

Some Direct Costs of Control for Avian Influenza

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Abstract

Asia, and parts of Europe and Africa, have been severely affected by Highly Pathogenic Avian Influenza (HPAI). Substantial costs are incurred by the implementation of control, eradication and surveillance measures that have to be viewed with a long term perspective, considering the impact of HPAI on the economy. The challenge faced by national and international authorities is to choose the appropriate level of disease control and supply veterinary services with sufficient resources to perform this work. Using examples drawn from selected countries in Asia and Africa this paper estimates the costs of different HPAI control strategies.

Introduction

Control and eradication of HPAI are complicated tasks that can only be achieved by a combination of measures. No single set of measures is likely to be appropriate and effective for all countries. The measures must be chosen and adapted according to the economic circumstances and disease status of each country or region. The overall goal for all control measures is to detect, control and preferably eradicate the virus in order to minimise the economic losses to farmers and limit the exposure of humans to virus.

The main measures used to prevent, contain and eradicate HPAI are (FAO 09/2004):

- Disease surveillance in order to quickly detect and report outbreaks and to assess the effectiveness of control measures
- Upgrading of biosecurity in poultry farms
- Control of movement of birds and products that may contain or be contaminated with H5N1 viruses, including temporary market closures and border controls
- Stamping out of infected poultry
- Cleaning and disinfection of farms, markets and associated equipment and facilities
- Vaccination of poultry
- Communication and education
- Industry restructuring and changes to marketing and production practices such as segregation of different types of poultry and changing to centralised slaughtering

Progressive selection of disease control measures

The set of measures employed depends on the overall goal of the program, the point in time, the infection status and progression of disease within a country. When outbreaks first occur stamping out with compensation, movement controls, cleaning and disinfection, and in some cases targeted vaccination are implemented. Several countries (notably Japan and Republic of Korea) have successfully applied stamping out and movement controls without vaccination whereas in places where infection was already widespread or the risk of reinfection is high, vaccination has been used as an additional measure.

It is important to recognise that if pockets of infection with H5N1 HPAI persist after stamping out, the virus may rapidly re-establish itself, especially if changes are not made to the way poultry are reared and marketed. Production and marketing systems in poor countries facilitate spread of the virus and gains from stamping out can be frustratingly short-lived as seen in Thailand and Viet Nam in 2004.

Surveillance is very important, regardless of the infection status in at-risk countries. Enhancement of testing capacity is likely to be needed in infected countries as the number of suspected outbreak investigations and the quantity of targeted surveillance to determine infection status increases.

Once the disease is eradicated from a compartment, zone or country attention shifts to preventive measures in order to avoid reoccurrence. Therefore changes to marketing practices and enhancements of farm biosecurity become more important, although some places have also used vaccination as an additional preventive measure (e.g. Hong Kong) due to the perceived high risk of reinfection.

Disease prevention and control measures lead to additional costs that need to be weighed against the cost of the disease. Different stakeholders involved including poultry producers, consumers and governments or

tax payers share the economic impact and costs of risk reduction unequally. Some of the costs are borne by governments or international donors, since control of HPAI (a zoonotic disease with pandemic potential) is recognised as a public good activity. Irrespective of the cost sharing and distributional effects between the stakeholders the full long-term cost of each measure should be estimated so that national and international policy makers are able to select the most efficient and cost effective control strategies.

This analysis is complicated because much remains unknown about the epidemiology of this disease and the long term effect of control measures cannot always be predicted. For example, decisions on the strategy to be adopted depend on whether the disease is eradicable in a country. However, this may not become apparent until the full extent of infection at the time of the first outbreak is known. In most countries the first case of disease identified was not the index case but this only became apparent retrospectively.

This paper will consider long term costs of control strategies such as surveillance, preventive vaccination, stamping out with compensation and upgrading of biosecurity in poultry farms. Estimates are derived on a case study basis for Asian countries and Nigeria, and investment and recurrent costs will be distinguished.

Surveillance and disease diagnosis

Comprehensive surveillance is extremely difficult to perform for diseases in countries where most of the poultry are in smallholder and scavenging systems, such as Viet Nam where over 8 million households rear poultry. Due to the decreased poultry density in scavenging flocks HPAI is not always as obvious and devastating as the disease in housed commercial flocks and disease recognition and diagnosis is sometimes delayed. HPAI may be mistaken for other diseases such as Newcastle disease, duck plague or fowl cholera.

Prevention and control of HPAI depend on early detection of virus incursions at the village or smallholder level, significant investment must be made in veterinary infrastructure and training. The level of investment required depends on the objective of the control program. However, in making this decision it needs to be recognised that uncontrolled cases of HPAI have the potential to escalate and undermine gains made elsewhere in controlling the disease. Therefore any gaps in the capacity to diagnose and respond to this disease will likely prove costly. The average time needed to report and confirm the suspicion of an outbreak is crucial. In highly developed production systems with a high proportion of the poultry stock being moved within a short time and possibly over long distances, reactions must be a lot more rapid than in less dynamic and less interlinked production systems, in order to limit the spread of the disease. Hence the costs to ensure appropriate surveillance depend on the specific conditions in each country.

The following areas need to be addressed to ensure adequate surveillance and early diagnosis of HPAI:

- Farmer awareness of disease reporting pathways

Farmers must know who should be contacted and the trigger points for reporting. High mortality rates within village poultry flocks are not unusual in Asia and Africa (Cunningham 1991). A situation where poultry keepers connect this occurrence with a possible HPAI outbreak and report the suspicion has to be achieved. The number of campaigns needed and therefore the resulting costs depend highly on the HPAI disease knowledge of poultry keepers and the available infrastructure to distribute information. A mass media campaign over a year in Viet Nam costs US\$ 1 million. In countries with predominantly industrialised poultry production, the target population is usually smaller and communication through industry groups can achieve the same results at a much lower cost.

- Compulsory disease reporting which requires legislative back up and enforcement capacity in the event of non-reporting

Most countries have animal health regulations that stipulate which diseases must be reported to veterinary authorities although many of these are outdated and only reviewed after a disease emergency. The process of updating regulations although not costly compared to the cost of uncontrolled disease can be time consuming and require extensive consultation with stakeholders.

- Incentives for reporting (or at least no disincentives) which usually means compensation and a removal of stigma associated with reporting (see "Stamping out and compensation" below)
- Suitable means of transport for CAHW and veterinarians to get to farms and suitable means of communication to district staff. In a number of countries in Asia field staff do not have vehicles or fuel for these vehicles

- Competent, field-based personnel who can make a preliminary assessment of disease outbreaks and undertake tracing.

These may be CAHWs or specialist teams at district or provincial level. The former have the advantage of being "on the spot" but must be sufficiently well trained to recognise the disease in atypical forms. CAHWs performing this type of work should be paid for it by government but in some places this is not established practice.

If only one CAHW per commune were paid a partial salary for public good work this would cost about \$1,000,000 per annum. One of the main benefits arising from payment of these CAHWs is early detection, which is likely to reduce the level of spread. However, there have been no accurate modelling studies done on the likely spread of virus in Asia if disease diagnosis is delayed, against early diagnosis. Such work would help to determine the break even point for additional investment in these staff.

Not all of this investment could be attributed to the control of avian influenza because the same skills would be applied to other diseases.

- Suitable items for collection of specimens and dispatch to laboratory.

A major requirement is appropriate swabs and transport medium and tubes for blood collection, or some way of transporting whole carcasses safely in a manner that prevents sample degradation.

- Competent laboratory staff working in properly equipped laboratories

These staff and laboratories should operate under standard operating procedures and participating in external quality assurance programs under conditions that do not endanger staff. In most cases, additional staff is required to perform the additional work arising from HPAI surveillance and diagnosis. In Thailand the diagnostic testing associated with each X-ray survey is reported to cost approximately \$1 million in laboratory costs alone.

Upgrading of laboratories is also necessary, and the costs depend on the state of existing laboratories. In Hong Kong, a new laboratory was required which cost approximately \$HK 47 million. Not all of this cost could be ascribed to avian influenza but without this facility it was not possible to conduct cultures and post mortem examinations on potentially infected poultry under appropriate conditions.

- An upgrade of the information system so that information can be input from the field and information from laboratories and the field is integrated.

Depending on the number of provinces and laboratories connected, this investment is estimated to be approximately US\$ 340,000 for Viet Nam, if information systems for laboratories in two thirds of the provinces are upgraded and linked.

- A system for conducting on-going surveillance

Even after eradication of the disease in a country, zone or compartment, surveillance must continue in order to monitor disease status. The duration of this surveillance depends on the disease risk within the region but both active and passive surveillance are required. One of the problems facing governments in upgrading their capabilities is that most of the costs are recurrent, which are usually not funded by international donors.

The reagent costs in Asia for each blood test is between \$US0.50 to 1.50. For virus isolation or real time PCR the cost is approximately \$10 to \$20. Calculations based on published government figures suggest that the recurrent costs of on-going surveillance and monitoring in Hong Kong farms and markets has added approximately \$US0.12 to the cost of each live bird sold (Health Welfare and Food Bureau Prevention of Avian Influenza 2004).

- A regional laboratory network

A regional approach of cooperation between laboratory networks is appropriate, although in practice has not always been fully implemented. Since HPAI is a transboundary disease that easily spreads from one country to another, regional cooperation is needed. The costs associated with this are not great apart from those associated with transport of samples across international borders, which can exceed \$US 1,000 per shipment if the material travels by air and is deemed to be an infectious substance. Potentially the use of one regional laboratory for groups of neighbouring countries can lead to economies of scale provided this is properly

resourced. In reality what has happened is that local laboratories link with international reference laboratories instead.

Stamping out and Compensation

The rapid destruction of infected birds and birds at risk is effective for control and local eradication of H5N1 HPAI provided it is done early and is accompanied by other measures such as movement controls, temporary market closures, proper investigation of cases and contact tracing. When stamping out is used, poultry on the infected premises and sometimes susceptible poultry in a zone around the infected premises are destroyed and disposed as quickly as possible. It is well recognised that delays in action in stamping out can potentiate spread of the disease and increase its cost. In addition, farms situated outside the defined radius that have been in contact with the infected premises through trade should be closely monitored for evidence of infection. Veterinary Authorities need to organise and establish stamping out teams with sufficient capacity to rapidly react to extensive numbers of outbreaks.

An appraisal of veterinary services in Viet Nam revealed that the staff resources required for this were not available at the central or regional level and that additional investment in veterinary and ancillary veterinary manpower was required to be able to form emergency management teams. In Viet Nam it is estimated to cost about US\$ 0.25 per bird to destroy and dispose of 200 chickens per farm. In Nigeria teams are organised on an ad hoc basis and the costs are estimated to reach about US\$ 1 per bird, if the team culls 1000 birds within a day.

Besides the costs for paying the culling team, disinfecting premises disposal of dead birds, the main costs arise from compensation payments to poultry keepers. Since the destruction of privately owned poultry is done by the state in order to achieve the public good of disease control farmers need to be compensated to some extent for the destruction of their assets. Compensation also helps to ensure the cooperation of poultry keepers and removes one of the disincentives for reporting of infected birds to veterinary officials. Early reporting and subsequent rapid reaction with stamping out measures limits the spread of the disease and therefore reduces the overall costs.

Therefore it is important to develop a compensation scheme before outbreaks of HPAI occur and ensure farmers are aware of the details of the compensation process in advance. In many countries funds for compensation have to be sought from the Treasury as an extraordinary expense. For example, in Hong Kong, the Finance committee had to approve new financial arrangements and funds for each outbreak (see, for example, FCR (97-98)87¹).

Often farmers are compensated partly for the loss of birds by paying a percentage of the market price. Losses due to production downtime are not normally considered and in some cases this has led to reluctance on the part of farmers to report disease. Compensation strategies have to be tailored to the differing conditions in each country. Finding the right level of compensation is a crucial issue. Financial support has to be sufficient to ensure cooperation of farmers, but not be overly generous so that farmers have no incentive to control disease, and must reflect the public financial resources available.

Governments are organising their compensation schemes and the rate of compensation differently. In Thailand compensation rates were 70 and 100 per cent of the market price of a bird. As of March 2004 farmers have been compensated for about 61 million heads of poultry (Dolberg 2005), resulting in the payment of US\$ 46.5 million to 407,338 farmers. During the HPAI outbreaks in early 2004 and 2005 in Viet Nam compensation rates differed between provinces. The effective cost share of the Vietnamese government was only about 20 to 30 per cent of the market value but even so, the cost was US\$ 18.5 million for 41.3 million birds (Riviere-Cinnamond 2005). In November 2005 it was decided by the Vietnamese government to raise the compensation rate to VND 15,000 (c. US\$ 1) per poultry culled. Had this been used from the commencement of the outbreak it would have resulted in compensation cost of nearly US\$ 40 million. Recently, costs of compensation have significantly decreased due to controlling of HPAI with vaccination and changes in stamping out strategies.

During the two months after the first outbreaks in Nigeria occurred in February 2006 about 440,000 birds have been destroyed. Assuming the disease follows the same course for the remaining year, compensation for 2.64 million birds will have to be paid in the first year. The Nigerian government has announced a compensation rate of US\$ 1.95 per culled chicken, which would result into a compensation bill of about US\$ 5.15 million for one year.

¹ <http://www.legco.gov.hk/yr97-98/english/fc/fc/papers/fc090187.htm>

Stamping out is generally used as an emergency measure for avian influenza with the goal of eradicating infection. The value of repeated stamping out as a primary control measure becomes questionable if this continues for an extended period of time and/or the agent becomes endemic.

Vaccination

Vaccination has been used to control HPAI in situations where the disease remained uncontrolled after use of other methods, or diagnosis was delayed resulting in widespread infection. In addition to this, exporting European countries such as France and the Netherlands have vaccinated parts of their poultry stock as a preventive measure. Vaccination reduces the number of susceptible poultry and the amount of circulating virus provided the program is properly applied using quality assured vaccines. Used alone, vaccination will not be successful in eradicating H5N1 HPAI viruses. However combined with other measures it can play a vital role in eradication, as has been demonstrated in Hong Kong.

Stamping out (coupled with other measures) has not eliminated H5N1 viruses from Viet Nam and it is unlikely that this will be feasible until such time as there is a major change in the way poultry are reared and marketed. Substantial investment in veterinary services down to the village/commune level is needed to eliminate the virus. Without vaccination, H5N1 viruses would probably continue to produce repeated waves of infection and significant high levels of mortality in poultry especially in the cooler months from November to March. HPAI would become similar to virulent Newcastle disease, which is recognised as a major cause of mortality in village and commercial poultry, and for which use of vaccines has been shown to make economic sense.

Vaccination against H5N1 HPAI will need to be used until such time as the risk of infection falls to a level that commercial farmers can rely on biosecurity to prevent entry of virus to their flocks. This point has not been reached in Viet Nam or in most Asian countries.

In Viet Nam, since September 2005, three rounds of vaccination for smallholder and village poultry have been conducted and the number of outbreaks and culled poultry decreased significantly. The precise contribution of vaccination to this reduction could not be determined due to implementation of a number of measures simultaneously but it has reduced the size of the susceptible population. The budget allocation for the vaccination program originally was US\$ 17.3 million for the planned vaccination of 160 million poultry (MARD 2005 and FAO 2006) over a two year period. By the end of January 246 million doses had been administered, at an approximate cost of \$10 million. This cost will reduce over time as the vaccination is targeted to high risk production sectors and areas based on surveillance data and epidemiological studies. Assuming this program is successful and leads to limited residual disease then this can be viewed as the minimum "cost" of endemic infection with H5N1 HPAI in Viet Nam.

In addition to the costs for vaccines and the logistical costs of injecting into birds, a vaccination campaign for HPAI also includes costs for pre and post vaccination surveillance. The cost of this for the first two initial years of the campaign in Viet Nam was estimated at US\$ 1.125 million. The majority of this cost is spent on laboratory tests for active surveillance to detect circulating viruses.

The post-vaccination surveillance performed in Viet Nam differs from that undertaken in Hong Kong or Europe where the program of control is at a different stage and all flocks are tested. In Hong Kong, which has an annual poultry turn over that is only a fraction of that in Viet Nam, the cost of this surveillance is already higher than that in Viet Nam. The costs involved in implementing such a post-vaccination surveillance program with a dispersed industry in countries like Viet Nam are prohibitive. However, consumers demanding 'influenza virus-free' produce will likely increase their demands for this type of surveillance on commercial farms in the future.

Nigeria is currently considering vaccination as an additional control measure. It is unlikely that a mass vaccination campaign as used in Viet Nam would be adopted in Nigeria due to the spatial dispersal of much of the scavenging poultry. It is estimated that 60% of the total 150 million poultry population is scavenging or backyard poultry. The highly industrialized and integrated poultry production systems represent 25% of the total poultry and about 15% is kept in semi-commercial sector III farms. Costs per dose delivered depend highly on the density of poultry within a region and its accessibility. The number of birds vaccinated can vary between 300, in rural areas with scavenging chicken, and 1000 per day and vaccination team. Costs range between US 14 cents and 38 cents, respectively. This would include a vaccine for 4 cents, allowances for two vaccinators, their transportation and protective clothing. In addition to this, costs for the post vaccination surveillance would arise. Investments in the cold chain for the appropriate storage of the vaccine are also necessary.

The cost per dose of vaccine delivered in Viet Nam differs significantly from those estimated for Nigeria. Due to the limited number of trained vaccinators available and the long distances between villages, relatively higher allowances would have to be paid to the vaccination team in Nigeria. Costs for a dose delivered to a chicken in Viet Nam are estimated at US 3.8 cents, assuming vaccine costs of 1.6 cents, a vaccinator team wage of 1.3 cents and other costs associated with vaccine delivery of 0.9 cents. The vaccines are imported from China for a relatively low price, which may not be possible for Nigeria. The vaccination team in Viet Nam is paid per bird vaccinated and therefore costs per dose delivered do not depend on the birds vaccinated per day. This might cause less motivation for vaccination teams in less densely poultry populated areas. Transportation and disinfectant costs have also to be covered by the per bird rate. It can be assumed that protective clothing and disinfectant have to be bought and delivered in addition to the daily allowance in order to ensure their availability.

Much of the cost of mass vaccination is borne by the government as the program is directed at smallholder and village-level poultry for public good purposes. However, large-scale farms are prepared to pay for vaccination, using this as an additional form of insurance on top of enhanced biosecurity.

It is also important to recognise that if HPAI were not a zoonotic disease with pandemic potential it is unlikely that mass vaccination involving village poultry would be implemented as a government funded project. This needs to be taken into account in performing any calculations on the costs and benefits of vaccination of poultry.

Biosecurity upgrading

The upgrading of biosecurity depends on the sector or production system. In addition the technical needs for upgrading a production system also highly depend on the definition of bio-secure production. In FAO production sectors sector I or II additional investments may only be marginal provided these farms are already meeting the required biosecurity standards. If additional investment is made in improved biosecurity it would be attributable to continued improvement of the system for competitive purposes, and not for HPAI control alone. The industrial integrated systems in sector I and the commercial poultry production in sector II operate with high levels of biosecurity in terms of avoiding exposure of poultry to wildlife. In reality many commercial farms in Asia and Africa still fall into production sector 3 in terms of biosecurity.

In contrast to this the village or backyard poultry production with scavenging chicken poses a high risk of infection. Confining these birds would require a twofold investment. Investments in material such as bamboo fences and the costs for this would highly depend on their natural availability. In addition to this confining scavenging chicken changes the production system. This implies the need for training in order to convince poultry keepers to change their way of poultry keeping and ensure the profitability of the system and this is not considered appropriate. Costs for the training would be faced by the government. In the case of Viet Nam with approximately 7 million smallholders the costs of providing training would be very high. Even providing training for 10% of these farms at an assumed per farm cost of 50\$ would result in US\$ 35 million. It is therefore not very realistic to assume that this production system will change rapidly. Smallholder commercial systems range from farms that could be upgraded relatively easy to sector II biosecurity and those with virtually no biosecurity. Costs of investment into upgrading the biosecurity are likely to be borne by the farmers. Assuming a minimum investment of US\$ 100 on average is sufficient (fence areas for grazing and build a small shelter), for a minimal enhancement of biosecurity, even this amount is unlikely to be found by most villagers rearing small flocks of poultry for commercial purposes.

Outbreaks of HPAI in Hong Kong led to a progressive tightening of biosecurity requirements for farms, with required conditions stipulated in farm licence conditions. This included wild bird proofing, construction of disinfectant baths and other measures. The cost of these varied from farm to farm but in a recent offer to farmers wanting to leave the industry, a sum of about \$US19,300 was provided to compensate for the improvements made by farmers (Hong Kong Government Finance Committee Paper 2005-06). Such an investment would be beyond most small scale farmers in Asia wanting to upgrade to the levels of biosecurity deemed necessary for modern industrial farms.

Conclusions

Disease control strategies have to be tailored to the conditions within each country. The relative proportion of costs for each control measure will change over time as the focus of disease control progresses from emergency response to control and finally eradication.

Surveillance is a key measure in controlling for HPAI and maintains its importance regardless of a country's disease control phase. Yet, apart from Hong Kong, which has established a zero tolerance for infection with

H5N1 HPAI, few places in Asia have invested sufficiently in active and passive reporting networks and therefore total costs of a complete and efficient surveillance measure are difficult to derive. Massive investment would be required in developing country veterinary services to ensure early diagnosis. The reporting time is critical to reduce the spread of the disease and therefore reduce the overall costs of HPAI. Incremental investment costs to reduce the reporting time are likely to be very profitable but a long term goal in many countries because of the need for change in regulations and behaviour as well as staff and facilities. High recurrent costs will arise from maintaining laboratories and paying for disease reporting down to the village level, so the sustainability of any project to enhance surveillance needs to be examined during the planning phase.

Stamping out is a widely used measure to combat HPAI. Since private assets are destroyed in order to achieve the public good of disease freedom compensation has to be paid. If the disease spread is out of control and stamping out does not work any more, costs for the destruction, disposal and compensation become very high. In this case (ring) vaccination is an option to limit the spread of the disease.

Mass vaccination in scavenging and backyard poultry is not likely to be economically viable or sustainable as a long term measure, and in African rural populations may be very difficult to implement even for a short time. The costs per dose delivered increase with decreasing density and accessibility of poultry. Vaccination costs of easily accessible dense poultry populations in commercial farming systems and around urban areas are relatively low. Commercial farmers could regard the vaccination of their flocks as insurance and would be ready to bear the costs, since they would face significant losses in case of an outbreak. Vaccination of scavenging chicken in villages might be done as a public health measure and the costs borne by the government.

It is tempting to perform a comparison between the annual cost of stamping out versus the cost of vaccination but such a comparison does not take account of the way these two measures are used or the dynamics of the disease. HPAI is a highly infectious virus that if allowed to remain unchecked will spread easily through poultry farms and markets. If stamping out fails, foci of infection remain and the virus will become endemic. Vaccination then becomes necessary to reduce the levels of infection in poultry to prevent adverse effects on poultry, and indirectly to provide some protection for humans. Proper use of vaccination will reduce the levels of expenditure on compensation by reducing the number of poultry being destroyed. However, it is not possible to do a direct comparison between the cost of vaccination and the cost of compensation. A more appropriate calculation (yet to be performed) would be to compare the costs and benefits associated with stamping out alone versus stamping out plus ring vaccination as first-line control strategies especially in developing countries with limited veterinary infrastructure. The former method has failed in all poor, densely populated countries for a number of reasons, including the reluctance of farmers to report disease and the dispersed nature of the poultry industry. Any such calculation on stamping out and ring vaccination should take into account the greater likelihood of disease reporting if farmers are offered vaccination for neighbouring flocks instead of culling in infected areas.

As the control of HPAI advances it is appropriate to invest in upgrading the biosecurity of poultry production and marketing systems. Costs for this are largely borne by the private sector.

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