

Research



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Assessment of the risk of outbreak of avian influenza in poultry farms in Ebonyi State, Nigeria: a cross-sectional study, 18th to 25th January, 2022

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Abstract

Introduction: sporadic outbreak of avian influenza (AI) is still being reported in Nigeria, albeit with increased disease incidence amongst intensive commercial poultry flocks. The purpose of this study was to conduct a rapid risk assessment (RRA) to determine the risk factors that may be associated with the introduction and spread of highly pathogenic avian influenza (HPAI) in poultry farms within Ebonyi State, Nigeria. **Methods:** this study was conducted from 18th to 25th January 2022. A rapid risk assessment team (RRA) was constituted, (Federal and State epidemiology officers, regional disease investigation surveillance system evaluation veterinary officers, and avian influenza (AI) desk officers in the 3 senatorial zones of the state). We reviewed the poultry disease line list obtained from the Epidemiology Unit of the Federal Department of Veterinary Services, Ebonyi State, Nigeria. We purposively identified poultry farms with a high incidence of suspected cases of Newcastle diseases (NCD) and confirmed cases of highly pathogenic avian influenza (HPAI) and conducted a RRA for the outbreak of HPAI based on the technical guidelines of the Food and agricultural organisation (FAO), rapid risk assessment for animal health threat. We defined RRA triage with an indicator score (yes) ≥ 50 , defined the hazard profile of HPAI, develop risk questions for RRA, plotted the scenario tree for the introduction of HPAI into poultry farms and determined the risk of an outbreak of AI in Ebonyi State, Nigeria. Additional information was obtained by the administration of a structured questionnaire, which accessed sources of poultry, poultry husbandry, biosecurity measures, and management of poultry flocks. **Results:** in all, we accessed 17 poultry farms in the three senatorial zones of Ebonyi State, the proportion of livestock kept were swine and poultry chicken, 4 (24%), ducks, poultry chicken, 2 (12%), swine, ducks, poultry chicken (6%), poultry chicken alone 10 (59%), 16 (96%) of poultry farmers obtained their poultry flock from plateau, Oyo, and Nasarawa State, Nigeria. Availability foots deep on farms are,

4 (24%), none of the farms visited has an isolation pen. In an event of an outbreak of AI 15 million poultry chicken may be at risk in the study area.

Conclusion: there is a high risk for the outbreak of AI in poultry farms accessed during the study period. An outbreak of AI may occur through the movement of apparently healthy poultry flocks by middlemen from states with confirmed outbreaks to Ebonyi State, the non-availability of biosecurity structures on the farms may ensure spread of infection within and between contiguous poultry units. Similarly, sales of poultry waste to crop farmers who use them as animal manures may contribute to the spread of HPAI, local chickens, wild birds, swine which scavenge on these poultry waste may contribute to the emergence of reassortant influenza strains with no prior human or animal immunity.

Introduction

The outbreak of avian influenza, (H5N1) was first reported in Nigeria in 2006 through 2008 [1-3], which resulted in the death of over 1.2 million poultry birds [3], one human mortality was reported in Lagos State [4]. Nigeria was declared free of avian influenza in 2013, [5]. However, in 2014, [6] reported circulating level of low pathogenic avian influenza (LPAI) in a pool of ducks at Shasha live bird Market (LBM) in Ibadan, [6], this may have underscored the assertions that Nigeria was free of HPAI, [7]. Consequently, in 2015, a resurgence of highly pathogenic avian influenza (HPAIV) was reported following increased mortality at a live bird market and backyard poultry farms in Lagos and Kano State respectively, [3,8]. This resulted in the loss of over 3.6 million poultry flocks and compensation paid to the tune of USD 7.2 million [7]. Retrospective reviews of outbreaks of highly pathogenic avian influenza (HPAI) in Nigeria, between 2015-2017, showed that 80% of the confirmed cases were reported amongst backyard poultry flocks and small scale poultry holdings [8]. However, from the 3rd quarter of 2021, to the 1st quarter of 2022, 21 states, have reported

outbreaks of HPAI, with increasing incidence in the number of cases within intensive commercial poultry farms. Ebonyi State has reported 4 confirmed outbreaks of HPAI, in 3 local government areas LGAs (Ebonyi, Izzi, Ohaukwu), between the 10th of January to 2016, to February 2019. The purpose of this study was to conduct a RRA to determine the risk factors that may be associated with the introduction, spread of HPAI into poultry farms within Ebonyi State, Nigeria.

Methods

Study area: Ebonyi State is located in the South-East of Nigeria on Latitude 6°15'N, Longitude 8°05'E, bordered by Enugu State to the West, Cross River State to the East, Benue and Abia State to the North and South [9] (Figure 1). Farming is the primary occupation of the people of Ebonyi State [10]. Nigeria has an estimated poultry population of 180 million, of these 80 million poultry chickens are raised in the extensive system, 60 million in the semi extensive system and 40 million in the intensive system [8,11]. Ebonyi State has an estimated poultry population of 15 million. The poultry subsector in Nigeria is the most capitalized of the agricultural sector estimated at 22 billion dollars per annum [1].

Study design: this study was conducted from 18th-25th January 2022. A rapid risk assessment team (RRA) which consist of the Federal and State epidemiology officers, regional disease investigation surveillance system evaluation (REDISSE) veterinary officers, and the avian influenza (AI) desk officers in 3 senatorial zones of the state was constituted. We reviewed the poultry disease line list from the Epidemiology Unit of the Federal Department of Veterinary Services in Ebonyi State, Nigeria.

Study population: we purposively identified poultry farms with a high incidence of suspected cases of Newcastle diseases (ND), and confirmed cases of highly pathogenic avian influenza (HPAI), chosen as sight for rapid risk analysis.

Estimated population of poultry in Ebonyi State at risk of avian influenza in 2022: we the estimated population of poultry in Ebonyi State from known variables on population of poultry in Nigeria 2003 and 2006 published by Adene and Oguntade [12,13]. Based on the formula:

$$S(\text{sum}) = n/2[(2a + (n - 1)d)]$$

Where n is the number of years from 2003 to 2022, a is the population of poultry in 2003, and d common difference, assuming the poultry population increase or decrease in arithmetic progression. Similarly, we a determined the percentage increase/decrease in the number of poultry from 2003 to 2006, given as:

$$n = \frac{\text{Number of poultry in 2006} - \text{Number of poultry 2003} \times \%}{\text{Total number of poultry in Nig. In 2006} - \text{Total no of poultry in Nig. 2003}} = \frac{219926 - 588947 \times 100}{65269582 - 137678943}$$

7.8% increase/decrease from 2003 to 2006 in 3yrs then=7.8/3=2.6%, increase/decrease in estimated poultry population.

$$S = n/2[(2a + (n - 1)d),$$

; $S = 19/2[(2 \times 5889847 + (18)566992)] = 9.5(11779694 - 10205856) = 1573838 \times 9.5 = 14,951,461$. Since annual increase in population of poultry in Nigeria between 2003 to 2006 = 2.6% of 14951461 = 388,737.986. Therefore, the total estimated poultry population in Ebonyi State in 2022 = 14,951,461 ± 388,738 = 15 million.

Data collection: was collected using ODK software's. We conducted a rapid risk assessment for an outbreak of HPAI based on technical guidelines of the Food and Agricultural Organisation (FAO), "rapid risk assessment for animal health threat", [13]. We defined RRA triage (Table 1), determined population of poultry at risk of AI in Ebonyi State in 2022. We defined the risk question for outbreak of highly pathogenic avian influenza, (Annex 1), plotted the scenario tree for the introduction of HPAIV into poultry farms (Figure 2) and determined the risk of an outbreak of AI in Ebonyi State, Nigeria. Additional

information was obtained by the administration of a structured questionnaire, (Table 2) which accessed sources of poultry, husbandry, biosecurity measures, and management of poultry flocks using open data kit (ODK) software.

Data analysis: questionnaires responses was downloaded in Microsoft Excel format from the server (google drive), frequencies of responses was determined using Microsoft Excel outcome was displayed in tables.

Ethical consideration: based on technical guideline of Food and Agricultural Organisation (FAO).

Results

Overall risk assessment statement: what is the probability of the introduction, spread of HPAI from affected states into Ebonyi State in the next six months with severe economic losses in the poultry subsector? Retrospective investigation showed that 16 (96%) of poultry (day old chick, point of lay, broilers) were sourced from Oyo, Nasarawa, and Plateau State respectively. These aforementioned states have reported a resurgence of avian influenza in 2021. Furthermore, Chieloka, 2021, [8], identified Plateau State, as a major hotspot for avian influenza in Nigeria. The risk of spread of avian influenza between contiguous poultry farms in Ebonyi State was high, we found out that 14 (80%) of the poultry farmer interviewed had none to inadequate biosecurity structures in place on the farms, the absence of foot deep, isolation pens, lack of farm records are the risk factor for the outbreak of diseases and were common features of most poultry farms visited by the rapid assessment team, similarly, these farms have been reporting high burden of suspected Newcastle disease (NCD) which may be false-positive cases for avian influenza since diagnosis was not based on laboratory test on suspected cases of NCD. During the study unusual poultry mortality was reported at the Live Bird Market (LBM) on latitude:

N6.2015072, longitude: 8.55374 E, we identified cases of moribund, dead poultry chicken amongst apparently healthy chicken on sale at the market, whole chicken carcass samples, (Figure 3) collected and sent to National Veterinary Research Institute, (NVRI, Jos) for laboratory diagnosis, was confirmed to be positive for HPAI H5N1, laboratory identification number, (VPD 172-A/22). LBM has since been decontaminated and disinfected. Similarly, available records showed that most poultry farmers in Ebonyi State stock their farms in anticipation of sales during festivities, consequently, the risk of disease outbreak may be higher during the festive period (January, April and December), due to increased movement of poultry and poultry products between contiguous states, live-bird markets, farms and households albeit with poor biosecurity/biosafety measures in place.

What is the distribution of poultry, sentinel animals (pigs), in mixed poultry farms as a risk factor for the spread of HPAI in Ebonyi State in the next 6 months? The RRA team assessed 17 poultry farms in the three senatorial zones of Ebonyi State, the proportion of livestock kept were, swine and poultry chicken, 4 (24%), ducks/poultry chicken, 2 (12%), swine/ducks/poultry 6%, chicken, poultry chicken alone, 10 (59%), mixed poultry farming involving pigs are risk factors for the emergence of reassortant influenza strains, pigs are mixing vessels for the genetic reassortment of homologous and heterologous influenza strain, which may lead to persistence of viral organism within the poultry subsector, thus the emergence of more virulent viral agents better adapted to cause infection in man and animals. It is worthy of note that the emergence of avian influenza H5N8 in the poultry subsector in Nigeria was identified in a pool of ducks at a free-range backyard poultry farm in Kano State, Nigeria in the 3rd quarter of 2016 [8], before 2017, avian influenza H5N1 has been responsible for major outbreak of AI in Nigeria, however, the isolation of H5N8 from a pool of ducks in 2016 may have marked a paradigm shift in the epidemiology of

avian influenza in Nigeria. In Ebonyi State, the spread of avian influenza between farms may be potentiated due to poor adherence to biosecurity measures within and between contiguous farms, an outbreak of HPAI may occur during the months of (January, April, December) due to increased stocking of poultry flocks, movement of poultry and poultry product in anticipation of the festive periods.

What is the estimated population of poultry that may be affected in an event of an outbreak of highly pathogenic avian influenza in Ebonyi State, Nigeria in the next 6 months, sources of information. According to Adene *et al.* 2008, the population of poultry in Ebonyi State, Nigeria was estimated at 5,889,847 and 219,926 in 2003 and 2006 [12]. We determined the estimated population of poultry in Ebonyi State to be 15 million. In an event of an outbreak of highly pathogenic avian influenza about 15 million poultry would be at risk of infection, households who depend on the poultry business, and its value chains would be most affected, further contributing to the economic losses already inflicted on the populace by the global pandemic COVID-19. The economic loss of such an outbreak is estimated at over 20 million dollars, based on USD 1.5 compensation per adult birds depopulated (2015-2018). However, this applies to farms with ≤ 3000 poultry, poultry farms more than 3000 birds are expected to be insured.

What is the possible sequence of events and risk factors that may contribute to an outbreak of HPAI in Ebonyi State in the next six months? The most likely sequence of entry of HPAIV into the poultry subsector in Ebonyi State was by the movement of infected poultry flocks, contaminated poultry products supplied by middlemen from states with confirmed outbreaks of HPAI, (Figure 2), non-adherence to biosafety measures by farmers may lead to zoonosis, absence or non-availability of biosecurity structures on farms may ensure the spread of infection to contiguous farms, similarly sales of poultry waste and leftovers to crop farmers who use such as animal manures, may

contribute to spread of HPAI. Similarly, local chickens, wild birds, pigs who scavenge on these poultry leftovers may contribute to the emergence of reassortant influenza strains with potential zoonotic risk.

Discussion

As of the 3rd quarter of 2021, 20 of the 36 states in Nigeria have reported the resurgence of highly pathogenic avian influenza. One confirmed case of HPAI was reported at a LBM during the rapid risk assessment. Investigation showed that poultry destined for Ebonyi State where sourced mainly from three states (Plateau, Oyo, Nasarawa). This brings to focus the increasing incidence of a suspected outbreak of Newcastle diseases reported by poultry farmers interviewed more so when the diagnosis of NCD was based on clinical symptoms alone. Furthermore, 14 (80%) poultry farm assessed had inadequate or no biosecurity structures on the farms the absence of (foot deep, isolation pen, absence of farm records) are risk factors for the outbreak of HPAI. It is plausible that movement or transport of apparently healthy, poultry flocks sourced from a state with a confirmed outbreak as was the case during the study the cheap cost of these poultry flocks raises suspicion it's health. Similarly, the poor or non-observance of minimum biosecurity measures use of foot deep, poor records keeping by farmers may be inimical to the national drive to stamp out avian influenza in the poultry subsector in Nigeria. Mixed poultry farming including the rearing of different poultry flocks, sentinel animals (pigs) is risk a factor for outbreak and emergence of reassortant avian influenza strains. In an event of an outbreak of highly pathogenic avian influenza in Ebonyi State, it's estimated that about 15 million poultry chickens would be at risk. The attendant economic loss is estimated at over 20 million dollars.

Conclusion

There is a high risk for the outbreak of HPAI in poultry farms accessed during the study period. Poor adherence to biosecurity measures on farms including the absence of foot deep, perimeter fencing and isolation pens are risk factors for the outbreak of HPAI, furthermore, poultry flocks sourced from middlemen in states with confirmed cases of avian influenza may contribute to the spread of the virus within the poultry subsector. In an event of an outbreak of highly pathogenic avian influenza about 15 million poultry would be at risk of infection, a household that depends on poultry farming, its value chains would be most affected, the attendant economic loss due to such an outbreak is estimated at over USD 20 million, coupled with other compensation claims by affected farmers may further deplete the already dwindling national reserve. The entry of AI into the poultry subsector may be through the movement of apparently healthy poultry flocks by middlemen from states with confirmed outbreaks into Ebonyi State, non-availability of biosecurity structures on farms may ensure the spread of infection within and between contiguous farms. Similarly, sales of poultry waste and leftovers to crop farmers who use them as animal manures may contribute to the spread of HPAI, local chickens, wild birds, swine which scavenge on these poultry leftovers may play a role in the emergence of zoonotic/reassortant influenza strains with no prior human or animal immunity. To this end we recommend that the state department of veterinary services should develop minimum operating, biosafety and biosecurity standard for would be poultry farmers before production licence are granted, the live bird market should be made exclusive for sales of poultry chicken, with a view to separate poultry business from other market activities, as such reduce the risk of zoonoses. As far as practicable epidemiology unit should discourage mixed poultry production especially rearing of poultry with other sentinel animals (pigs), sensitize poultry stakeholders on the need to observe, maintain

biosecurity/biosafety measures along poultry production value chains, poultry manure should be processed, packaged in an aseptic way before being sold for use as organic manure to other farmers, alternatively, the state government should subsidize the cost of organic manure for would be poultry farmers this may reduce the risk of spread of infection and intensify disease surveillance especially in the month of (January, April, December) since these months are associated with increased movement of poultry and poultry product in anticipation of festivities. Expert opinion: sufficient evidence, information and opinions of researchers on HPAI, RRA was obtained from [1, 3,8,12,14].

Funding: this study was funded by Food and Agricultural organization (FAO).

What is known about this topic

- *Sporadic outbreak of HPAI is still being Nigeria;*
- *There is increasing incidence in number of AI cases in intensive commercial poultry farms;*
- *Ebonyi State has reported 4 confirmed outbreaks of HPAI, in 3 local government areas LGAs.*

What this study adds

- *Sales of poultry waste to crop farmers as animal manures may contribute to spread of HPAI by resident local chickens, wild birds, and who scavenge on hem;*
- *In an event of an outbreak of HPAI about 15 million poultry would be at risk in Ebonyi State;*
- *There is poor adherence to biosecurity measures, absence of foot deep, perimeter fencing and isolation pen in most farm accessed are risk factor in outbreak, spread of HPAI.*

Competing interests

The author declares no competing interest.

Authors' contributions

Dr Okoli Solomon Chieloka wrote this manuscript. The author has read and agreed to the final manuscript.

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Tables and figures

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Table 2: questionnaire responses on risk assessment of HPAI in poultry farms in Ebonyi State

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Figure 2: scenario tree for the introduction of HPAIV into Ebonyi State through entry of infected poultry flocks (day old chicks, layers, pullets, and broilers), its products and spread within sentinel animals (pigs) in farms and human

Figure 3: carcass of suspected cases of avian influenza

Annex

Annex 1: health event and risk questions for outbreak of avian influenza

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Table 1: triage for evaluation of the need for rapid risk assessment

Criteria	Yes(1)	No(0)	Unknown(*)
Credibility of data sources			
Has the health event been reported by multiple independent and reliable unofficial sources, (OIE, ARIS II, FMARD)		0	
Has the health event been reported or confirmed by an official source? HPAI outbreak in Ebonyi (NVRI, Jos 2016, 2019)	1		
Disease severity and consequence			
Any international spread of the HPAI from Ebonyi State		0	
Has the disease been shown to have a significant impact on the health of domestic animals in multiple countries?	1		
Is it a zoonotic disease associated with severe consequences for public health?	1		
Has the disease been shown to have a significant impact on animal production and/or trade with possible detrimental economic consequences for the affected country	1		
Has the disease been shown to have a significant impact on the health of wildlife or on the environment, including biodiversity, in one or more countries?			*
Has the causative agent of the disease developed resistance to treatments, thereby posing a significant danger to public and/or animal health?			*
Relevance of the health events			
Is the observed health event possibly linked to the evolution or change of an existing Disease agent?	1		
Is the observed health event related to the spread of a known disease to a new geographic area, species or population?	1		
Is the observed health event related to a known disease that is occurring with increased incidence or morbidity in the host population(s)?	1		
Is the observed health event caused by an unknown or previously unrecognized disease agent?		0	
Is the observed health event affecting vulnerable groups of the population, such as infants or elderly people, who are likely to be disproportionately affected?			*
Is the observed health event attracting a high actual or potential level of media interest or public concern?	1		
Sub-total=14 key *unknown	8(57%)	3(21%)	3(21%)

Table 2: questionnaire responses on risk assessment of HPAI in poultry farms in Ebonyi State

Sources of poultry	Value (percentages)
Oyo State(South West), Nasarawa State (North central), Plateau State (North central)	16(96%)
Local breeders	6%
Management/biosecurity practices	
Availability of foot deep on farms	
Yes	4(24%)
None	13(77%)
Availability of isolation pen on farms	
Yes	0
No	17(100%)
Farms practices all in all out stocking of poultry chicken	
Yes	8(47%)
No	9(53%)
Type flock, animals managed on poultry farms	
Swine and poultry chicken	4(24%)
Ducks/poultry chicken	2(12%)
Swine/ducks/poultry chicken	6%
Only poultry chicken	10(59%)

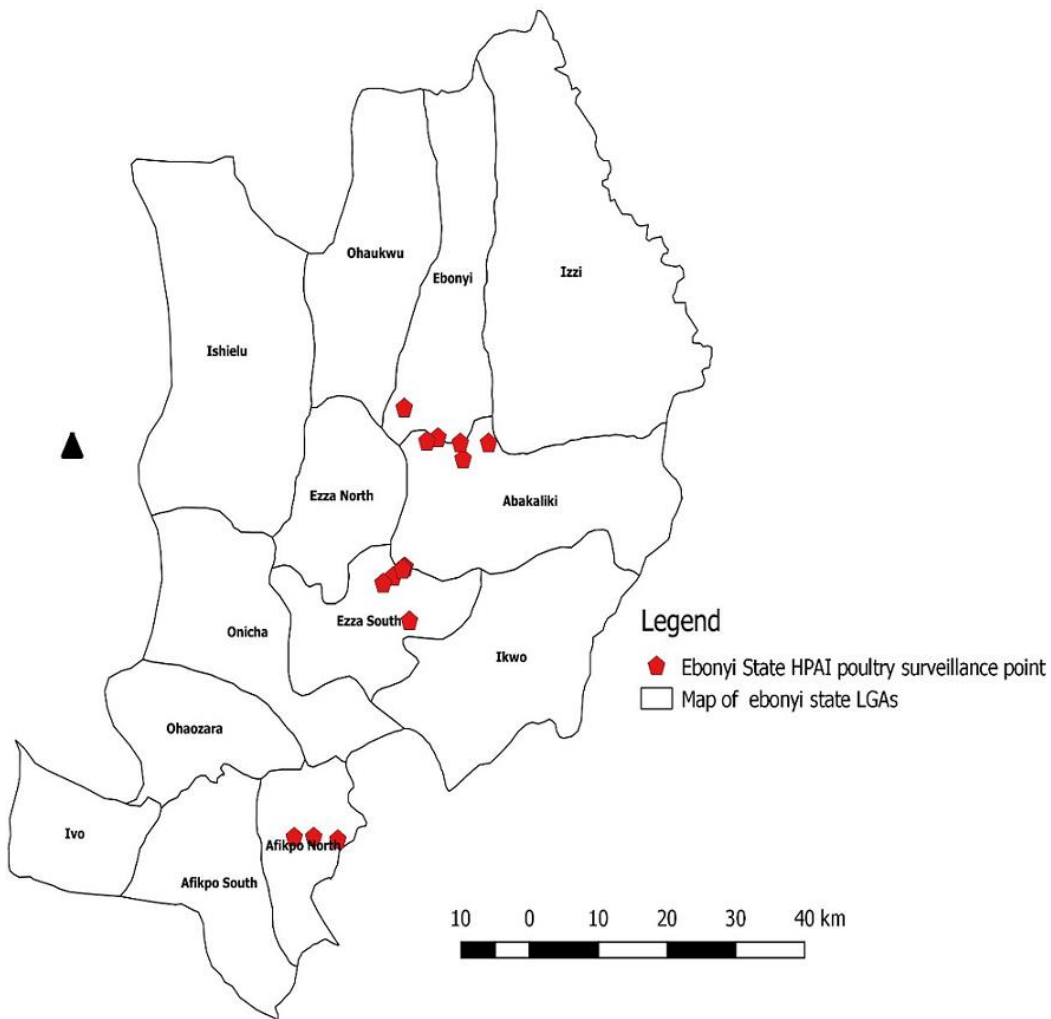


Figure 1: map of Ebonyi State showing local government areas and surveillance points for HPAI

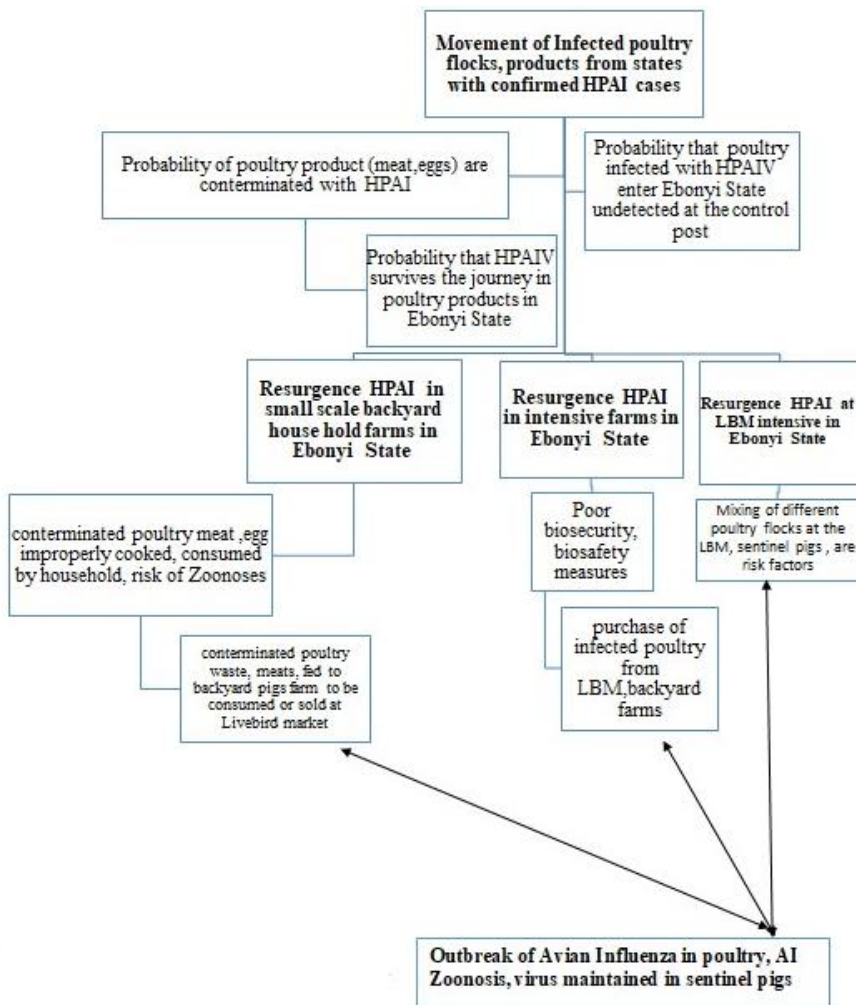


Figure 2: scenario tree for the introduction of HPAIV into Ebonyi State through entry of infected poultry flocks (day old chicks, layers, pullets, and broilers), its products and spread within sentinel animals (pigs) in farms and human



Figure 3: carcass of suspected cases of avian influenza