Using Risk Analysis to Capture the Spatial Spread of Avian Influenza, Evaluating the Cost-Effectiveness of Alternative Control Strategies, and Assessing the Impact on the Poor

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Abstract
Avian influenza represents an emerging disease of key interest, with potential impacts extending from human morbidity and mortality to economic disaster for those involved in the poultry industry. A main concern is that the highly pathogenic virus may develop through a combination of mutation and reassortment into a strain transmissible by humans. Many evaluations to date have focused on prevention and eradication strategies in poultry populations, while little attention has been paid to understanding the impact of those measures on the livelihoods of poor households in Asia and other countries to which the disease may spread. A collaborative initiative was launched in May 2007 that includes assessing economic impacts at the local level to guide more fully informed control strategies. This initiative involves assessing risks considering the spatial spread of avian flu through various mechanisms, evaluating the cost-effectiveness of candidate mitigation measures, and assessing impacts on the poor. Interlinked modules have been defined to frame this joint evaluation across geographic regions and economic scales. This paper outlines the technical concepts of this new study and the role of integrated analyses.

1. Overview of Avian Influenza and Economic Impacts
Many human diseases have arisen from infections of domestic and wild animals. As the ecology of human/animal interactions enters a new phase of dynamic change globally, the risk of “new” diseases emerging that threaten human health and livelihoods is an immediate and growing concern. Avian influenza is one example. While strains avian influenza (AI) virus of low pathogenicity for chicken have been recorded regularly over the last century, recent occurrences of highly pathogenic AI (HPAI) in East and Southeast Asia, with subsequent extensions in distribution to Europe and Africa have caused tremendous concern worldwide.

The spread of HPAI, its actual impacts on agriculture, and its potential impacts on human health, put this disease at the forefront of global human safety and development policy dialogues. On the human side many developed countries are implementing pandemic preparedness with large funds going toward human flu vaccine development and stockpiling Tamiflu. On the poultry side most efforts have focused on implementing prevention and eradication measures in poultry populations. However, much less emphasis has been placed on understanding the effect of these mitigation strategies on the livelihoods of smallholder farmers and their families in affected countries or on measures aimed at controlling the transmission from wild migratory birds or by uncontrolled trade.

While there is a fear that the virus may develop into a strain capable of sustained human-to-human transmission, the greatest impacts to date have been on the highly diverse poultry industries in affected countries. Infections of wild and domestic bird populations by low-pathogenic strains of AI (LPAI) have been reported. They are typically carried by wild birds that do not manifest clinical signs, but result in mild illness in domestic birds (NAS, 2005). Wild birds also transmit HPAI, but unlike LPAI, the HPAI strain results directly in domestic bird deaths, as well as the intentional depopulation of poultry flocks, to prevent its spread.

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The H5N1 strain of HPAI is now endemic in parts of Southeast Asia, where Cambodia, Indonesia, Laos, Thailand, Indonesia, and Viet Nam are the most affected countries. The continuing outbreaks that began in late 2003 and early 2004 have been disastrous for the poultry industry in the region, with recent infections of HPAI resulting in the destruction of more than 140 million birds in Southeast Asia alone, with costs estimated to be in excess of US$10 billion. If a one-year pandemic were to occur, it could lead to global economic losses of about $800 billion (World Bank, 2007).

The World Bank, the Office International des Epizooties (OIE, or World Organization for Animal Health), and the Food and Agriculture Organization (FAO) have warned that the avian influenza epidemic could be transported to other countries by migratory birds, or through other vectors such as trade, informal movement of livestock commodities and other human-mediated transport mechanisms (FAO, 2006; OIE, 2007; World Bank, 2007).

2. Impacts at the Local Level

Poultry are an important component of the diverse livelihoods of many poor households in most developing countries. Further, poultry meat and eggs are good sources of bioavailable essential micro nutrients for the poor, children and women, and it is known that in general, small animal husbandry is positively associated with intake of animal source foods. Poultry are thus likely to provide an important contribution to the nutrition of vulnerable groups. A large number of households keep backyard flocks, with potential contacts with wild birds. Most such flocks scavenge for food, often entering households or sharing outdoor areas where children play creating multiple opportunities for human exposure. The economic and human losses faced by rural communities in the region could be devastating.

There is considerable uncertainty about the timing, extent, and severity of a potential outbreak, yet developing countries must make critical decisions about ways to defend against a potential outbreak of HPAI. If an outbreak occurs, decision makers must take action to eliminate the disease and prevent further spread. Such action will involve direct costs associated with the eradication effort, as well as indirect costs that accrue to poultry producers and infected people. The costs and control methods are likely to be different depending on the mechanisms for disease spread, i.e., whether disease spreads locally and/or over long distances.

Short-distance localized spread often involves contact with infected animals or human-mediated contacts, such as in wet-markets, while long-distance spread can be though migratory birds, the sale of inputs, or the illegal movement of birds such as fighting cocks. The costs associated with control are also likely to differ in the short run when disease is acute, from the long run when disease has become endemic. Furthermore, there are likely to be differential economic impacts on different income groups and sectors of the economy. The rural poor, whose livelihoods depend in larger part on poultry and who consume their own poultry, may disproportionately feel these costs.

3. Integrated Assessment and Communication Approach

The issues outlined above suggest a number of research questions that have not been adequately addressed and are of particular relevance to poor households in developing countries. These are beginning to be evaluated via a collaborative initiative launched in May 2007 by the International Food Policy Research Institute/International Livestock Research Institute (IFPRI/ILRI) and FAO/Royal Veterinary College (RVC)/Berkeley (IFPRI/ILRI, 2007). This initiative will use the risk analysis framework to capture the spatial spread of avian influenza through various spread mechanisms, evaluate the cost-effectiveness of alternative control strategies, and assess the impact on the poor.
The work is based on nine separate interlinking modules, which together emphasize the integration and communication of a wide variety of information needed to address this issue. These modules are:

**Module 1:** Description of systems and current disease situation  
**Module 2:** Risk assessment  
**Module 3:** Economic impacts of HPAI  
**Module 4:** Impact of HPAI on livelihoods and nutrition of the poor  
**Module 5:** Impact of HPAI on institutions  
**Module 6:** Cost/benefit and/or cost/effectiveness analysis  
**Module 7:** Management of institutions (pre-disease and post-disease) towards intersectoral strategies/integrated veterinary-medical strategies including conduct of a set of field experiments  
**Module 8:** Risk communication and development of decision support tools  
**Module 9:** Short-term capacity building through targeted training workshops

4. **Preliminary Findings**

This project is addressing both technical and administrative components of collaborative environmental health and economic research. A set of underlying hypotheses has been developed to frame the methodologies being outlined for the nine modules identified above. These analyses are being coordinated across two large geographic areas, by technical leads within two main organizations (IFPRI and FAO). Preliminary findings of geo-spatial analysis of data available from Vietnam indicate spatial clustering of HPAI outbreaks in lowland areas and in proximity of human population aggregations. Considerations for program implementation across the nine modules are expected to be available within the next several months. The progress achieved by this fledgling project will be reported in the conference presentation.

**Bibliography**