HPAI PRO-POOR HPAI
RISK REDUCTION
HIGHLY PATHOGENIC
AVIAN INFLUENZA

Methodologies to Assess the Economy Wide Impact of Avian Flu

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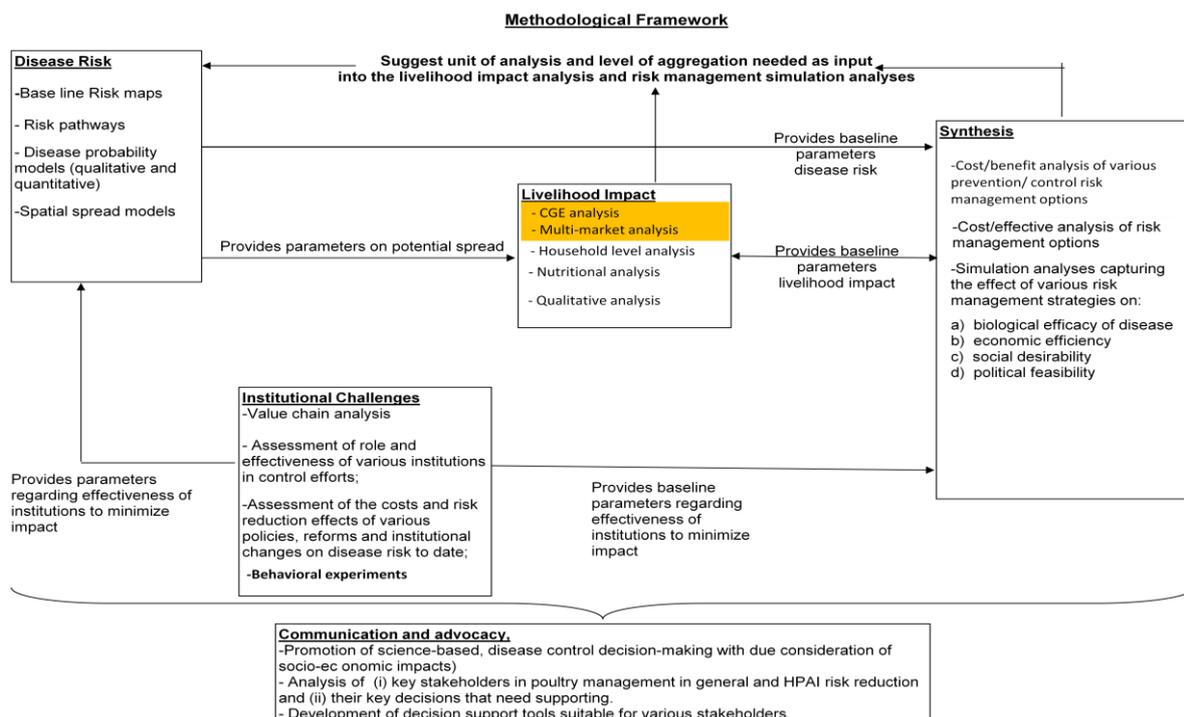
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Preface

Since its re-emergence, HPAI H5N1 has attracted considerable public and media attention because the viruses involved have been shown to be capable of producing fatal disease in humans. While there is fear that the virus may mutate into a strain capable of sustained human-to-human transmission, the greatest impact to date has been on the highly diverse poultry industries in affected countries. In response to this, HPAI control measures have so far focused on implementing prevention and eradication measures in poultry populations, with more than 175 million birds culled in Southeast Asia alone.

Until now, significantly less emphasis has been placed on assessing the efficacy of risk reduction measures, including their effects on the livelihoods of smallholder farmers and their families. In order to improve local and global capacity for evidence-based decision making on the control of HPAI (and other diseases with epidemic potential), which inevitably has major social and economic impacts, the UK Department for International Development (DFID) has agreed to fund a collaborative, multidisciplinary HPAI research project for Southeast Asia and Africa.

The specific purpose of the project is to aid decision makers in developing evidence-based, pro-poor HPAI control measures at national and international levels. These control measures should not only be cost-effective and efficient in reducing disease risk, but also protect and enhance livelihoods, particularly those of smallholder producers in developing countries, who are and will remain the majority of livestock producers in these countries for some time to come.

To facilitate the development of evidence based pro-poor HPAI control measures the project is designed so that there are five work streams: disease risk, livelihood impact, institutional mechanisms, risk communication, and synthesis analysis. Project teams are allocating and collecting various types of data from study countries and employing novel methodologies from several disciplines within each of these work streams. So that efforts aren't duplicated and the outputs of one type of analysis feeds into another the methodologies in each work stream will be applied in a cohesive framework to gain complementarities between them based on uniformity of baselines and assumptions so that policy makers can have consistent policy recommendations. The figure below is the methodological framework used to depict how work stream outputs fit together. This brief discusses the methodologies to be used when conducting the macroeconomics impact highlighted in the methodological framework below.

Methodological Framework

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More information

For more information about the project please refer to www.hpai-research.net.

1.   Introduction

This paper is aimed at suggesting common methodologies to assess the economy wide impact of avian flu outbreak in the following five countries: Ethiopia, Ghana, Indonesia, Kenya and Nigeria. Indeed, these countries differ in their socio-economic, veterinary and institutional contexts including the importance of the poultry sector, its structure and the history of the disease. Hence, a uniform methodology that can be applied to all countries has its limitations in terms of applicability to each individual country. However, the objective is to suggest a broadly similar methodology that can be modified to fit the context of individual countries and can answer the main research questions of interest. The choice of methodology is related to questions such as whether a partial or a general equilibrium modeling is to be implemented, how the shocks to the models will be determined, what shocks the models will include and what will be the appropriate unit of analysis.

Animal disease outbreaks such as Avian Influenza in principle can have far reaching economic impacts. The extent of the economic impact depends upon several factors notably the economic size of the sector and its forward and backward linkages with other sectors. The economic impact and the points of impact are vital information for the policy makers in designing prevention and mitigation strategies. Note that the economic impact of Avian Flu occurs from three channels

   (i)   If the disease occurs, then the major channel is its impact and the effects of control and mitigation strategies that are put into place (including compensation)
   (ii)   If the disease does not occur, the major channel is the impact of the costs of the preventive strategies and the benefits of not having an outbreak
   (iii)   If the disease occurs or does not occur it can result in a demand shock where the demand for poultry products is likely to be affected.

The overall impact of the disease (including that of control measures) hence can occur from both demand as well as supply side. As consumer perceptions change with the occurrence of HPAI, the demand of poultry products and therefore the livelihoods of producers and other agents employed in the value chain of poultry will be affected. Disease shocks also affect the available supply of poultry products due to mortality (from disease and also because of mitigation measures such as culling) and this will affect market prices. Both control and mitigation policies (Table 1, below) are expected to reduce the overall rate of disease incidence and thereby affect the economy favorably.

It is important to capture the list of control measures and mitigation strategies that span the universe of possible options. Control and mitigation strategies will always have associated indirect cost in terms of the impact on livelihoods. Hence, some policy measures will require specific interventions to safeguard the livelihoods of the poor (for example culling will need to be supplemented with compensation). Similarly, it is also important to take into account the direct costs of implementing these measures (for example cost of vaccines).

Table 1   A synopsis of policies for containment and mitigation of HPAI influenza

Strategy Type	Sub-Category	Individual policies (M: mitigation; C: containment, L: Livelihood rebuilding)
Non-medication based	National or central	• Inter-city movement restrictions (C, M) • Aspects of quarantine (C, M) • Public communications (C, M) • Measures to balance the price and income terms of trade of the affected (L)
Medication based	Vaccination (local, regional or national)	• Targeted vaccination policies (M) • Broad-based vaccination policy (C, M) • Subsidy for vaccination and enabling of supply of vaccines (L)
Stamping out	Culling (regional policy)	• Culling in identified radius after the outbreak (C)
Incentives based	Reporting (local)	• Universal or targeted compensation policy (C,L)

Source: extended from Dutta (2008)

Given the emphasis on timely and efficient containment operations, resource-poor countries at a risk of initial outbreaks may have to invest in containment measures that can address a wide range of scenarios of infectiousness (Dutta 2008). The policies listed above (containment, mitigation and livelihood rebuilding) have resource costs. Hence, depending upon the extent of allocation or reallocation of resources that it entails and the strength of inter-linkages of the poultry sector, there will be economy wide impacts of a HPAI outbreak and its control measures. The disease itself has impact on the poultry sector and through its linkages on other sectors. Depending upon the model the effect will be captured over a set of markets (through multi-market models) or at the economy wide level (through CGE models).

The discussion here presents a generic modeling approach to capture the macroeconomic (only within country effects) impact of avian flu outbreak and control measures. Note that the term macroeconomic is used for both the whole economy as well as for a set of linked markets (as in a multi-market model) that do not span the complete set of markets.

The approach has four main pillars:

(i)   The economic model should have linkage with the disease spatial spread models produced under the disease risk work package that captures transmission of HPAI

(ii)   The economic model should be disaggregated at the regional level (to allow spatial analysis) within the country possibly characterized by inter-regional trade flows especially in poultry

(iii)   The economic model should capture all significant linkages with other sectors of the economy (both direct linkages such as with the feed sector and indirect linkages with sectors such as tourism) and

(iv)   The macro-economic model should have linkage with household data (wherever possible) disaggregated by the type of poultry sector. Note that association with

household data can capture the micro level effect using additional tools such as micro-simulations for computable general equilibrium (CGE) models. In case of CGE models, micro-simulation is a model based on a dataset that contains information on individual microeconomic agents (individuals, households, firms). Microsimulations will allow simulation of the effect of policies/shocks on individuals. Microsimulations in this case would be most useful for obtaining counterfactual distributions of income (and hence poverty) from an AI outbreak or from control measures. The project is particularly interested in distinguishing the impact across types of poultry sector such as small scale, medium scale and large scale commercial.

However, the existing situation (in terms of data) in the five countries might not allow all four components of the generic methodology to be covered in each of the five countries.

This brief is organized as follows. Section 2 lays out an integrated modeling framework for capturing the macroeconomic impact of HPAI. Section 3 presents brief description of the size and structure of the poultry sector in each country that provide information towards selection of the appropriate model. Section 4 concludes.

2. Integrated Modeling Framework to Capture the Economy Wide Impact of HPAI

The modeling methods in this project must use an integrated approach that combines spatial disease spread models with the economic models.[1] Spatial spread models are usually based on the concept of state-transition. There are two important variables viz. state and the transition probabilities that determine the disease spread model. For the economic models it is important that both the states and transition probabilities (from spatial spread models) are available at the unit of analysis employed in the economic model. Thus, if the model is disaggregated to the level of regions within a country, the epidemiological models must provide the state and transition probabilities at the level of regions. From the state transition functions, the level of disease shock at the level of the unit of analysis need to be derived.

Note that the transition probabilities are not independent of economic flows and also depend on control measures. Thus, even though we call it a spatial spread model that determines the disease transmission, in effect the model incorporates several elements. During any time period, depending on various factors, birds in a country have a probability of remaining in that state or move to another state (a transition).

Spatial pattern is an important characteristic of the spread of AI. An outbreak of AI usually occurs in a particular geographic location and spreads from thereon (You and Diao 2007). The risk of exposure to HPAI is also spatial, depending on the distance from AI transmission routes and contact with infected flocks.

Outputs of the spatial spread models will be linked to the macro- economic model. The macroeconomic model usually a Computable General Equilibrium (CGE) model or a partial equilibrium multi-market (MM) model will capture the costs of disease spread. As the outputs of the disease risk package will be available after some time the macro-economic models will be run initially with arbitrary shocks then later integrate with disease risk outputs once completed so as to capture spatial dimensions of HPAI outbreak which captures disease shocks as well as shocks following control measures. The modelers will thus use the initial disease risk maps to do the first round of the potential economic and livelihood impact of spatial spread of HPAI to different regions and refine the analysis when the risk assessment and spatial spread models are completed.

This will be done by incorporating the demand and supply shocks, the inter-linkages to other sectors, and possibly the resource cost shocks (both public and private) implied by the disease and by the control strategies. Linkage with a household data wherever possible will then translate the effects to a disaggregated level. The cost benefit analysis in this project will provide information on costs incurred or to be incurred by the public and private sectors to implement control and containment measures. This information will be used to determine the resource cost shocks wherever applicable.

Note that one form of demand shocks will be international or regional (within country) trade restrictions that could result from an outbreak (this can be modeled as a relative price shock or a

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[1] Even though the focus is on within country or on the single country impacts, note that disease risk models can extend to trans-boundary transmission. The models in this project are likely to focus on within country transmission channels.

shock in terms of quantitative restrictions (this would also lead to a price wedge)). The supply shocks in terms of reduced output could usually be regional (could be modeled as a percentage decline in the output of the poultry sector ideally for each of the sub-sectors in poultry). Demand shocks could extend to other sectors such as tourism which the literature usually terms as the knock-on effects. The models should strive to include all significant forward and backward linkages to capture the knock on effects.

The resource cost shocks would include among others stamping out costs including the cost of culling (for example cleaning and disinfection), compensation paid after culling and costs associated with imposition of quarantine. Table 2 summarizes the potential impact of HPAI at the economy wide level and the feedback on the households.

Table 2   Economic Impact of HPAI

Economic Impact of HPAI		
• Supply shocks to the poultry sector from disease outbreak • Demand shocks to the poultry sector from disease outbreak or perceived outbreak • Demand and supply shocks to the related sectors (forward and backward linkages) – from perceived or actual outbreaks • The demand and supply shocks from control and mitigation strategies • Resource cost shocks from channeling government resources towards AI prevention and control	Microsimulations in CGE models or household disaggregation in multi-market models ⟹	• Household incomes • Household consumption and nutrition • Impacts on household's saving and investment

In summary the common methodology that will be employed across all five countries in the project will either be a CGE model (Nigeria and Ghana) or a multi-market model (Ethiopia, Kenya and Indonesia). The choice of the method between these two models is determined by the following criteria.

(1) The size of the poultry sector in relation to the economy – implies whether or not economy wide effects are important.
(2) The structure of the poultry sector and the extent of its interlinkages - implies whether the partial equilibrium or general equilibrium analysis is relevant.

Further, the regional and spatial disparity in poultry population, density, structure and vulnerability to introduction and spread of disease implies the need for regional disaggregation in multi-market or CGE models.

Note that CGE or multi-market models are best suited to long-run analyses during which all factors of production can adjust to a new equilibrium. These models will not capture the short run impact.[2] Further, much greater impacts of Avian flu can occur if the disease takes the form of a pandemic where impacts can occur also on labor supply. All the cases in the project will abstain from a pandemic shock.

The next section provides relevant details for the poultry sector in each country and discusses its implications for modeling. The choice of the model is based on the nature of the poultry sector in each country which is described below.

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[2] There might be value towards modifying the models to make them applicable to the short run. There is relatively scant literature on modeling disequilibrium in CGE/multi-market models. The typical ways in which this is done is as follows (e.g., Rose and Liao, 2005). First, the ease at which one input can be substituted for another can be reduced to reflect the more limited options available in the immediate aftermath of a HPAI outbreak. It can also be supplemented by explicit *disequilibrium* closure rules. These reflect key account balances in labor, capital and goods markets, government activity, and trade. Examples include allowing less than full employment equilibria, government deficit spending, and trade imbalances. This short run impact will not be captured by the models.

3. Details of the Poultry Sector In the Five Countries and Its Implications for Modeling

All the countries in the project have a large share of small scale unorganized poultry sector including backyard production. Table 3 below presents the characteristics of the poultry sector in the five countries. Since the project's focus is on poor, it is suggested that attempt be made to disaggregate the poultry sector into finer components particularly the small scale producers. Impact on such producers is crucial for the estimation of impact on poverty. In this regard, it is important that models are linked with household data to disaggregate the impacts.

Table 3   Characteristics of the poultry production systems for the five country studies

	Industrial and integrated	Commercial not integrated	Backyard market-oriented	Village or backyard subsistence
Characteristics				
Bird and output marketing	Commercial Export and urban	Usually commercial Urban/rural	Birds usually sold in live markets urban/rural	Birds and products consumed locally Rural/urban
Use of purchased inputs	High	High	High	Low
Dependence on good roads	High	High	High	Low
Location	Near capital and major cities	Near capital and major cities	Smaller towns and rural areas	Everywhere; dominates in remote areas
Birds kept	Indoors	Indoors	Indoors/Part-time outdoors	Outdoors most of the day
No. of birds kept				
Ethiopia	Above 10,000 birds		1,000-5,000	Below 500 birds
Ghana	10,000 and above	1,000-5,000	150-500 birds	3-200 birds
Indonesia				<50
Kenya		100-1000	50-100?	<20
Nigeria	5000 and over	1000-4999	50-999	5-49

Poultry numbers

Ethiopia		Exist but poorly developed	Exist but poorly developed	80% of poultry population
Ghana				
Indonesia	9.7 million poultry	58.1 million poultry	32.4 million poultry	174 million birds producing 175 million birds per year and 43.5 million eggs
Kenya				Over 75% of the total chicken population
Nigeria				>80% of national poultry inventory (estimated to be 143 million)
Shed	Closed	Closed	Closed/open	Open
Veterinary service other than in epizootic disease control	Own veterinarian	Pays for veterinary service	Pays for veterinary service	Irregular, depends on government services
Source of medicine and vaccine	Company or market	Market	Market	Government and market
Source of technical information	Company and associated	Sellers of inputs	Sellers of inputs	Government and extension
Source of finance	Banks and own	Banks and own	Banks and private	Private and banks
Breed of poultry	Commercial	Commercial	Commercial	Native

Sources: Adapted from http://www.fao.org/docs/eims/upload//214190/ProductionSystemsCharacteristics.pdf; Demeke, S. 2007; Aning, K.G, P.K. Turkson, and S. Asuming-Brempong 2008, Annex II; Sumiarto, B., B. Arifin 2008, Annex III; Omiti, J., L. Ndirangu, and S. Okuthe 2008, Annex IV; Uzochukwu Obi, T., A. O. Oparinde, and G.A. Maina 2008, Annex V.

3.1   Ethiopia

3.1.1   Background information on Ethiopia's poultry sector

Ethiopia has one of the largest livestock populations in Africa. However, the role of poultry within livestock is comparatively less important. A CSA (2005) report revealed that 97.8% of the total poultry population comprises indigenous birds while 2.2% are exotic breeds. The mode of production for these indigenous birds is largely backyard production.

The poultry sector in Ethiopia can be characterized into three major production systems based on some selected parameters such as breed, flock size, housing, feed, health, technology, and bio-

security (Alemu & Tadelle, 1997; Bush, 2006; Goutard & Magalhaes, 2006; AHINTC, 2006). These are village or backyard poultry production system, small scale poultry production system and commercial poultry production system.

Alternatively, the FAO classifies poultry production systems into four sectors, depending on the level of bio-security. Based on this system of classification, Ethiopia has three poultry production systems: large commercial poultry production with "moderate to high biosecurity" (sector 2), small commercial poultry production with "low to minimal" biosecurity (sector 3) and village or backyard production with "minimal biosecurity" (sector 4) (Nzietcheung 2008). Note that that the poultry sector in Ethiopia plausibly does not contain any sector 1.

The sector 2 system of poultry production is developing and the main commercial poultry farms – Elflora, Agro Industry, Genesis and Alema – are located around Debre Zeit in Oromia. The sector 3 system is emerging around the urban and peri-urban areas of Ethiopia. In terms of the FAO definition, sector 4 or the village or backyard production represents the main poultry production system in most parts of the country. In the dominant system of backyard poultry, there is little or no inputs for housing, feeding or health care. Based on Dessie *et al.*, (2003), Bush (2006) and field interviews in Nzietcheung (2008), typical household flock sizes vary from 2 to 15 chickens.

The backyard poultry production systems are not business oriented. In this case, the major purposes of poultry production include eggs for hatching (51.8%), sale (22.6%), and home consumption (20.2%) while chickens for sale (26.6%) and home consumption (19.5%).

The next system prevalent in Ethiopia is small-scale commercial poultry production with modest flock sizes usually ranging from 50 to 500 exotic breeds kept for operating on a more commercial basis. Most small-scale poultry farms are located around Debre Zeit town in Oromia region and Addis Ababa. This production system is characterized by medium level of feed, water and veterinary service inputs. Flock sizes vary from 20 to 1000. Most small-scale poultry farms obtain their feed and foundation stock from large-scale commercial farms (Genesis or Alema) (Nzietcheung 2008).

Finally there are some large scale commercial farms in Ethiopia. This system is a highly intensive production system that involves, on average, greater or equal to 10,000 birds. This system depends heavily on imported exotic breeds that require intensive inputs such as feed, housing, health, and modern management system. It is estimated that this sector accounts for nearly 2% of the national poultry population. This poultry production is entirely market-oriented to meet the large poultry demand in major cities.

In Ethiopia, the commercial poultry sector is situated mostly in Debre Zeit areas. In the intensive poultry production system, there are also 7 public poultry multiplication and distribution centers (PMDC) that are located in different regions operating with the major objective of distributing improved exotic breeds to smallholders. In all centers, day-old chicks were either imported from Egypt, Germany and Holland, or sourced from Elflora and Genesis commercial farms.

Regionally, there is significant variation in poultry numbers and density. The discussion above points out that there is difference in structure of poultry sector across regions with comparatively organized segments located in Debre Zeit areas. Further, because of several risk factors threat of introduction of HPAI is also different across regions owing to different possible pathways.

The poultry population is mainly concentrated (in order) of Oromiya, Amhara, SNNR, Tigray, and Benhsangul Regional states. This regional distribution of the poultry population is closely associated

with the pattern of human population density in the respective regions. The regions with higher poultry population (Tigray, Amhara, Oromia and SNNPR) had also higher poultry densities.

In international trade, Ethiopia's imports are limited to import of live birds. The private and public large scale intensive poultry farms are mainly dependent on the import of day old chicks from abroad mainly from the Netherlands, Saudi Arabia, Egypt, UK, Germany, and Kenya (Goutard & Magalhaes, 2006). Since 2006 Ethiopia has banned import of poultry products from Egypt, UK, and Germany due to the incidence of HPAI in these countries. In 2006/07, some imports also occurred from France.

3.1.2   Implications of the structure of poultry sector for modeling of macroeconomic impacts

Following the discussion above, in Ethiopia, for the majority of poultry farms, the linkage with other sectors of the economy seems weak. There are localized markets for inputs and outputs and a big part of poultry output is geared towards self consumption. Moreover, a vast majority of poultry farms do not use purchased inputs thereby delinking them from the immediate upstream firms such as the feed producers. The commercial poultry sector that has more pronounced inter-sectoral linkages continues to be small. Hence, aggregate economy wide impacts are likely to be negligible in Ethiopia.

The effects are likely to be concentrated in the poultry sector along with in markets most directly linked with poultry. This motivates the use of a multi-market model in case of Ethiopia.

Secondly, as discussed above there is regional concentration in poultry holdings. The impact of a shock (both if disease strikes in these regions or because of spillover effects from other regions) is likely to be more severe with high poultry population and density. The regional concentration becomes even more pronounced in terms of commercial poultry production where there is concentration around Debre Zeit region. The economic model needs to have this spatial dimension because it is possible that nationally there is insignificant impact but regionally there are strong effects of a shock to the poultry sector (either demand or supply).

The proposed multi-market model for Ethiopia is based on Diao et al (2007). This model contains disaggregation to include poultry and eggs as a separate sector (market).   The model is also regionally disaggregated across regions and zones. The shocks at the level of regional disaggregation available in the model will be obtained from the disease spread model.

The model also classifies households into decile categories. The effects of shocks to commercial poultry production in Ethiopia at the regional level will produce results on the economy and also on specific income decile groups.

Given that the data in the model will not include backyard producers, the estimated effects will come from shocks to a small segment of the poultry sector. However, this is a dynamic segment of the poultry economy in Ethiopia and effect of shocks to the commercial poultry production in Ethiopia is a pertinent research question to address. Moreover, the share of semi-commercial and commercial poultry has gone up over time.

3.2 Ghana[3]

3.2.1 Background of the poultry sector in Ghana

Livestock and poultry, together contribute 7% of the national agricultural GDP of Ghana in 2005. Poultry is an important livestock for the consumers and usually there is a net deficit in terms of domestic demand supply balance. Ghana imports 60-70% of its poultry meat requirements.

In poultry, free-range village poultry accounts for 60-80% of the national poultry population (FASDEP, 2002; Gyening, 2006) and was estimated to contain between 12 and 20 million birds between 2000 and 2005 (Amakye-Anim, 2000; FAOSTAT, 2005). Rural poultry comprises village chickens, local guinea fowls, ducks, turkeys and pigeons.

Even though village poultry are kept all over the country, its production is concentrated in the three northern regions of Ghana (LPIU, 2006). The commercial poultry producers rely heavily on local maize production that is often supplemented with yellow maize imports. Wheat bran is an important feed ingredient and it is supplied as a by-product of wheat flour milling by four factories in the country. Other feed ingredients such as fishmeal, soya bean cake and vitamin-mineral premix are imported, as are poultry drugs and vaccines. Medium and small-scale commercial farms rely on feed milling companies for their feed needs (Aning et al 2008).

Like in case of Ethiopia, poultry production in Ghana may be classified into three categories viz. commercial (or industrial), semi-commercial and backyard producers (Aning, 2006). There are a few large-scale commercial farms in Ghana, which are integrated with hatchery, production, feed mill marketing and sometimes processing units (Aning, 2006).

Large-scale farms have an installed capacity of over 10,000 birds each, and operate their own feed mill. There are only five such farms in Ghana and are located mainly in the Ashanti and Greater Accra and Brong-Ahafo regions. Medium commercial poultry farmers have installed capacities of 1,000 to 5,000 birds, whereas small-scale farms produce less than 500 birds. Medium and small-scale commercial farms rely on the large-scale integrated farms for their day old chicks and feed, but may also obtain feed from other sources.

Semi-commercial poultry farms are usually located in the owners' backyard where the number of birds kept typically is below 500. The backyard system is typical as in other countries with low usage of purchased inputs and limited market orientation.

Relative to most other countries in the project, in Ghana the import of poultry meat is important Note that Ghana imports only from countries that have an AI free status. The recent increases in poultry meat imports have been significant, particularly for chicken which has increased more than four times between 2000 and 2005.

Since 1999, the proportion of poultry meat imported has increased. In 2003, domestic production supplied only 53% of total poultry meat in Ghana. The major countries exporting poultry meat to

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[3] This section draws upon the background paper for the HPAI project by Aning et al (2008).

Ghana are Brazil, the member countries of the European Union and the United States of America, which together account for more than 75% of total poultry imports with the USA being the biggest exporter followed by the Netherlands and Brazil.

3.2.2 Poultry sector in Ghana and its Implications for Modeling

As discussed above, like in other countries Ghana also has a sizable backyard poultry sector. Still the size of semi-commercial and commercial sector in Ghana is significant. Also, among the five countries, Ghana has the highest importance of poultry as a traded product (both meats and eggs). It mainly imports meat and exports some eggs. Hence apart from the common shocks discussed the introduction above, a further shock in terms of possible trade bans could be relevant for Ghana.

There are significant differences in the distribution of poultry sector in Ghana (in terms of number and density). There is spatial variation also in terms of the structure of the poultry sector. As the outbreaks of last year show there is potentially significant dispersion in the outbreak in Ghana. The epidemiological models will provide information of high risk areas in Ghana.

In this project, given the importance of poultry sector in Ghana in terms of domestic consumption and trade we propose that a CGE analysis combined with microsimulations if possible to be employed in Ghana. The poultry sector in Ghana (a sizeable portion of it) also has significant upstream and downstream interlinkages with other sectors.

The 2005 Ghana Social Accounting Matrix (SAM) being developed at IFPRI estimates the structure of the Ghanaian economy in 2005 and includes detailed information on 56 production sectors, six factors of production, income and expenditures of rural and urban households, the government budget, and the balance of payments. A regionally disaggregated version of the SAM is available. The SAM is regionally divided into four main regions.

The Ghana Living Standards Survey for 2005 (which has been used in the construction of SAM) can be utilized for obtaining the disaggregated impact on households).

3.3   Indonesia[4]

3.3.1   Background information on poultry sector in Indonesia

Indonesia fulfills the consumption of poultry and poultry products, mostly from domestic production. Indonesia also has negligible exports of poultry products. This implies that restricting import/exports of poultry and poultry products, for example in the case of Avian Influenza (AI) outbreak in neighboring countries/Indonesia might not have significant impacts on the domestic economy.

The income elasticity of demand for poultry products in Indonesia is high, shown by a significant decrease (5.25 percent) in its consumption during the economic crisis in the end of 1990s. After the crisis, the level of consumption of poultry products increased by 9.75 percent.

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[4] This section draws upon the background paper on Indonesia in the HPAI project.

The island of Java host around 70% of the total poultry and 60% of human population of Indonesia. Java´s poultry population grew faster compared to other poultry business of other island, specially the commercial poultry sector.

Overall, Indonesia has a large poultry industry with high regional concentration in Java. As discussed above, production is mainly aimed to supply the national market, although some export of processed products and one-day-old chicks may be regionally important. In 2004 and 2005, however, no export of live birds was carried.

Structure of poultry sector in Indonesia varies greatly ranging from backyard poultry to commercial breeding farms. About half of them are vertically integrated operations. However, most of the small – medium enterprises lack integration with operations relating to Day old chicks (DOC), Hatchery egg suppliers, feed mills, abattoirs belonging to different actors.

CASERED (2004) present a classification of the Indonesian poultry sector based on the FAO system. In commercially orientated production systems (sector 2) there are thought to be 58.2 million birds in 83 thousand farms, and these systems employ a total of 385 thousand people. There are also nearly 16 thousand farms that have high level bio-security (sector 1) and are associated with industrially integrated system. Johnston *et al.*(1992) in a study on Newcastle disease in South east Asia estimated that 174 million birds were kept in backyard systems (sector 4) with an annual offtake of 175 million birds and 43.5 million eggs. Assuming that there has been little change in this backyard production flock over the last 15 years this would suggest that the remaining 32.4 million birds are found in sector 3 (Rushton and Viscara 2005).

Chicken is the most popular meat in Indonesia. Consumption in 2005 was around 1000 kt or 4.45 kg per capita per year, followed by beef at 2.4 kg per capita. There were no Poultry exports of significance. Much of the feed (maize, soybeans) is imported, and the industry is not competitive with Thailand and other Asian chicken producers. Although not currently an exporter, Indonesia has been so in the past and could do so once again if a ban on exports from countries such as Thailand were implemented elsewhere resulting in trade diversion. In 2003 exports were worth US$6.6 million. Japan was the major market. In that year the 700 tonne of imports were valued at $1,321 per tonne. The USA, Australia and Brazil were the primary sources of supply of chicken meat.

3.3.2   Implications for modeling of macroeconomic impact of HPAI in Indonesia

Recently, computable general equilibrium model (Oktaviani 2008) has been used to assess the overall costs to the Indonesian economy because of the avian flu outbreak between 2004-2007. This has been a study commissioned by the government (it has not been released in English). According to the model results, Indonesia suffered financial losses of Rp4.1 trillion due to bird flu outbreaks during 2004-2007. The losses were estimated based on the impact of outbreaks leading to financial losses due to chicken culls, reduced demand for poultry products, lower chicken and egg consumption, costs incurred by farmers as well as the government for bird flu control, and the decline in the number of tourist visits.

Also, Vanzetti (2007) employs a simulation model (bilateral deterministic trade model called GSIM). The important structural innovation that Vanzetti includes is to differentiate between light and dark poultry meat based on Petersen and Orden (2005). Bilateral trade model is considered as the main focus is on trade flows and bans are likely to be at the bilateral level.   Different scenarios are

considered in Vanzetti (2007) where the magnitude of shocks are derived arbitrarily (and not form an epidemiological model).

The research in this project should first assess the analysis in these papers and then identify the research gaps that could be filled. The models to be employed in this project in Indonesia should have regional disaggregation given the concentration of poultry in Java. Further, the impact is likely to differ between the epidemic and endemic phase of the disease in the country.

In terms of existing data, the 1995 SAM for Indonesia (at IFPRI) is a 57x57 matrix with accounts for 17 sectors (separate activities and commodities), 6 factors, 7 households, 1 enterprise, the government, the rest-of-the-world, 2 tax types, and aggregate institutional savings-investments. The SAM is an aggregation of a 22 sector SAM produced by the Indonesia statistical authority with a revised treatment of trade and transportation costs (disaggregation across imports, exports and domestic sales on the basis of value shares). The SAM that IFPRI has for Indonesia for 1995 has 17 activities that includes livestock but not poultry separately.

The most disaggregated SAM for Indonesia seems to be constructed by Arief Anshory Yousouf. This Indonesian SAM for the year 2003 contains 181 industries, 181 commodities, and 200 households (100 urban and 100 rural households grouped by expenditure per capita centiles). The SAM (with the size of 768x768 accounts) constitutes the most disaggregated SAM for Indonesia at both the sectoral and household level.

Given that CGE models assessing the impact of HPAI on Indonesia's economy already exist, one possibility is to construct a multi-market (MM) model linking poultry and a set of markets where there are significant links. The MM model should also be disaggregated regionally.

3.4   Kenya[5]

3.4.1   Background information on Kenya's poultry sector

Poultry keeping is one of the most popular livestock enterprises in Kenya. In Kenya, free-ranging indigenous birds comprise 84.1% of population. The poultry sub-sector contributes about 55% to the livestock sector and 30% of the agricultural GDP (RoK, 2007). The sub-sector employs about two million people directly in production and marketing and indirectly through linkages with suppliers of such inputs as day-old-chicks, feeds and veterinary services. Poultry are a major source of animal proteins and is used in many diets. About 65% of all Kenyan households keep chickens. At the macro-level however poultry is still concentrated in the backyard (free ranging) system.

The total poultry population in Kenya varied greatly between 2001 and 2006. Rift Valley Province had the highest poultry population followed by Nyanza and Central Provinces. As expected, indigenous chickens form the largest proportion of the total poultry population in each year (Details available in Omiti and Okuthe 2008).

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[5] This section draws from the background paper on Kenya for the HPAI project.

There is moreover strong regional disparity in poultry holdings. Nairobi province has the highest number of chicken kept per household (91.3). In contrast in the North eastern province only 2% of all households keep chicken, a figure far below the national average; these households also keep the least number of chickens (5.4) in the country. Indigenous birds are mainly reared in the rural areas while commercial birds (broilers and layers are kept in the outskirts of main urban centers such as Nairobi, Kisumu, Nakuru and Mombasa.

Even though poultry sector in Kenya might not be a significant contributor to the economy as whole it does have strong linkages with some sectors. The poultry sector in Kenya is highly integrated upstream with the poultry feed industry (importers of premixes and feed manufacturers) and animal health service providers. It also has strong downstream integration with the farming community (mainly dairying and crop producers via manure), fishing industry (feathers are used to manufacture fishing baits) and the food industry (through eggs and poultry meat).

Some of the sectors that the poultry industry is integrated with contribute significantly to Kenya's economy. For instance, the dairy sub-sector contributes about 10% of the livestock GDP. Crop production contributes 16% of agricultural GDP. Between 1999 and 2003, the fishing industry accounted for 0.3% of the total GDP (EPZA, 2005). The food industry where poultry products are mainly consumed is highly integrated with the tourism sector which contributes about 19% to the overall economy.

Feed millers constitute the largest players in the animal feed industry. Animal feed (including poultry feed) is manufactured from imported feed premixes and locally produced cereals – mainly maize, wheat and rice. The large number of feed millers in Nairobi and Central Provinces is an indication of the importance of commercial poultry farming in these areas. Indigenous chicken producers like in other countries rarely purchase commercial feeds.

The fully industrial sector has high use of external inputs for housing, feeding and processing. The scale of production is large consisting of several thousand commercial birds. Such farms are integrated with hatcheries that produce day chicks for use on the farm and for sale.

In the commercial poultry production system, this sector consists of hatcheries where poultry is bred and hatched for commercial purposes and day old chicks are sold to farmers (FAO, 2007). Hatcheries are well linked with most players in the poultry industry and the rest of the economy. Most of the day old chicks are sold to smallholder poultry farmers. Culled hens are sold to retailers and wholesalers in major towns and urban centers. Manure is sold to coffee and flower farmers and also to dairy producers especially during the dry season.

In commercial turkey production, the breeding stock is usually imported from the United Kingdom. Turkey feed is sourced from feed manufacturers. There is only one commercial duck hatchery farm in Kenya. Ducks are hatched, bred and slaughtered on the farm. Dressed carcasses are sold in Nairobi for further processing by a meat processing and packaging company. Duck feed is bought from feed manufacturers.

The village (traditional) poultry production system comprises indigenous chicken, ducks, turkeys and other poultry types kept in the rural areas and in the urban informal settlements. The numbers kept
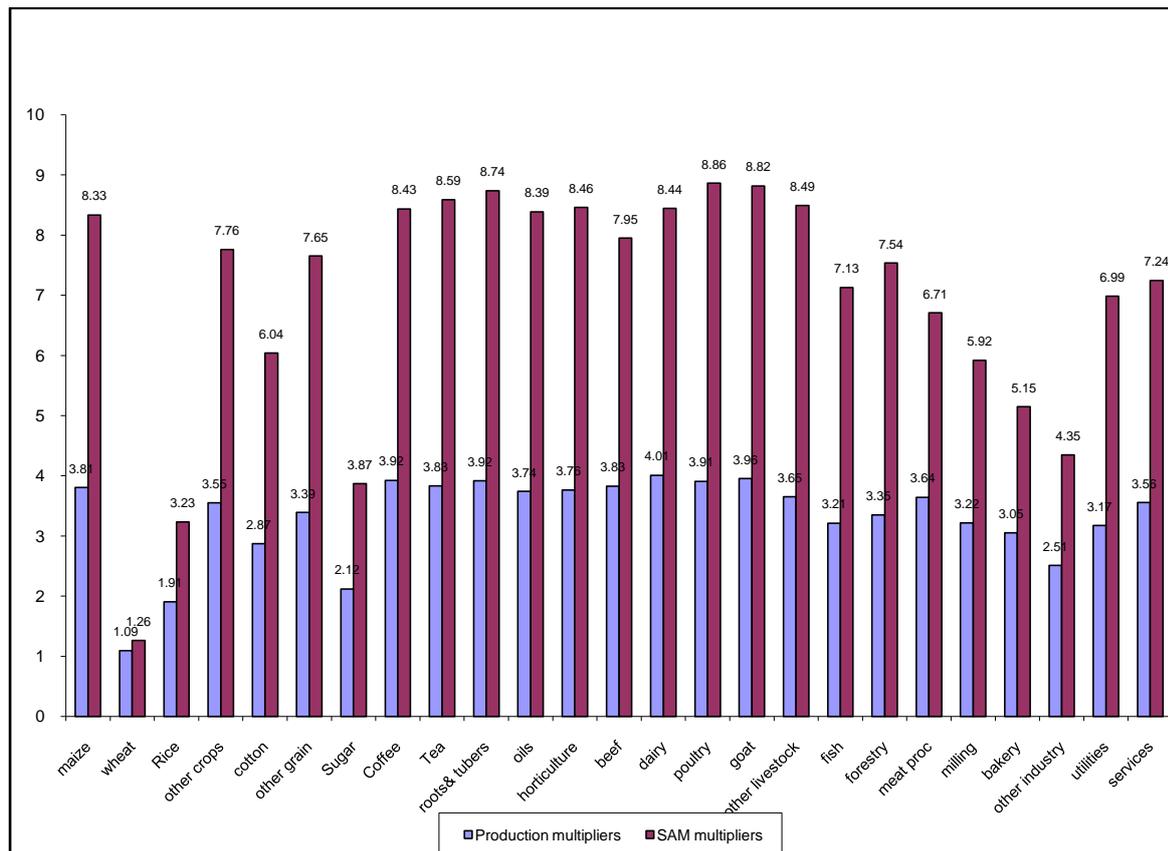
vary with region, species and consumption needs. This is a low-input, low-output production system which involves low income households.

Kenya is generally self-sufficient in egg and poultry meat. Currently, Kenya does not import or export any chicken meat. However, other poultry products are traded. Day old chicks are the major exports while hatching eggs are the major imports. A substantial number of day old chicks are imported as well. Kenyan hatching eggs and day old chicks are exported to the neighboring countries – Uganda, Tanzania and Ethiopia. Kenya imports poultry breeding stock (parent birds, fertilized eggs and day old chicks) mainly from Mauritius, Holland, Egypt, India and South Africa. Commercial turkeys are mainly imported from the United Kingdom and the USA Omiti and Okuthe 2008).

3.4.2   Implications for modeling of macroeconomic impact of HPAI in Kenya

An overwhelming majority of Kenya's poultry sector is in the backyard sector. Yet, the commercial and semi commercial sectors are sizable in Kenya and exhibit strong linkages with upstream and downstream sectors.

Given the size and structure of the poultry sector, in this project we propose that either a CGE model or a multi-market model could be the adequate one for Kenya. Among the countries in the project, Kenya has perhaps the most heterogeneous poultry sector. Hence disaggregating the poultry sector is very important for the case of Kenya. Figure 1 below shows (from the SAM for Kenya) that the multipliers for poultry are large implying that an elaborate multi-market model or a CGE model could be employed.

Figure 1: Production and SAM multipliers in Kenya

SAM, 2003 for Kenya

In terms of data availability, the Kenya 2003 Social Accounting Matrix (SAM) has been developed at IFPRI in collaboration with Kenya Institute for Public Policy research and Analysis (KIPPRA). In the Kenya SAM the production account (activities and commodities) has been disaggregated into 27 sectors each as defined in national accounts.[6] The data is not disaggregated to include poultry. In terms of regional disaggregation, however households were disaggregated according to region (rural/urban) and expenditure deciles (lower/upper).

Multi- market models have also been applied for economic analysis in Kenya. These models could be customized to address the macroeconomic impact of HPAI in Kenya. For example Karanjaa et al (2003) use a multi-market model to compute both absolute and relative welfare effects of technological change on different household types located in six distinct agro-ecological zones and in urban areas. The model has 13 different household types: small farms and large farms in each of Kenya's six agro-ecological zones plus urban households. However, the households are assumed to

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[6] The sectors are: Agriculture[6], Fishing, Forestry, Mining and Quarrying, Meat and dairy processing, Milling, Bakery and confectionary, Beverages and tobacco, Other food manufactures, Textiles and Footwear, Wood and Paper, Printing and Publishing, Petroleum, Chemicals, Metals and Machinery, Non-metallic manufactures, Other manufactures, Electricity and Water; Building and construction; Trade; Hotels and restaurants; Transport and communication; Financial services; Other services; Education; Health and; Public Administration.

produce only two commodities. More recently MM models have been developed by Omamo et al (2006) that have more commodities and include poultry. The MM model by Omamo et al (2006) needs to be regionally disaggregated. The existing model is at a regional level for East Africa. Hence, this regional model needs to be disaggregated at a national level for Kenya and subsequently to the sub-regional level.

3.5   Nigeria[7]

3.5.1   Background of the poultry sector in Nigeria

Backyard and/or village extensive production system forms 60% of the poultry in Nigeria. Semi-commercial system of poultry production forms 15% while commercial forms the rest 25%. Location is an important factor determining the type of poultry management system practiced in Nigeria. Extensive and backyard (extensive) poultry production systems are common in the rural areas while backyard (intensive) system is common in rural-town and urban areas in Nigeria (Uzochukwu Obi et al 2008).

Village poultry production system in Nigeria is a 'low input low output type' with a small flock size. Mostly, the raising of birds does not involve many purchased inputs. This could imply weak linkages with other sectors on the input side. Households usually engage in free-range village poultry production for their own consumption while only few sell their poultry products for additional income (implying weak linkages on the output side).

Existing evidences show that village poultry dominates the poultry sub-sector in Nigeria. Almost every household in rural areas keep poultry in Nigeria. About 70% of the inhabitants of Oyo State keep livestock particularly poultry (Afolabi, 2007) and ownership of poultry is common across the six geopolitical zones.

Across regions, subsistence poultry keeping is higher in the south than in the north. The percentage of households rearing poultry is highest in the south zone (64.42%) followed by south-west (56.44%) while north-west have the lowest number of families that engage in poultry production (29.96%).

In south west Nigeria, Ogun State has highest percentage of households keeping subsistence poultry (74%) followed by Osun State (57.3%) while Oyo State has the lowest (42.4%). This is on expected lines as Ogun State has one of the key international borders (Idiroko Border Station) through which poultry import (legal and illegal) takes place. Ogun (Uzochukwu Obi et al 2008).

The contribution of village poultry in the national economy of Nigeria has been significant over decades. Akinwumi et. al. (1979)'s work show that family poultry contributed 61% and 19.5% to the total poultry meat and egg production respectively between 1977 and 1978 in Nigeria. Also, evidence from Sonaiya et. al. (1990; cited in Sonaiya, 2007: 134) indicates that family poultry contributed 68.9% of the total poultry meat produced in the country. Recently, UNDP (2006) indicates that the total number of birds under village extensive and backyard semi-intensive/intensive production systems constitute about 70% of the total poultry population in Nigeria. Backyard (intensive) poultry producers

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[7] This section draws upon the background paper for the HPAI project.

are widely distributed in the peri-urban areas. The density of backyard poultry farms and markets for livestock inputs (feeds, drugs, etc) is very high in Agege (Oko-Oba) areas in Lagos State and Oke-Aro areas in Ogun State.

Some small commercial poultry producing farms with a flock size ranging from 1000 – 4999 birds are unevenly located across the six geopolitical zones in Nigeria. This sector focuses primarily on egg production with some farmers also engaged in broiler meat production simultaneously. Available data also show that most of these sector 3 farms are located in Lagos and Ogun States, and those states close to them. This could be due to the fact that Lagos and Ogun States are the major entry points for imported poultry inputs such as vaccines and drugs in Nigeria. Besides, the market for poultry products in Lagos and other southern states (especially eggs) is large. Large commercial farms of operation capacity within 5,000 and 100,000 birds dominate the commercial production sector. Many of those that have production capacity on the lower tail are widely spread in Lagos, Osun, Ogun, Oyo, Ekiti, Ondo, Delta, Edo and northern states. The second group of large commercial farms are those with relatively high production capacity as high as 250,000 birds. They are few in number and are mainly found in the southern Nigeria.

In terms of the linkage with other sectors, in the village extensive or free range production system, birds mainly depend on scavengable resource base (SRB) within the community. In the backyard semi-intensive/intensive production system, flock is fed with a combination of feeds purchased from feed mills and shop outlets. Feeds are expensive and as a result the smallholders usually produce feeds themselves using locally available inputs. Most backyard farmers produce their feeds using a mixture of local materials like corn and bone meal only or in combination with oyster shell, fish meal, and wheat offal.

Commercial farmers obtain their feeds from both local and international sources. Many operators in the commercial poultry sector also have their own feed mill. Another common group in feed production in the country are the toll millers who do not package processed feeds into the market but only mill ingredients for poultry farmers for a fee and thus are usually located within surroundings of livestock farms (e.g. Oke-Aro area in Ogun State and Oko-Oba area in Lagos).

Until 2002 when the government placed a ban on the import of poultry and poultry products, imports comprised a very significant source of inputs (D.O.C, equipment, feed concentrates, drugs, vaccines, etc) and poultry products (such as frozen chicken, frozen turkey, etc). Illegal import of poultry is very important but has not been quantified.

Nigeria imports products of animal origin from majority of its neighbors like Ghana and Cameroon. The importation of live animals and products of animal origin in the country has been on an increasing trend since 1999.

With a rapid spread of HPAI across many states in Nigeria within a year of its emergence, it is also important to review the distribution of trading activities across the zones. Most of the import took place in South-West (Lagos) and south in 2006. But the disease spread to other regions where inter-zonal trade also had a role to play (Uzochukwu Obi et al 2008).

3.5.2 Implications for modeling of macroeconomic impact of HPAI in Nigeria

In this project it is proposed that a CGE model be applied to assess the macroeconomic impact of a HPAI outbreak in Nigeria.

In terms of data, the social accounting matrix that Paul Dorosh developed at IFPRI has a base year of 1987. Nwafor et al have the SAM for the base year 1997. Both these datasets are quite aggregated and need to be disaggregated to capture poultry as a separate sector. Like in other countries, disaggregating the poultry sector itself is important for a country like Nigeria.

For spatial data FAO's Animal Production and Health Division has, in collaboration with the Environmental Research Group Oxford (ERGO) developed the "Gridded Livestock of the World" (GLW). The GLW's main objective is to produce and distribute contemporary global distribution maps for the main species of livestock. These maps are created through the spatial disaggregation of sub-national statistical data based on empirical relationships with environmental variables in similar agro-ecological zones. The data are produced in ESRI grid format at a spatial resolution of 3 minutes of arc (roughly 5 km at the equator) for cattle, buffalo, sheep, goats, pigs and poultry/chickens and are freely available for download via FAO's GeoNetwork data repository. In a big country like Nigeria spatial data could be extremely relevant.

Nigeria has a 2004 Living Standards Survey that could be used in combination with the CGE model. The household level impact should aim to get impacts by poultry sector type and household categories.

4.   Conclusions

This paper suggests a common framework for assessing the impact of an AI outbreak in the five countries covered in the project. These countries differ on three main aspects that have implications for the modeling techniques to be adopted (in addition to the data availability that will determine modeling choices). These are whether or not the country in question had an AI outbreak, what is the importance of poultry sector in the national and regional economy and what are the potential disease risk spread mechanisms.

The choice of the models will be based on these criteria. Moreover a common principle guiding the methods in the project is to combine the information and knowledge from the other components of the project (disease risk work package) into the analysis. The approach in this project is to appeal to the existing methods and enrich them with the knowledge from other disciplines.

A CGE or a multi-market model that is regionally disaggregated and draws upon shocks from an epidemiological model is suggested as the common method. All models are suggested to link up with household data. The estimated impacts are likely to be most meaningful by differentiating the results by the type of poultry sector. In some countries, disaggregation of SAM to include the poultry sector is required. A more challenging job however is to disaggregate the poultry sector itself into different components such as backyard and commercial production.

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