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Potential Impact of HPAI on Ghana: A Multi-Market Model Analysis

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Key Findings

- Although income from poultry production is affected significantly by supply and demand shocks, effects on household income are limited due to the low share of poultry in households' total income.
- Poultry-related supply and demand shocks can result in income effects beyond poultry production through changes in incomes from maize and other food crops, and from labor involved in the poultry supply chain.
- With the high poultry imports to Ghana, supply and demand shocks on the domestic poultry sector are significant if the imports will be non-substitutes to the domestic poultry.

Like in most African countries, the livestock sector is an important part of the economy in Ghana. At an aggregate level it contributes to about 7 percent of Ghana's GDP and more than 40 percent to the agricultural GDP (Aning et al. 2008). Within the livestock sector, poultry comprising chicken, ducks, guinea fowls, turkeys, and ostrich constitutes an integral part of the rural farming system. Though Ghana has some commercial and semi commercial large farms, most poultry production – an estimated 60 to 80 percent – takes place at a smaller scale, where chickens are free range with minimal use of purchased inputs.

Ghana also imports poultry. Poultry meat imports, particularly chicken, have increased more than four times between 2000 and 2005, and they account for around 75 percent of total consumption (Aning et al. 2008).

This structure of the sector provides a situation where both the poultry sector including the linked sectors as well as livelihoods are likely to be affected if any shock were to occur to the poultry sector in Ghana. The comparatively large producers might be more affected since the income portfolio is less diverse compared to smallholder farmers in the traditional mode of production but this could vary in different contexts.

One of the most formidable shocks that can affect the poultry sector is an outbreak of highly pathogenic avian flu (HPAI), which has had wide ranging effects on poultry and sectors related to it (see for example Oktaviani 2008). In May 2007, Ghana became the eighth African country to confirm HPAI H5N1 outbreaks in poultry.

After the initial outbreaks were detected mid-April 2007 on a farm near Tema, two more sites were identified, in Sunyani in May 2007 and in the Volta region (city of Aflao) in June 2007 (USAID 2006). Though there have been no outbreaks since then, the occurrence in the past puts Ghana at higher risk of another outbreak. Risk assessment studies also indicate that the threat remains high.

The Poultry Sector in Ghana

Poultry production is an important rural household livelihoods activity in Ghana. More than half of all rural households keep small-scale flocks, ranging in size from 1 to 500 birds. Table 1 shows the regional breakdown of chicken production in Ghana. The Forest zone, as the most important agricultural production area in Ghana, is the biggest contributor to national chicken production from smallholders.

Table 1. Agriculture and chicken production by zones

	Share of chicken production relative to total agricultural production	Share of national chicken production (smallholder)	Share of national chicken production (total)	Share of total agricultural production
Greater Accra	7.7%	0.3 %	36.6 %	10.9%
Coast		11.3%	6.8%	
Forest	2.2%	37.7%	28.0%	41.4%
S. Savannah	0.5%	9.9%	5.5%	27.3%
N. Savannah	2.1%	40.8%	23.2%	20.4%
National	2.3 %	100.0 %	100.0 %	100.0 %

Source: GSS (2008), Aning et al. (2008), Diao (2009)

Although rural poultry are kept all over the country, poultry production is concentrated in the three northern regions of Ghana (LPIU 2006) where poverty is endemic (Aning et al 2008). Further, while the chicken industry is a relatively small sector in the overall economy, its importance varies at the sub-national level. Chicken production is relatively more important in the Coast zone, accounting for 7.7 percent of zonal agricultural production. On the other hand, chicken accounts for only 0.5 percent of South Savannah agriculture and 2.1 percent of North Savanna agriculture. While share of chicken in agricultural production within zones is the highest in Coast zone, in terms of national chicken production, the Northern Savannah region is most important (based on the Ghana Living Standards Survey [GLSS] V data). However, the GLSS V data include only smallholder and semi-commercial producers; accounting for commercial and modern poultry producers increases the share of Greater Accra region significantly.

With this background, this paper assesses the potential impact of an HPAI outbreak on Ghana using a spatially disaggregated multi-market model. Together, the spatial differences in the importance of poultry in the economy and the risk of introduction and spread of disease in Ghana imply that a spatially disaggregated model such as the one applied here is appropriate to address the issue of the impact of any shock to the poultry sector.

Brief Model Description and Relevant Base Data

In this model the effect of an avian flu outbreak in Ghana is treated as a combination of a demand and a supply shock to the poultry sector. The focus is on the effect to the poultry sector and maize, which is closely linked to poultry in its use as feed. The ultimate focus is on impact at the household level. To this end, a spatially disaggregated multi-market model (MMM) for Ghana is linked with GLSS V household data. Households were categorized into 1 of 10 deciles based on a welfare measure and then grouped into three categories: Very poor (deciles 1 and 2); poor (decile 3); and rich (deciles 4-10).[1] Within each of the three categories, households are further stratified as rural or urban, making a total of six household types. In the MMM, these are analyzed in each of Ghana's five regions (Northern Savannah, Southern Savannah, Forest, Coastal, and Accra). [2]

In addition to poultry, the model contains five of Ghana's six most important product groups: maize, millet/sorghum, rice, roots, and tubers (the sixth, cocoa, is not included). Due to data limitations, fertilizer, water and tractor usage are not incorporated, and labor supply and allocation to each of the production activities is assumed to be fixed (see Stifel and Randrianariosa 2006).

Five sets of equations summarize the model relating to prices, supply, consumption, income, and market equilibrium.

1) The price equations relate to the world market price, border price, and consumer and producer price, via the specific margins between them.
2) The supply block represents the domestic production of food crops and of poultry.
3) The consumption block represents household demand for food consumption.
4) The income equations describe household income as the sum of income derived from agricultural production and exogenous non-agricultural income.
5) The equilibrium conditions block contains equations equating domestic supply and net imports to demand for each of the six product categories.[3]

Shocks in the Model for Simulations

As discussed above, an HPAI outbreak in Ghana would result in demand and supply shock to the poultry sector. From an economic standpoint, a demand shock resulting in preferences away from poultry could assume a more significant role than supply shocks (e.g., bird mortality or culling); indeed, this has been the case in several countries (including in Ghana) experiencing only a scare or a localized outbreak. Thus, two simulations were developed combining demand and a supply shock, with the magnitude of supply shock kept lower (Table 2).

[1] The poverty line in the GLSS data is defined from a special welfare measure. This is a consumption-based measure of total expenditure over a 12 month period, which has been weighted for inflation by a poverty price index based on January 1999 prices.

[2] Because Accra does not have rural households, the total number of household types considered in the model is 27, rather than 30.

[3] The demand, supply, and income elasticities used in the model come from Al-Hassan and Diao (2007).

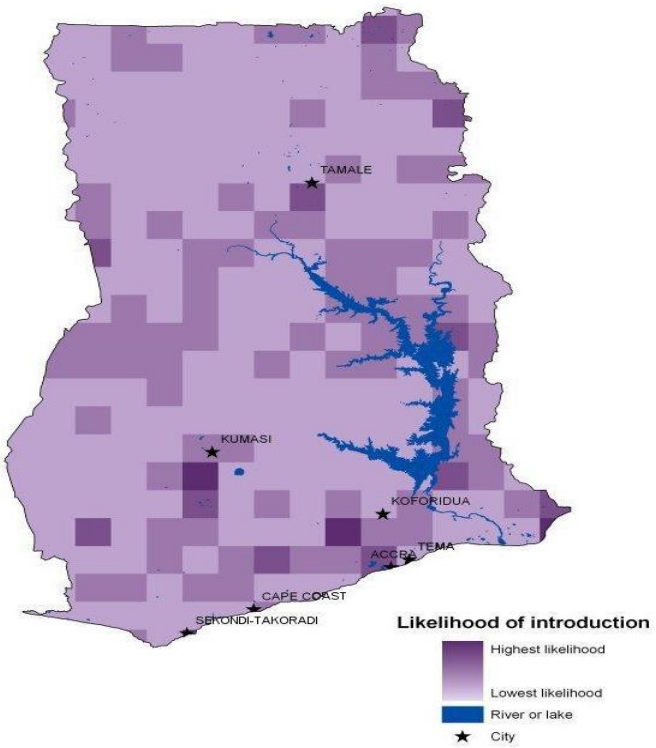
Table 2. Description of the shocks

	Production Shock (PS)	Consumption Shock (CS)
Simulation 1	0%	25%
Simulation 2	10%	40%

Disease risk maps for Ghana (Stevens et al. 2009) were used to identify the high, medium, and low risk areas in the model (Figure 1) (Coastal and Accra were identified as high risk areas, Forest and Southern Savannah were identified as medium risk areas, and Northern Savannah was identified as a low risk area).[4] Using that map, the three simulations were applied to assess the impacts under the following three scenarios: (i) when simulations 1 or 2 affect only the high risk areas (HA); (ii) when simulations 1 or 2 affect high and medium risk areas and (HMA); and (iii) when the entire country is affected by these shocks (i.e. high, medium, and low risk areas are affected) (HMLA). In all the three cases, the demand shock is applied as a national shock given that the shift in preference away from poultry following an HPAI outbreak has almost always transcended the source region.

In addition, two different scenarios have been analyzed: one in which imports are frozen, and the other in which imports are allowed to adjust following a shock. Together with assumed zero elasticity of supply of maize, frozen imports constitute a short-term scenario while the scenario in which imports and maize supply adjust constitute a long-term scenario.[5]

Figure 1. Avian flu disease risk map of Ghana



[4] Any particular region is taken as high, medium or low risk if more than 50 percent of the districts in the region are of a particular risk category.

[5] Imports being frozen is not particularly indicative of short-term in terms reduction in exports that usually happens quickly. In the event of a HPAI outbreak increasing imports could, however, take time as there might be requirements to establish disease-free status, and more clearances might be needed.

Results from Simulation

Results presented here are of the shocks to the poultry and maize sectors. The results of the simulations consider a feed conversion ratio of 2.5 (obtained from Ghana Poultry Association).[6]

Table 3. Effect of the different shocks on poultry and maize sector (short-term scenario: Imports of poultry unchanged and supply elasticity of maize equal to zero)

	Base	25% CS	10% PS + 40% CS		
			HA	HMA	HMLA
Price (in old GHc/kg)					
Maize	**2,182.8**	**0.1%**	**-0.6%**	**-1.2%**	**-1.4%**
Poultry	**16,022.9**	**-17.0%**	**-27.4%**	**-26.8%**	**-26.4%**
Production ('000 tons)					
Maize	**1,223.1**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
Poultry	**28.8**	**-1.0%**	**-5.9%**	**-9.2%**	**-11.4%**
Poultry Import	**49.9**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
Consumption ('000 tons)					
Maize	**1,166.7**	**0.0%**	**0.3%**	**0.5%**	**0.5%**
Poultry	**78.7**	**-0.3%**	**-2.1%**	**-3.3%**	**-4.2%**
Maize Feed	**56.4**	**-0.9%**	**-6.8%**	**-10.2%**	**-11.4%**

Table 4. Effect of the different shocks on poultry and maize sector (long-term scenario: Imports of poultry free to change and supply elasticity of maize positive)

	Base	25% CS	10% PS + 40% CS		
			HA	HMA	HMLA
Price (in old GHc/kg)					
Maize	**2,586.7**	**0.0%**	**-0.8%**	**-0.5%**	**-0.9%**
Poultry	**15,873.8**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
Production ('000 tons)					
Maize	**1,174.0**	**0.0%**	**-0.2%**	**-0.1%**	**-0.2%**
Poultry	**28.8**	**0.0%**	**-7.7%**	**-4.3%**	**-10.0%**
Poultry Import	**52.4**	**-38.7%**	**-57.6%**	**-59.5%**	**-56.3%**
Consumption ('000 tons)					
Maize	**1,117.6**	**0.0%**	**0.3%**	**0.2%**	**0.3%**
Poultry	**81.2**	**-25.0%**	**-39.9%**	**-40.0%**	**-39.9%**
Maize Feed	**56.4**	**0.0%**	**-8.8%**	**-5.3%**	**-10.0%**

Tables 3 and 4 highlight the important role of imports in determining the nature and extent of the effects of an HPAI outbreak. With imports adjusting along with domestic production, the net effect on the domestic poultry production is mitigated to some extent. Allowing the imports to adjust is what preserves the small economy assumption for Ghana in poultry trade. The economy works as a price taker and the domestic price of poultry does not change (Table 4). This, of course, is a simplified scenario where domestic poultry and imported poultry are treated as perfect substitutes. If there is

[6] Sensitivity analysis has been conducted with different feed conversion ratios.

imperfect substitution which could get more pronounced in the event of an outbreak (for example foreign poultry could be credibly believed to be from an avian flu free zone) then the effect on the domestic poultry will be magnified. In general, the extent to which domestic and foreign poultry substitute in consumption will determine the share of adjustment post shocks by the domestic poultry and imports.

Note that maize supply elasticity is taken to equal zero in Table 3. Hence the effect on the maize sector (as food or feed) is a combined effect of restricted imports as well as restricted supply. Both these factors mean that the net effect on the maize sector is limited in the scenario captured in Table 4 along with lower adjustment in the poultry sector itself. Further, given the linear feed conversion function in poultry, the percent reduction in maize feed demand mimics the percent reduction in poultry production. Thus, maize feed also has a smaller effect if imports are allowed to vary. In the analysis above, effects of combined shocks (demand and supply) have been assessed. While a demand shock leads to reduced prices due to a downward shift of the demand curve, a supply shock results in increased prices following an upward shift of the supply curve. However, because prices have decreased for poultry products in most countries with an avian flu outbreak, it can be concluded that the demand shocks were much larger than the supply shocks.

Table 5 presents the effects of HPAI shock on the nominal household income disaggregated by the 27 household groups included in the model.

Table 5. Effect of the different shocks on the nominal household income

			Base ($/capita)	Short-Term		Long-Term	
				25% CS	10% PS + 40% CS	25% CS	10% PS + 40% CS
North Sav.	*Urban*	VPoor	744.0	0.4%	0.3%	0%	-0.10%
		Poor	1,133.5	0.5%	0.9%	0%	0.14%
		Rich	2,380.9	0.5%	0.7%	0%	0.07%
	Rural	VPoor	696.9	0.1%	0.0%	0%	-0.06%
		Poor	1,128.4	0.0%	0.0%	0%	-0.02%
		Rich	2,057.3	0.0%	0.0%	0%	0.01%
South Sav.	*Urban*	VPoor	668.5	0.3%	0.1%	0%	-0.11%
		Poor	1,015.7	-0.4%	-0.9%	0%	-0.09%
		Rich	2,518.7	0.4%	0.7%	0%	0.18%
	Rural	VPoor	960.8	0.4%	0.6%	0%	0.06%
		Poor	1,439.6	0.5%	0.9%	0%	0.17%
		Rich	3,581.4	0.2%	0.3%	0%	0.07%
Forest	*Urban*	VPoor	808.4	0.5%	0.8%	0%	0.18%
		Poor	966.3	0.5%	0.9%	0%	0.16%
		Rich	2,621.9	0.2%	0.4%	0%	0.19%
	Rural	VPoor	1,040.0	0.4%	0.6%	0%	0.12%
		Poor	1,268.6	0.3%	0.4%	0%	0.10%
		Rich	1,924.5	0.3%	0.5%	0%	0.14%
Coast	*Urban*	VPoor	758.3	-2.5%	-4.2%	0%	-0.25%
		Poor	1,174.5	0.1%	0.2%	0%	0.02%
		Rich	2,638.0	0.2%	0.3%	0%	0.15%
	Rural	VPoor	894.6	0.0%	-0.1%	0%	0.02%
		Poor	1,221.1	0.2%	0.3%	0%	0.07%
		Rich	1,854.7	0.3%	0.4%	0%	0.11%
Accra	*Urban*	VPoor	1,161.2	0.4%	0.7%	0%	0.16%
		Poor	1,203.3	0.6%	0.9%	0%	0.16%
		Rich	3,668.0	-0.1%	0.0%	0%	0.16%

The outcome variable of interest is income of the household groups post shock. Results indicate that the overall effect of the shocks at the household level is negligible, even after accounting for regional differences. This is likely because poultry is usually a relatively minor contributor to household income; in many cases it does not contribute at all. The households in the Coastal region will have the highest negative effect from a shock to the poultry sector. The small positive effects for households appear because of positive effects on prices of some products following the shocks.

Concluding Remarks

This simple multi-market analysis shows that the effect of a shock to the poultry sector will largely be concentrated in the poultry sector itself. Focusing on small-scale poultry producers identified from the GLSS V data, the effect on the maize sector is limited. The households also experience a negligible change in incomes, mainly because most have limited or no dependence on poultry as an income source. This does not discount the fact that some households have a significant dependence on poultry (greater than 20 percent). However, given the dual poultry sector in Ghana, accounting for organized poultry production with its significant inter-sectoral linkages could be important. Computable General Equilibrium analysis by Diao (2009) suggests, however, that economywide effects of shocks to poultry sector are small.

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