The impact of avian flu on livelihood outcomes in Africa: evidence from Ethiopia, Ghana, Kenya and Nigeria

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Abstract

In this paper we investigate the role of poultry in households' livelihood portfolios, and the livelihood impacts of supply and demand shocks that may be caused by avian flu outbreaks and scares. We focus on four sub-Saharan African countries that represent a spectrum of disease status and spread. By using nationally representative data and econometric methods, we profile the characteristics of households that are most likely to keep poultry and to be engaged in intensive poultry production, and estimate the ex-ante *livelihood impacts of avian flu shocks. The results are expected to aid in the design of targeted avian flu control policies.*

Keywords: avian flu; highly pathogenic avian influenza (HPAI); supply-and-demand shocks; livelihoods; **s**ub-Saharan Africa; Ethiopia; Ghana; Kenya; Nigeria

1. Introduction

Poverty is both a cause and a consequence of inability to cope with shocks. The poor are more vulnerable to shocks because of their assumed lack of diversification in their income and asset portfolios. In the low-income countries of sub-Saharan Africa (SSA), the vulnerability of the poor is of the utmost policy importance for policy targeting. Livestock play an important role in the livelihood portfolios of poor households (Livestock in Development 1999; FAO 2002). Shocks to the livestock sector, particularly to those livestock types kept by the poor, therefore should be of paramount importance to policymakers (Sonaiya *et al*. 1999).

In 2006, amid fears of a human pandemic, donors pledged substantial funding – US$1.9 billion – for the prevention and control of avian flu (highly pathogenic avian influenza [HPAI]) (World Bank 2006). Significant components of this fund were allocated to the strengthening of disease surveillance and control systems in developing countries, and controlling the spread of the disease, especially through the preservation of livelihoods. In this context, disease control and livelihood preservation are inextricably linked. The incentive to report an outbreak depends on its impact on livelihoods. Hence, a system of compensation is often built into control measures, such as culling of poultry after an avian flu outbreak.

Traditional policies, focusing solely on the supply shock effects, ignore the more nuanced elements of HPAI shocks. In this paper we emphasise that an HPAI shock needs to be treated both as a demand shock (due to consumer panic leading to a fall in the price/value of poultry and eggs) and a supply shock (from disease mortality for poultry). Demand shock is generally non-localised and can occur even without an outbreak, since it is a perception-based consumer response. Demand shock is also often discrete, and its impact may even far outweigh those of a supply shock.

Both the demand and supply side effects and transboundary nature of HPAI rationalise our focus on four countries in SSA. These are Ethiopia and Kenya in East Africa, and Nigeria and Ghana in West Africa. Ethiopia and Kenya have not yet experienced any outbreaks, but the virus has been circulating in neighbouring countries, e.g. Sudan, and it could enter these countries through various pathways, including illegal bird trade. Ghana and Nigeria have both experienced several outbreaks and are on the same bird flyways. The study countries thus represent a spectrum of HPAI status: Nigeria has experienced several outbreaks, although the disease did not reach endemic status (Henning *et al*. 2013), there have been three outbreaks in Ghana, while there have been no outbreaks in Kenya and Ethiopia, although both countries have experienced scares resulting in demand shocks (Alemu *et al*. 2008; Aning *et al*. 2008; Obi *et al*. 2008; Omiti & Okuthe 2008).

This paper contributes to the literature in different ways. Several studies have investigated the economy-wide, inter-sectoral or sector-wide impacts of HPAI in SSA (You & Diao 2007; Diao 2009; Diao *et al*. 2009; Schmitz & Roy 2009; Thomas *et al*. 2009; Thurlow 2010). However, studies that investigate the impact of HPAI on small-scale producers' livelihoods are scarce (Bush 2006; Kimani *et al*. 2006; UNDP 2006; Obayelu 2007; UNICEF/AED 2008). These studies are based mainly on rapid assessment techniques applied in selected states or regions. We argue that, although informative, these studies have significant limitations in assessing the impact of HPAI shocks on livelihood outcomes. These location-specific case studies can present a biased picture and do not generate policy prescriptions for resource allocation. The same critique applies to qualitative methods.

Starting from the assumption that poultry plays an important role in livelihood outcomes (for example income, wealth, food and nutrition security), we see merit in conducting a detailed investigation of the impact of HPAI on small-scale poultry producers' livelihoods by using rigorous quantitative methods. The evidence shows clearly that, in general, poultry production in these countries is very small in scale, with minimal or no biosecurity measures (Alemu *et al*. 2008; Aning *et al*. 2008; Obi *et al*. 2008; Omiti & Okuthe 2008). The assessment of the livelihood impacts of HPAI-induced supply-and-demand shocks is critical for the design of targeted and effective control and mitigation policies.

This paper aims to answer the following questions:

1. Who are the poultry keepers and where are they located? Do they have diversified income or asset portfolios?
2. What is the intensity of participation in poultry production and how does intensity vary by location?
3. What are the characteristics of poultry producers who are likely to bear the brunt of the disease?
4. What is the likely effect of the disease outbreaks and scares for/threats to livelihoods?

Our reliance on nationally representative data is vindicated ex post, with significant interregional disparities in households' income and asset portfolios. In addition, the datasets that we used allow looking at the whole income and asset portfolio, thereby providing a more accurate measure of the overall impact of HPAI, rather than looking only at its impact on poultry-related livelihood outcomes.

The results highlight some interesting and important policy implications. We find that, across the four countries studied, poultry-producing households have significantly diversified livelihood portfolios. Therefore any idiosyncratic shock would have only a limited effect, particularly if the livelihood activity affected by the shock contributes only in a minor way to the overall livelihood portfolio. More importantly, our results highlight the significance of the nature of the shock. An idiosyncratic shock to the small-scale poultry sector implies negligible covariance with other sectors. In the short to medium run, evidence from the countries studied here shows that an avian flu shock will not have a significant effect on livelihoods. This finding, however, does not imply that preserving livelihoods is not important in an avian flu-control strategy for SSA. As long as the poor are loss averse and effects on livelihoods are nonzero, small effects on livelihoods can translate into first-order effects on disease control.

The remainder of the paper is organised as follows. The next section introduces the data sources and presents the descriptive statistics. Section 3 reports the results of the analysis, and Section 4 concludes the paper with implications for HPAI prevention and control policies.

2. Data Sources and Descriptive Statistics

2.1 Data sources

This study relies on nationally representative data from each country. Such data enable us to investigate the regional or location-related variations (e.g. urban versus rural, or high HPAI risk versus low HPAI risk regions), and also provide information on the sources of income and livelihood strategies, as well as on the type and quantity of assets owned.

We use the Living Standards Measurement Study (LSMS) survey data for Nigeria (Nigerian Living Standard Survey [NLSS] 2004-2005) and Ghana (Ghana Living Standards Survey [GLSS] 2005-2006). The data used for Kenya come from the Kenya Integrated Household Budget Survey (KIHBS 2005-2006), whereas for Ethiopia we used the Household Income and Consumption ([HICE] 2004-2005) survey. Each one of these studies collected data on the number of poultry kept by the sampled households in the study year and, in the case of Kenya, Nigeria and Ghana, on the number of poultry sold and prices received. For Ethiopia we relied on monthly producer price data collected for 2004 and 2005 by the Central Statistical Authority to derive the value of poultry owned by the households.

2.2 Descriptive statistics

Table 1 reveals that, across the four countries studied, 30 to 43% of all households engaged in small-scale poultry production. In Ghana, Nigeria and Kenya, greater proportions of rural households keep poultry, whereas in Ethiopia, poultry is popular among both urban and rural households. Among the four countries, households in Nigeria held the largest flocks, with 17 birds, while the smallest were in Ethiopia, with five birds.

Table 1: Poultry-producing households, average flock size and share in total income

	All households	**Rural households**	**Urban households**
ETHIOPIA			
% households that keep poultry	41.94	41.40	43.42
Average flock size of poultry keepers	4.82 (7.43)	4.81 (8.08)	4.83 (5.35)
KENYA			
% households that keep poultry***	43	54	15
Average flock size of poultry keepers	14.57 (25.76)	14.30 (23.79)	16.38 (36.56)
% poultry income in total income for poultry keepers	2.22 (11.06)	2.29 (11.07)	1.75 (10.97)
GHANA			
% households that keep poultry*	34.6	51.43	11.03
Average flock size of poultry keepers***	13.74 (15.48)	13.77 (14.31)	13.54 (21.70)
% poultry income in total income for poultry keepers	4.16 (9.67)	4.40 (9.99)	2.00 (5.38)
NIGERIA			
% households that keep poultry*	29.70	37.20	6.33
Average flock size of poultry keepers	16.94 (25.44)	16.92 (25.06)	17.26 (31.55)
% poultry income in total income for poultry keepers	5.61 (17.23)	5.63 (17.26)	5.08 (16.72)

Note: *Significantly different between urban and rural households, * at 10% and *** at 1% significance levels
Source: Authors' calculations from HICE (2004-2005), KIHBS (2005-2006), GLSS (2005-2006) and NLSS (2004-2005).

Total annual household income includes salaries, income from livestock and crop sales, remittances, rent, and other reported income. On average, poultry and egg sales contribute 4.1% to the total annual household income in Ghana, whereas this figure is only 2.1% in Kenya but as high as 5.61% in Nigeria. In Ethiopia, HICE data did not include information on the number of live birds and eggs sold by the households; therefore we could not calculate the share of income from poultry in total income for this country.

Figure 1 presents the share of poultry income in total income and the number of birds kept across income quintiles. Nigeria, Kenya and Ghana revealed an overall increasing trend for flock size and a decreasing trend for the share of income from poultry across income quintiles. In Ethiopia, however, the average flock size was similar across income quintiles.

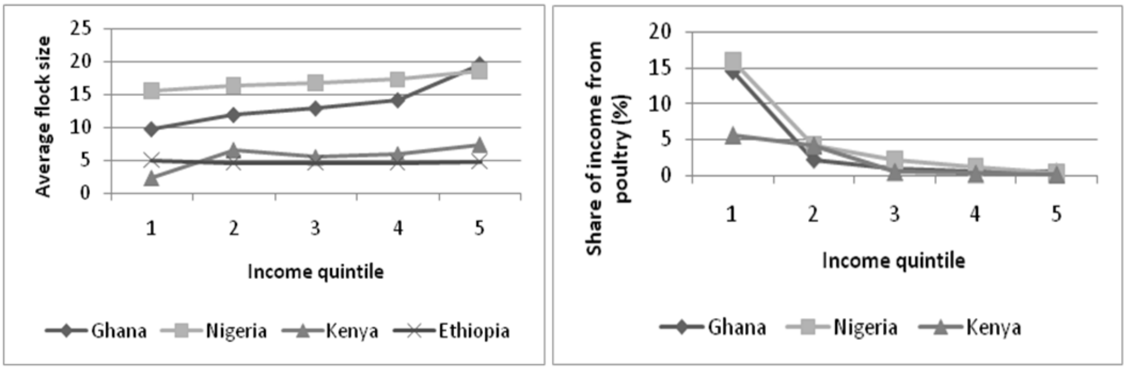

Figure 1: Average flock size (left) and share of income from poultry (right), by income quintile

Source: Authors' calculations from HICE (2004-2005), KIHBS (2005-2006), GLSS (2005-2006) and NLSS (2004-2005).

3. Results

3.1 Role of poultry in household livelihoods

3.1.1 Estimating the determinants of participation in poultry production

To understand the impact of HPAI on livelihoods, we first estimated country-specific probit models to identify household-level and regional factors that affect household decisions on whether or not to partake in poultry production. Each one of the probit models is highly significant according to the likelihood ratio test, and they perform well by assigning 67% (Ethiopia), 72% (Ghana), 75% (Kenya) and 85% (Nigeria) of predictions into the correct category.

Subsequently we used these probit models to predict each household's likelihood of being a poultry keeper. Household, farm and location characteristics of predicted poultry keepers were compared with those of predicted non-keepers and the results are reported in Table 2.

Table 2 reveals that, in all four countries, predicted poultry keepers have larger households and a higher proportion of adult women and of children. Previous studies showed that, in SSA, women and children tend to be involved in the rearing and selling of poultry (Aklilu *et al*. 2008; Sonaiya 2007). Children's schooling costs are often financed from poultry income (Hailemariam *et al*. 2006), and women are important stakeholders in village-level poultry in Africa, owning more than 70% of it (Alders 1996; Gueye 1998, 2000). Across these countries, households with less-educated heads are significantly more likely to keep poultry, mainly because household-level poultry is a low-input, low-output activity not requiring high levels of skill and education (Alemu *et al*. 2008; Aning *et al*. 2008; Obi *et al*. 2008; Omiti & Okuthe 2008).

Table 2: Characteristics of households predicted to be poultry keepers

Household, farm and regional characteristics	Ethiopia	Kenya	Ghana	Nigeria
Larger households	✓	✓	✓	✓
More adult women in the household	✓	✓	✓	✓
More children in the household	✓	✓	✓	✓
Less-educated household heads	✓	✓	✓	✓
More income sources	✓	✓	✓	✓
Other livestock production (small)	✓	✓	✓	✓
Other livestock production (large)	✓	✓	✓	✓
Crop production	✓	✓	✓	✓
Less off-farm employment/income	✓	✓	✓	✓
Lower income per capita	✓	✓	✓	✓
Income below extreme poverty line	ns*	✓	ns	X
Higher livestock wealth	✓	✓	ns	✓
Higher overall wealth (house, land, livestock)	na*	✓	ns	✓
Rural location	✓	✓	✓	✓

Source: Summary results of authors' estimations from HICE (2004-2005), KIHBS (2005-2006), GLSS (2005-2006) and NLSS (2004-2005).
*Note: ns = not significant; na = not applicable.

Most importantly, in all four countries studied, predicted poultry keepers had a higher number of income sources. Since poultry comprises a small proportion of household income, this is expected. Across all countries, predicted poultry keepers were also more likely to keep other livestock and produce crops. Previous studies found that poultry production is often complementary to crop production, since farm manure and cropland area are inputs to poultry production by providing feed and area for scavenging and roaming (Wadsworth 1991). Households that own other livestock are also more likely to be engaged in poultry, which is considered a first step in the livestock ownership ladder (Gueye 2000; Aklilu *et al*. 2008). With diversified income sources, livelihood outcomes are likely to be resilient against shocks and stresses that may be caused by HPAI outbreaks and scares (Ellis 2000). In all countries except Ghana, households that had higher livestock wealth (market value of livestock owned) were more likely to keep poultry.

To identify regional variations within the study countries, we used the probit models to calculate the percentage of households that were predicted to keep poultry in rural and urban areas, as well as in the different regions/districts of the countries. In Nigeria, 23% of all, 32% of rural and 4% of urban households were predicted to be poultry keepers. Across geopolitical zones, a greater majority of households located in the northern zones (45% in the North West, 36% in the North East and 28% in the North Central zones) were predicted to keep poultry. Among the southern zones, South East hosted the highest proportion of predicted poultry keepers, with 29%. According to the HPAI risk spread map developed by Stevens *et al*. (2009), the high HPAI risk areas mainly cover the South East zone, while the North Central, North East and North West zones are mid-level HPAI risk areas.

In Ghana, one-fifth of all Ghanaian households, 37% of rural and 4.9% of urban households were predicted to be poultry keepers. Greater proportions of households located in the Upper East (80%), Upper West (56%), Northern (55%) and Volta (42%) regions were predicted to be poultry keepers. These four regions all fall under the high HPAI risk areas identified by Stevens *et al*. (2009).

In Kenya, 34% of all, 53% of rural and only 3% of urban households were predicted to be poultry keepers. Across regions, 25% of households in Eastern Province, followed by Nyanza (22%), Western (19%) and Rift Valley (17%), were predicted to be poultry keepers. In Kenya, high HPAI risk areas include districts in Western and Nyanza provinces, whereas the Coast and Rift Valley provinces are designated as mid-level HPAI risk areas (Stevens *et al*. 2009).

In Ethiopia, 60% of all households are predicted to keep poultry. This figure is 66% in rural areas and 53% in urban areas. With 87%, Tigray supports the highest proportion of households predicted to keep poultry, followed by Afar (86%), Benishangul Gumuz (71%) and Somale (65%). High HPAI risk areas include Tigray and Benishangul Gumuz, whereas Somale is designated as a mid-level HPAI risk area (Stevens *et al*. 2009).

3.1.2 Estimating the determinants of poultry flock size

This subsection profiles poultry keepers who keep larger flocks, since they are likely to suffer more as a result of HPAI shocks. Following the results of over-dispersion (Cameron & Trivedi 1990), Vuong (1989) and likelihood ratio tests, the zero inflated negative binomial (ZINB) model was found to be the most appropriate model to describe the determinants of the size of flock managed by the households. In the logit component of the ZINB model (inflate panel), only the significant explanatory variables in the estimated logit models are used to determine the households' likelihood of being a "certain zero" – that is, not keeping poultry. In the second component of the ZINB model, household, farm and regional factors that affect the flock size were estimated.

Based on the probabilistic ZINB model, an average predicted poultry-keeper household in Nigeria is predicted to keep five birds in a year, with six in Kenya, two birds in Ethiopia, and as high as 11 birds in Ghana. The predicted and actual flock sizes are reported in Table 3. For each one of the countries, Theil's inequality coefficient is closer to zero, revealing that each of the models explains the actual data well.

Table 3: Actual and predicted average flock sizes and Theil's U for all households

	Actual average flock size Mean (standard deviation)	Predicted average flock size Mean (standard deviation)	Theil's U
Ethiopia	2.22 (5.87)	2.23 (2.05)	0.29
Kenya	5.77 (17.70)	5.72 (5.04)	0.212
Ghana	11.54 (15.05)	10.71 (2.7)	0.12
Nigeria	5.03 (15.88)	4.95 (6.42)	0.14

Source: Authors' estimations from HICE (2004-2005), KIHBS (2005-2006), GLSS (2005-2006) and NLSS (2004-2005).

Table 4 presents the characteristics of households predicted to keep above-average-sized flocks. These households are larger and have a higher proportion of women and children. In Ethiopia and Nigeria, more educated households were less likely to keep larger flocks, whereas the opposite was true for Kenya and Ghana. Across all countries, households with more income sources were more likely to keep larger flocks.

The evidence, however, is mixed with regard to the income level and poverty status of the "larger" small-scale producers. In Ghana and Nigeria, those households that have lower income per capita and those that are below the extreme poverty line are more likely to keep above-average-sized flocks. Households with higher livestock wealth (across all four countries) and other wealth such as land (across all countries except Ethiopia, where data on wealth were not available) were more likely to keep above-average flocks. Even though poorer households may be more likely to keep "larger" flocks in Ghana and Nigeria, these households have greater wealth, possibly enabling them to hedge against the HPAI shocks and stresses.

Table 4: Characteristics of households predicted to keep above-average-sized flocks

Household, farm and regional characteristics	Ethiopia	Kenya	Ghana	Nigeria
Larger households	✓	✓	✓	✓
More adult women in the household	x	✓	✓	✓
More children in the household	✓	✓	✓	✓
Less-educated household heads	✓	x	x	✓
More income sources	✓	✓	✓	✓
Other livestock production (small)	✓	✓	✓	✓
Other livestock production (large)	✓	✓	ns	✓
Crop production	✓	✓	✓	✓
Less off-farm employment/income	✓	✓	✓	✓
More income per capita	ns*	ns	x	x
Income below extreme poverty line	ns	ns	✓	✓
Higher livestock wealth	✓	✓	✓	✓
Higher overall wealth (houses, land, livestock)	na*	✓	✓	✓
Rural location	✓	✓	✓	✓

*Note: NS = not significant; NA = not applicable
Source: Summary results of authors' estimations from HICE (2004-2005), KIHBS (2005-2006), GLSS (2005-2006) and NLSS (2004-2005).

In all countries, households with higher numbers of birds live in high to medium HPAI risk areas, as defined by Stevens *et al*. (2009). In Nigeria, keepers of larger flocks are located in the North West and North Central zones, with about eight birds, followed by the South East and North East zones, with about seven birds. In Ghana, households in the Western region keep the largest flocks, with about 13 birds, followed by Volta and Ashanti with 12 birds, and the Central and Eastern regions with an average of 11 birds. In Kenya, households predicted to manage the largest flocks are located in the Nyanza, Coast and Western provinces (with around seven birds each). Finally, in Ethiopia, households in Tigray, Somale and Afar provinces are predicted to keep the largest flocks – approximately three birds.

3.2 Impact of HPAI on livelihoods of poultry-producing households

This study investigated the livelihood impacts of HPAI supply-and-demand shocks on two livelihood indicators – namely livestock income (that is, income from the sales of livestock) and livestock wealth (that is, market value of livestock owned). We focused on these livestock-specific indicators, rather than total income and total wealth, because of the relatively small contribution of poultry to these, as explained in Section 2.2 above. We used an *ex-ante* evaluation method, as proposed by Ichimura and Taber (2000) and Todd and Wolpin (2006), to estimate this impact. This method involves matching households in treatment and control groups by using propensity score matching. Treatment groups, defined as "households who have been exposed to the HPAI outbreaks and scares", represent the result of the HPAI-induced supply-and-demand shocks, whereas the control group comprises households not affected by HPAI, representing the status quo (if no HPAI shocks occurred).

The basic idea in matching is to find a large group of non-treated households (control group) that are similar to the treated households (treatment group) in all relevant pre-treatment characteristics. That being done, differences in outcomes of this well-selected control group and of the treated group can be attributed to the treatment or shock, which in this case is HPAI outbreaks or scares.

We simulated six counterfactual scenarios, which considered the livelihood impacts of both demand (Scenario 4) and supply shocks (all other scenarios), as well as the impact of the supply shocks on poultry keepers of different scales. The duration of the livelihood impacts of these shocks were assumed to be one year. This is because the variables used to derive the impacts of these shocks were all annual data collected through the nationally representative survey instruments.

It is possible that the impacts of the shocks were shorter or longer than the one year. In the case of a supply shock (such as culling), farmers are generally allowed to restock in about three months. Farmers who could afford to and/or who were still interested in being poultry producers could restock as soon as they were allowed to, whereas some could take longer. The duration of the recovery from shock would depend on the initial flock size, and the impact of the supply shock on it. The duration of the shocks would also depend on the compensation provided. Similarly, the impact of the demand shock could also vary. In Nigeria, for example, poultry prices had not recovered to their pre-shock levels four months after the outbreak (UNDP 2006).

Scenario 1 assumes a countrywide shock in which all poultry-producing households in the study country experience a total loss (that is, a 100% loss). In this scenario, the outcomes of households with poultry are compared to those without poultry.

To estimate the impact of avian flu on producers of different scales, we divided the producers into two groups, with “smaller” small-scale producers having one bird to the 25th percentile number of birds, and more intensive, “larger” small-scale producers having more than the 25th percentile number of birds, but fewer than 500 birds, where 500 is the cut-off point for small-scale household poultry (see Alemu *et al*. 2008; Aning *et al*. 2008; Obi *et al*. 2008; Omiti & Okuthe 2008). In Scenario 2, only households with “smaller” small-scale flocks are assumed to be affected and they lose all of their flocks. On the other hand, Scenario 3 assumes “larger” small-scale producers to be adversely affected, and they lose some of their birds (75 to 85%, depending on the country) and are left with a flock size similar to “smaller” small-scale producers.

Scenario 4 assesses the impact of a demand shock that is assumed to be countrywide. We looked at the impact of a price shock on the livelihood outcomes of those poultry producers who sell. Of those households that sell, we compared households getting higher prices (above the median) with those that get lower (below-median) prices, for each country.

Scenarios 5 and 6 use the disease spread map developed by Stevens *et al*. (2009), presenting the likelihood of the spread of HPAI in each country conditional on disease being introduced. In Scenario 5, households in high-risk areas are assumed to be affected and to lose 100% of their birds. Finally, in Scenario 6, only “larger” small-scale producers in medium-risk areas are adversely affected, and they lose some of their birds (75 to 85%, depending on the country), leaving them with a flock size similar to “smaller” small-scale producers. These scenarios are summarised in Table 5.

In implementing the matching estimator, the groups were matched based on household characteristics expected to affect propensity to be in the treatment, as well as the livelihood outcomes (livestock income and livestock wealth). According to this method, the two groups should differ only in poultry ownership characteristics. The results of this analysis are presented in Table 6.

Table 5: Description of HPAI scenarios for poultry keeping at the household level

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5*	Scenario 6*
Description of simulated impact	100% loss of poultry flock	100% loss of small-scale poultry flocks	75 to 85% loss in large-scale poultry flock	50% reduction in poultry price	100% loss of poultry flock in high-risk areas	75 to 85% loss in large-scale poultry flock in medium- risk areas
Treatment group	All households without poultry	All households without poultry	Small-scale poultry keepers (1 to *x* birds)	Poultry keepers who sold at low prices	All households without poultry	Small-scale poultry keepers (1 to *x* birds)
Control group	All households with poultry	Small-scale poultry keepers (1 to *x*[†] birds)	Large-scale poultry keepers (*x* to 500 birds)	Poultry keepers who sold at high prices	All households with poultry	Large-scale poultry keepers (*x* to 500 birds)

*For Scenarios 5 and 6, country-level disease spread maps (Stevens *et al*. 2009) were used to allocate locations (districts, provinces or zones) into high HPAI spread risk and medium HPAI spread risk areas.
[†] The 25th percentile number of birds in each study country.

Table 6: Estimated impact of HPAI on the livelihood outcomes

	Ethiopia	Kenya		Ghana		Nigeria	
Scenarios	**Livestock wealth, %**	**Livestock income (total income), %**	**Livestock wealth (total wealth), %**	**Livestock income (total income), %**	**Livestock wealth (total wealth), %**	**Livestock income (total income), %**	**Livestock wealth (total wealth), %**
1. All countries: lose all poultry	—	—	—	17 (0.8)	—	—	—
2. All countries: lose all small flocks	—	—	—	—	—	—	—
3. All countries: large flocks become small flocks	51	28 (7)	31 (6)	—	23 (12)	42 (7.4)	—
4. Poultry sellers: high price falls to low price	—	—	—	—	—	—	—
5. High HPAI risk: lose all poultry	—	67 (8)	46 (4)	22 (1.6)	—	—	—
6. Medium HPAI risk: large flocks become small flocks	31	—	41 (9)	30 (0.5)	31 (16)	39 (8)	21 (15)

Source: Summary results of authors' estimations from HICE (2004-2005), KIHBS (2005-2006), GLSS (2005-2006) and NLSS (2004-2005).

In Scenarios 2 and 4, the *average* treated household would not experience any losses. Similarly, Scenario 1 results in only one significant outcome across study countries. It is likely that, within the group of treated households, some may experience losses. To capture this heterogeneity, we considered "larger" small-scale producers in Scenarios 3 and 6 and found that, across all countries, supply shocks in both of these scenarios result in significant effects on the livelihood outcomes of these "larger" small-scale poultry producers. Consideration of "larger" smaller-scale producers enabled us to understand that, on average, their losses are significant compared with the consideration of all producers as a homogenous group, as in Scenario1.

In Scenario 3, if an average poultry-producing household that manages a "larger" small-scale flock loses 75 to 85% (depending on the country) of its flock, its livestock wealth would decrease by almost a quarter in Ghana, by a third in Kenya and by half in Ethiopia. This scenario also affects livestock income, reducing it by almost a third in Kenya and by over two-fifths in Nigeria.

According to Scenario 6, total livestock wealth would decrease by one-fifth in Nigeria, by a third in Ethiopia and Ghana, and by over two-fifths in Kenya. The impact of this scenario is significant in Ghana and Nigeria, where these producers may be losing around a third of their livestock income as a result of this shock.

Finally, in Scenario 5, significant impacts on livelihoods are found only in the case of Kenyan and Ghanaian households. In Kenya, in the high HPAI risk areas, households would lose over two-thirds of their annual income from livestock and almost half of their total livestock wealth. In Ghana, this scenario would amount to a reduction in livestock incomes by about one-fifth.

4. Conclusions and Policy Implications

The *ex-ante* assessment of livelihood impacts of avian flu in the four African countries studied reveals that households across these countries that are more likely to keep poultry and to keep above-average-sized flocks have similar profiles. They have higher values of livestock wealth and other assets (for example land), as well as more diversified livelihoods strategies, in terms of numbers of income sources and participation in other agricultural activities (crop and other livestock production). Thus, these households could be resilient against HPAI-related supply-and-demand shocks.

We used the propensity score-matching method to assess the impacts of disease shocks on the livelihood outcomes (livestock income and wealth) of poultry-producing households. Our results reveal that, across all four study countries, households with “larger” small-scale flocks, and especially those located in high and medium HPAI risk areas, are most vulnerable to HPAI-related shocks.

Given the magnitude of loss in assets and income for the poultry-producing households with “larger” small-scale flocks, and the important role of poultry in the sustainability of future livelihoods, targeted intervention measures should be in place to encourage the adoption of HPAI-mitigation measures. Households with “larger” small-scale flocks, especially those located in medium- and high-risk areas, should be given special focus when designing preventive, training and compensation programmes.

Policy measures to support capacity building and to create incentives for investment in poultry production, especially in biosecurity, are of fundamental importance for the strengthening of the small-scale poultry sector against shocks such as HPAI. Training and education in biosecurity and better poultry production are of paramount importance for disease risk reduction, and are likely to result in high returns.

Finally, our results have implications for other shocks to livelihood, whether through livestock diseases or in general. Our study revealed that a greater proportion of poultry keepers are in rural areas, have diversified agricultural livelihood strategies (including crop and other livestock production), and have associated wealth (land and other livestock). Therefore, an idiosyncratic shock that affects only one of the many agricultural livelihood strategies they may practice (in this case, poultry production) and/or one of the several livelihoods assets they may own (for example, poultry flock) should not have as significant an effect on the overall livelihood outcomes, compared with covariant shocks (such as droughts), which may affect several of the livelihood strategies and assets at once. The framework and data presented in this paper would be suitable for the analysis of idiosyncratic shocks (such as livestock or crop diseases); however, more dynamic frameworks and analyses are required to study the impact of covariant shocks on household-level livelihood outcomes.

Acknowledgments

We are grateful to Maximo Torero, Pippa Chevenix Trench and the editor of the IFPRI Discussion Paper Series, for their valuable comments and suggestions. This research is part of the Pro-poor Highly Pathogenic Avian Influenza (HPAI) Control Strategies research project (www.hpai-research.net), funded by the UK Department for International Development (DfID).

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