailand. The traditional role of small farm livestock for the Thai farmer is a varied one and economically the farmer relies heavily on the health of his/her stock. Traditionally, role of livestock in communities have been more of a risk diversification (from only cropping), asset ownership and prestige, provision of food, etc. The nature of these traditional roles, however, is changing with the rapid development of the Thai economy and the changing nature of demand for agricultural products. The position of the livestock sector as a sub-sector of agriculture within the national economy is undergoing change and pressure to reform from its traditional roles as the economic development of the country progresses.

4.1.1. Animal Health System

There is an increasing focus on disease control programs in developing countries such as Thailand and Vietnam, and a growing use of economic techniques to assist in policy making for disease control. Thailand's experience with Foot and Mouth Disease (FMD) has caused the Thai government to focus more resources on disease control and management strategies. With the emergence of Avian Flu , the need for such systems is increasingly apparent. However, relative to other fields of agricultural economics, there is limited published literature on the economic assessment of animal diseases and control strategies. The work that is available is concentrated on major diseases such as FMD and tuberculosis.

In recent times, the general approach to disease control has witnessed the integration of economics and epidemiology in order to determine the optimal management of control programs. While the number of documented studies on the modeling of disease control is increasing with time, they can be criticized on the appropriateness of the economic techniques applied and whether they sufficiently represent the appropriate epidemiological and economic features of disease.(Murphy, 2??).

4.2. Vietnam

Agriculture in Vietnam accounts for 30% of the GDP and is based mainly on rice production, followed by other crops such as maize, sweet potato, cassava, groundnuts, soy beans and sugar cane. There are also fruit trees and other perennial trees like coffee, rubber, tea and coconut. Livestock production, mainly buffalo, cattle, pigs and poultry contributes 25% of the agricultural output. Animals and poultry form an integral part of village life and have important social functions in Vietnam. They are an important source of income for village families and provide a cheap source of protein for rural people.

Despite receiving much less government support and direction livestock production is growing as rapidly as crop production. The Vietnamese livestock sector has exhibited a fairly strong growth during the last decade of reforms,

growing at an average annual rate of 4.4 percent per year and accelerating in the second half of the 1990s. The livestock sector together with aquaculture has increased its contribution to at least one-third of total increases in agricultural revenues (Vietnam Development Report 2001)

Livestock and veterinary services account for just 4 percent of the national agricultural budget—far short of the sector's economic importance. Nor does livestock policy reflect the fact that the majority of the farming population is involved in some livestock production. Potential for growth in livestock production is strong. Although consumption has grown by 6 percent a year, the Vietnamese still eat less meat than their neighbors in China, in the rest of Asia, and in many other developing countries.

Livestock production in Vietnam is primarily undertaken on household farms where crops and other agricultural products are also produced. More than 92 percent of producers utilize only household labor in the livestock enterprise (62 percent in general agriculture); they cultivate 0.77 hectares of land on average. In terms of livestock sales, 60 percent of their sales are pigs, 23 percent are poultry and only 8 percent are cattle (see table 2 ??). More than 99 percent of producers who kept pigs or chickens were involved in pigs and chickens sales. Livestock products are predominately sold to assemblers and wholesalers at the farm gate, or (in the case of pigs) direct to small slaughterhouses. Direct sales of products to consumers are uncommon due to the relatively remote locations of many livestock firms. A lack of an organized livestock marketplace infrastructure means that farmers usually deal with buyers on individual basis.

IFPRI (2001) finds diseconomies of scale in livestock production, with profits increasing at a slower rate as inventories and revenues increase. This implies that the efficiency levels on smaller farms, based on raising local animals with low cost feedstuffs are higher than those on larger farms employing intensive high quality feed production techniques.

4.2.1. The Animal Health System

In Vietnam, animal diseases are often not detected, not reported in time, or not reported adequately and accurately. Generally speaking, in many cases diseases are not diagnosed or wrongly diagnosed, leading to inappropriate treatment and a misleading picture of the epidemiological situation, which may delay the appropriate reaction to epidemic disease outbreaks. These shortcomings are a result of a combination of reasons:

1) At grass root levels, veterinary 'fieldwork' is done by animal health workers (AHW), private agents earning their income from farmer service fees (Landon-Lane and Thao: 2001). However, the activities of AHW are only loosely controlled, their training is very limited, and their total income is low (Lan 2000); These characteristics may contribute to unreliable reporting, and make AHW susceptible to financial coercion (ASPS and ACI 2002).

2) Producers are reluctant to report animal disease outbreaks since they cannot or do not want to pay for treatment and are afraid to have their animals culled. Therefore, producers may react by sale or slaughter of affected animals and failure to report locally contagious conditions (ASPS and ACI 2002). Further, they may have incentives to bribe health and other local inspectors to divert attention from diseased animal stocks.

Since liberalization, subsidies for vaccination have dropped substantially and are now only paid in areas with special conditions. As a result, vaccination coverage has decreased from 70-80% in the 1980s to 40-50% in the 1990s (Thuy 1999). While official vaccination campaigns are compulsory, their efficiency is limited and risks have increased for poor vaccine storage and handling, as well as improper application (Lan 2000); (Thuy 2001). Due to ignorance or negative experiences, many producers do not consider vaccinations to be necessary, to be too expensive, unhelpful or even dangerous (Lemke et al. 2000); (Thuy 2001).

4.2.2. Livestock Policy

Policy making and implementation is hindered by a political ambivalence about rural development in general (see Vu:2003 for more detail). This results in a

restrictive land policy that inhibits the potential of rural producers while restricting the growth of off farm employment opportunities that may benefit the poor. Livestock extension and veterinary services have been strengthened and received increased funding, but are still woefully inadequate. Credit institutions to serve the poor operate like charities and lack sound financial and legal bases. In general, policymaking is, for the most part, still in the centrally planning mode. Great emphasis is placed on ambitious targets with little attention to efficiency, market or social demand, or the real impact on the poor and the disadvantaged.

4.2.3. Village Poultry Production

The poultry population of Vietnam increased during the past decade. Chickens are raised in every village in Vietnam, and 75% of the national flock is kept under traditional village conditions. Villagers use free-range, backyard or semi-intensive systems but not intensive systems. Most farmers keep chickens, but the smaller flocks contain only a few birds. Other poultry such as ducks (including Muscovies) and geese are also kept in villages. During the past three decades, the Vietnamese government has encouraged the industrialisation of poultry production. Exotic breeds of broilers (Plymouth, Hybro, Cobb, Hubbard, Ann Arbor) and layers (Leghorn, Hubbard, Comet, Moravia, Goldline-54, ISA-brown, Brown Nick) were imported. Industrial production required not only exotic breeds, but access to concentrates, vaccines and professional management.

Local chicken meat is perceived to be more tasty and of higher quality than that of many exotic breeds. This has led to an increased demand for 'garden chickens' in Vietnam. Although village chicken production has increased in response to consumer preference for local birds, there remain major constraints. The productivity of village chickens is low and needs to be improved. Limited production has led to a high price for the product. Most are sold live and consumed locally. In remote areas, there are no good facilities for slaughtering and processing. Disease control is difficult in unconfined chickens and infectious diseases and parasites cause substantial losses.

5. ECONOMIC MODELING OF DISEASE

An essential element in the evaluation of control programs has been the representation of disease dynamics through modeling techniques. While this process is often a difficult task, the historical development of mathematical theories on the spread of endemic? disease has formed the backbone for a more accurate assessment of the dynamics and impact of disease in many contemporary economic studies of disease control programs.

5.1.1. Techniques applied in economic evaluation of disease control

Many economic studies on disease control generally try to combine approaches of epidemiology and economics and to apply them to animal health problems in order to either 1) evaluate the causal relationships, 2) predict and measure the losses and, 3) prescribe preventive and or control measures (Ngategize and Kaneene, 1985, p. 153).

Studies on the quantitative techniques applied to analysis of animal health problems have been classified in a variety of ways in the literature. In respect to animal health, Ngategize and Kaneene(1985), Dijkhuizen (1988) and Bennett (1992) have provided comprehensive assessments of a broad range of quantitative modeling approaches utilised in economic assessments. The former two studies considered the modeling of animal health within two broad headings 1) statistical and/ or epidemiological models, 2) economic models. Under the first category they had included a range of techniques that are predominantly statistical such as regression, discriminant variance and path analysis. Under the "Economic" category, Ngategize and Kaneene (1985) include cost benefit analysis, partial budgeting and the "equimarginal" principle. Other economic modeling approaches applied to animal health are decision analysis, linear programming, markov chains, systems simulation and dynamic programming. Bennett(1992) considered a similar range of quantitative economic modeling approaches that in Bennett's (1992) study

were 1) mathematical programming, 2) network analysis, 3) decision analysis 4) simulation 5) cost-benefit analysis. James and Ellis (1979) simply categorized the modeling approaches into positive and normative approaches. The positive approach is essentially a description of relevant processes by statistical epidemiological data analysis (ie empirical modeling). The normative approach to the economic effect of animal disease requires a conceptual model of the animal production system and the economic system on which it operates on purely theoretical grounds . This is then used to predict the effect of the disease on the system (James and Ellis, 1979, p 366). Put simply, the positive approach is all data and no model and the normative approach is all model with no data (James and Ellis,1979). Generally the approaches undertaken contain elements of both. Livestock disease models which appear to be normative in practice contain many elements which have been estimated by empirical methods (James and Ellis, 1979.p367) There is considerable overlap between these modeling approaches, particularly where they are applied in several of the same applications.

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