Economic Losses and Implications of Highly Pathogenic Avian Influenza (HPAI) H5N1 Resurgence in Nigeria

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Abstract
Highly pathogenic avian influenza (HPAI) virus of the H5N1 subtype is a disease that has devastating effect on the poultry industry. So far, over 3.7 million birds have been culled and over 4million birds exposed in the current resurgence of the virus in Nigeria which was officially confirmed in the country on the 2nd of January 2015. H5N1 was first detected in the country in February 2006, in chickens at a commercial poultry farm in Kaduna state, Northern Nigeria and over 1.2 million birds were culled in the outbreaks that occurred from 2006 to 2008. This has led to the implementation of this study to estimate the losses due to the current resurgence in the country. Analyzed data revealed; total cost of birds exposed (dead birds + culled birds) at ₦8,131,752,000.00 (US$26,614,361.46); total cost of birds culled [₦7,472,048,000.00 (US$24,455,220.27)]; total cost of birds that died (mortality) at ₦659,704,000.00 (US$2,159,141.19); total cost of eggs destroyed (₦68,876,053.33 /US$225,424.02); estimated cost of feed destroyed =₦900,000.00 (US$2,945.61) and total cost of losses from farmers alone [estimated direct loss]= ₦8,201,528,053.00 (US$ 26,842,731.08). Calculated production loss [indirect loss] as it relates to egg production by layers was ₦1,549,974.667.00 (US$5,072,902.62). The direct and indirect losses encountered by farmers amounted to ₦9,751,502,720.00 (US$31,915,633.70). The total compensation [paid compensation (₦674,238,300.00 / US$2,206,710.41) + outstanding compensation (₦1,767,974,498.00 / US$5,786,392.94)] was ₦2, 441,987,798 / US$7,992,366.95. The percentage of compensation [paid + outstanding] compared to the direct loss by farmers is 29.78% while the estimated percentage of the poultry industry affected based on the current poultry population was 2.5%. The ratio of birds killed to those that were culled is 1:8.8. The direct economic losses in the current HPAI H5NI resurgence is much more than the previous outbreaks that occurred from 2006 to 2008 in the country and the percentage of birds that were exposed to the total poultry population have more than doubled that of the previous outbreaks (2006-2008). This is an indication that more jobs have been lost, more loss in production and its attendant effect on businesses that are related to poultry production in the country such as veterinary health care services, the poultry feed industries and restaurants. Furthermore, there is need to implement government plans on ground such as intensive biosecurity and strict movement control in order to curtail the current outbreaks and possible elimination of the disease from the country. In essence. There is need for timely payment of compensation to the farmers to encourage effective disease reporting by affected farmers and also reduce the spread of the disease to other farms.

Index Terms— Economic losses, direct losses, indirect losses, impact of losses, HPAI H5N1, Nigeria, Farmers

1 INTRODUCTION

The Nigerian poultry industry is one of the main agricultural industries in the livestock subsector (LSS). As a unit of the LSS, the industry attracts investment and yields at a net worth of US$ 1.7 billion a year (FRN, 2007; SAHEL, 2015). It is the most commercialized of all of Nigeria's agricultural subsector and fastest expanding segment in the animal husbandry subsector but still faces many problems (Heise *et al*., 2015; SAHEL, 2015) and is estimated at ₦80 billion ($600 million), comprised of approximately 165 million birds, which produced 650,000 MT of eggs and 290,000 MT of poultry meat in 2013. From a market size perspective, Nigeria's egg production is the largest in Africa (South Africa is the next largest at 540,000 MT of eggs) and has the 2nd largest chicken population after South Africa's 200 million birds (SAHEL, 2015). Analysts have projected a 20% annual growth in the poultry industry between 2010-2020 driven by Nigeria's large population and rapidly growing middle class (SAHEL, 2015).

Livestock production contributes 6-8% of the Gross Domestic Products (GDP) and 20-25% of the Agricultural GDP providing about 36.5% of the total protein intake of Nigerians (FMARD, 2017). Although Nigeria is a net importer both in terms of livestock products and poultry in particular, it is believed to have potential for export (OIE, 2007). High population growth and growing income led to increasing demand for poultry products in Nigeria. Most rural households have poultry cared for by women, children and vulnerable people (the aged and physically challenged) (Ntsefong *et al*., 2017). Family poultry generates 19–50% of rural family income, makes up about 77% of the national flock and contributes about 98% of poultry products consumed in the villages of developing countries (Alders, 1996).

Highly pathogenic avian influenza (HPAI) virus of the H5N1 subtype in Nigeria was first detected in February 2006, in chickens at a commercial poultry farm in Kaduna state, Northern Nigeria (Bird Flu Watch, 2009; Fusaro *et al*., 2009). From February 2006 to July 2008, outbreaks of HPAI (H5N1) virus infection had a negative effect on poultry, public health as well as the agricultural sector and trade (Monne *et al*., 2014). These outbreaks were caused by viruses belonging to genetic clades 2.2 and 2.2.1 (Fusaro *et al*., 2010).

In January 2015, seven years after disappearance of the virus, clinical signs of HPAI (swollen head and wattles, hemorrhagic shank and feet) and increased mortality rates were observed among backyard poultry in Kano and in a live bird market in Lagos State, Nigeria (Monne *et al*., 2014). The results obtained from whole-genome analysis provide evidence that a novel clade of the A (H5N1) virus, specifically clade 2.3.2.1c, has reached Nigeria. The identification of genetic clustering between the strains from Nigeria and the HPAI A (H5N1) viruses originally identified in Asia suggests an unknown epidemiologic link between these regions, probably associated with human activities, migratory bird movements, or both (Monne *et al*., 2014).
So far, over 4 million birds (culled and died) have been affected by the HPAI resurgence in the country which led to the necessity of this study to estimate the losses encountered by farmers and to relate the impact on the economy.

2 MATERIALS AND METHODS

Data on the ongoing resurgence of Highly Pathogenic Avian Influenza (HPAI H5N1) from December 2014 to May, 2017 was collected and collated by the Epidemiology Division of the Department of Veterinary and Pest Control Services, Federal Ministry of Agriculture and Rural Development (FMARD), Abuja, Nigeria. A farm survey of prices of birds (broilers, layers and local chickens) was conducted and the average cost was calculated based on the current prices.
Total cost of birds exposed = Estimated cost of live bird (₦2000) x (total number of birds destroyed + total mortality)
Percentage of compensation paid compared to the direct loss by farmers =

$$\frac{Total\ compensation\ paid + outstanding\ compensation}{Total\ cost\ of\ loss\ by\ the\ farmers} \times \frac{100}{1}$$

Total cost of birds culled = Total number of birds culled × estimated cost of a bird (₦2000). This flat rate was given because majority of the birds that were culled were layers followed by broilers.
Total cost of birds that died (mortality) = Total mortality × estimated cost of a bird (₦2000)
Total cost of eggs destroyed = Total number of eggs destroyed/ 30 (eggs in a crate) × estimated cost of a crate of egg at farm level (₦800)
7500kg of feed were destroyed/ weight of a bag of feed (25kg) = 300 bags of feed
Therefore the estimated cost of feed destroyed = Total number of bags of feed destroyed × Average cost of a bag of feed in the market (₦3000).
Estimated production loss of layers:
Total number of layers destroyed × average number of eggs produced within a period of 3months (50 eggs).
Average number of eggs produced by a hen with a production cycle (52-56 weeks) = 180-200 eggs per hen (FAO, 2003). There within 3 months (200/4) = 50 eggs
Number of crates of eggs that would have been destroyed = [total number of eggs to be produce (58,124,050)/30 eggs in a crate].
Therefore total loss in egg production = 1,937,468.33 crates × cost of a crate (₦800)
Total estimated direct loss= Total cost of birds exposed + Total cost of eggs destroyed + estimated cost of feed destroyed
Percentage of exposed birds (died + culled) as compared to the current stipulated poultry population in Nigeria (165 million) =

$$\frac{total\ number\ of\ birds\ exposed\ (4{,}065{,}876)}{current\ sted\ poultry\ population\ in\ Nigeria\ (165{,}000{,}000)} \times 100$$

Population of poultry in Nigeria is estimated at 165million birds (SAHEL, 2015).
Conversion from Naira to Dollar was done at the official exchange rate of Naira to Dollar (USD) at the rate of ₦305.54 to a dollar ($) (CBN, 2017), prevailing rates as at May, 2017, source(CBN Monthly Average Exchange Rates of the Naira; Naira Per Unit of Foreign Currency (*https://www.cbn.gov.ng/rates/exrate.asp*)

3 RESULT

Table 1: Indicating detailed summary of farms affected and compensation claims by state in Nigeria (2015- May 2017)

S/NO	State	No. of LGAs affected	Total number of farms affected	Total number of LBMs affected	Total number of birds exposed	Total number of birds that died (mortality)	Total number of layers culled (outstanding payment)	Total number of birds culled	Total number of eggs destroyed	Total number of feed destroyed (Kg)	NO. of farmers paid	Amount paid	NO. of farmers outstanding	Amount outstanding
1	Kano	29	286	2	1,137,549	43,698	0	1,093,851	551,928	0	113	330,045,200	136	437,713,035.00
2	Lagos	10	30	6	94,339	11,935	71,628	82,404	50670	0	4	12,654,000	23	42,022,575.00
3	Ogun	5	7	3	83,441	5,703	29,814	77,738	2580	0	6	11,468,483	1	17,712,050.00
4	Rivers	3	50	0	121,768	28,586	82,443	93,182	36900	0	5	10,289,250	41	52,193,175.00
5	Delta	6	11	0	355,637	11,157	299,108	344,480	0	0	4	3,008,200	5	241,227,100.00
6	Plateau	4	227	0	733,153	27,064	0	706,089	359678	0	92	229,977,539	120	177,141,048.00
7	Edo	6	11	0	37,160	5,909	18,536	31,251	19360	0	2	1,504,500	4	12,639,580.00
8	Gombe	2	2	0	8,120	4,850	350	3,270	0	0	1	3,625,000.00	1	288,200.00
9	Imo	1	1	0	10,000	5,750	7,502	4,250	0	0	1	6,162,500.00	0	-
10	Oyo	4	8	0	29,250	15,807	7,378	13,443	0	0	4	8,333,325	3	3,490,250.00
11	Jigawa	6	6	0	14,685	2,629	6,143	12,056	4935	0	3	2,494,775	2	4,462,837.50
12	Kaduna	7	38	0	184,168	23,978	130,345	160,190	24060	0	3	3,184,500	26	70,581,725.00
13	Bauchi	5	33	0	217,543	20,106	98,185	197,437	67745	0	25	31,318,923	8	48,517,227.50
14	Zamfara	3	6	0	52,286	5,993	22,390	46,293	26058	0	3	10,956,935	3	14,944,900.00
15	Katsina	7	17	0	188,196	10,579	144,411	177,617	24751	0	2	5,158,025	14	102,541,757.50
16	Sokoto	4	5	0	14,000	3,016	3,150	10,984	0	0	4	1,951,500	1	2,347,625.00
17	Anambra	2	3	1	10,750	2,365	3,962	8,385	0	0	3	1,927,645	1	2,575,300.00
18	Nassarawa	2	5	0	153,897	21,531	110,257	132,366	5173	0	1	178,000	3	50,093,997.50
19	Enugu	3	4	0	127,493	29,429	85,844	98,064	0	0	0	0	4	60,220,300.00
20	Abia	2	2	0	6,569	2,518	1,742	4,051	0	0	0	0	2	2,011,375.00
21	FCT	3	17	1	425,967	40,096	0	385,871	1340822	0	0	0	13	390,748,990.00
22	Bayelsa	1	2	0	25,800	2,650	19,000	23,150	50400	7,500	0	0	2	16,240,000.00
23	Ebonyi	2	3	0	3,355	375	0	2,980	1200	0	0	0	3	1,827,750.00
24	Adamawa	3	3	0	28,900	3,380	17,915	25,520	5400	0	0	0	3	9,624,275.00
25	Kebbi	1	1	0	1,500	600	0	900	0	0	0	0	0	-
26	Benue	1	1	0	350	148	0	202	11192	0	0	0	1	6,629,425.00
	Total	**122**	**779**	**13**	**4,065,876**	**329,852**	**1,162,481**	**3,736,024**	**2,582,852**	**7500**	**276**	**674,238,300**	**420**	**1,767,794,498.00**

Source: Compiled by (Epidemiology Division, Department of Veterinary and Pest Control Services, FMARD, 2017) and modified

The total cost of birds exposed amounted to ₦8,131,752,000.00 (US$ 26,842,731.08) while total cost of birds those that were culled is ₦7, 472,048,000 (US$24,455,220.27) and the total cost of birds that died (mortality) is ₦659, 704,000 ($2,159, 141.19). Others include; total cost of eggs destroyed (₦68,876,053.33 / US$225,424.02), the estimated cost of feed destroyed (₦900,000 / US$2,945.61); total cost of loss by the farmers [estimated direct loss at (₦8,201,528,053.00/ $26,870,909.08)]. The indirect loss (egg production loss for 3 months) encountered due to culled layers was ₦1,549,974,667.00/ $5,072,902.62, while calculated direct and indirect losses was ₦9,751,502,720.00 / US$31,915,633.70. Total compensation [paid compensation (₦674,238,300.00 / US$2,206,710.41) + outstanding (₦1,767,974,498.00 / US$5,786,392.94)] = (₦2, 441,987,798 / US$7,992,366.95)] while the percentage of compensation paid compared to the direct loss by farmers amounted to 29.74% and the estimated percentage of the poultry industry affected based on the current poultry population was 2.5%. The ratio of birds killed to those that were culled was 1:8.8.

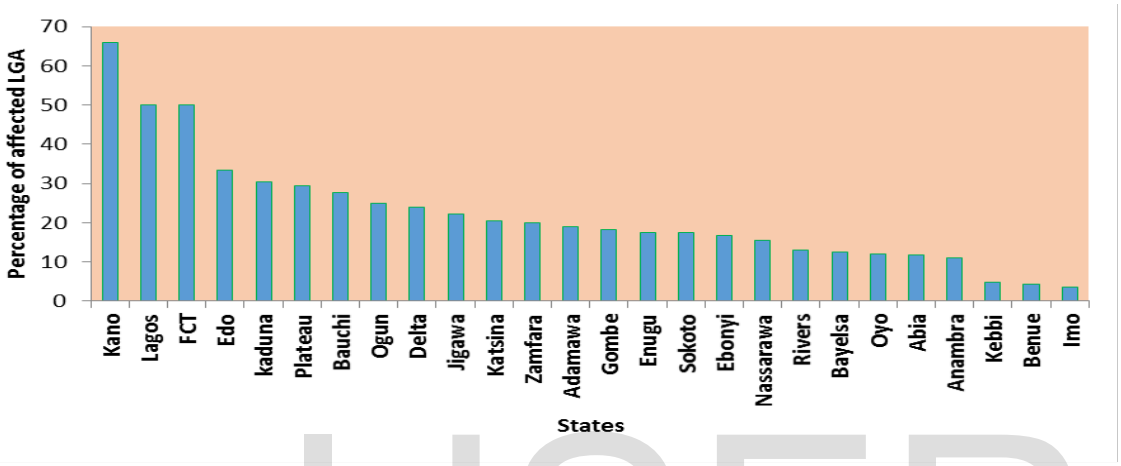

Fig 1: Affected States plus Federal Capital Territory (FCT) and proportion of affected Local Government Areas (LGAs)
Source: Epidemiology Division, Department of Veterinary and Pest Control Services, FMARD, 2017.

Analysis of data based on the affected state indicates that Kano state is the worst hit by the HPAI H5N1 resurgence, other states affected include; Lagos, FCT, Edo, Kaduna, Plateau, Bauchi, Ogun, Delta, Jigawa, Katsina, Zamfara, Gombe, Enugu, Sokoto, Eboyi, Nasarawa, Adamawa, Rivers, Bayelsa, Oyo, Abia, Anambara, Kebbi, Benue and Imo respectively as indicated above (Fig. 1). So far, 26 states including the FCT has been affected by the resurgence.

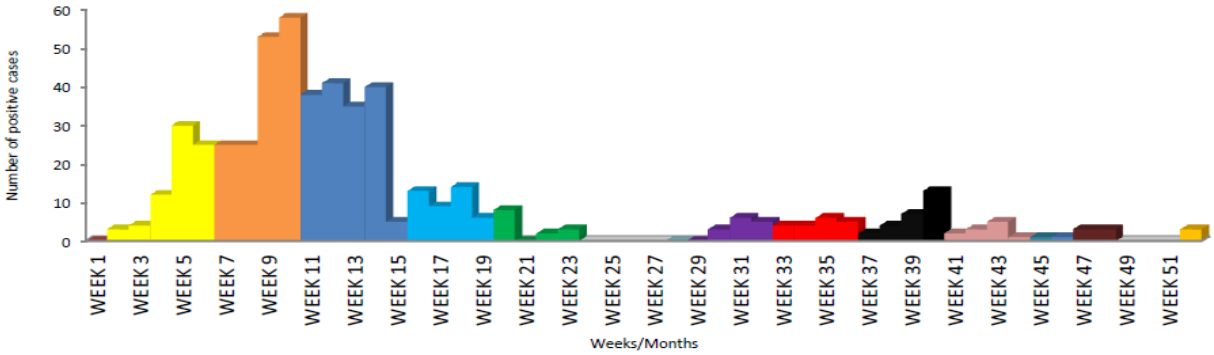

Fig 2: Epidemic Curve of HPAI Resurgence in Nigeria from 24th December, 2014 to 31st December, 2015
Source: Epidemiology Division, Department of Veterinary and Pest Control Services, FMARD, 2016.

The above diagram (Fig. 2) indicates that week's 5 to 14 of 2015 witnessed the peak of the outbreaks of HPAI H5N1 in the country which subsequently subsided.

Fig. 3: Epidemic Curve of HPAI Resurgence in Nigeria from 1st January to 31st December, 2016
Source: Epidemiology Division, Department of Veterinary and Pest Control Services, FMARD, 2017.

In 2016, as represented above (Fig. 3), the poultry industry was worst heat by the HPAI H5N1 outbreaks from week's 1-12 which drastically reduced up to the end of the year.

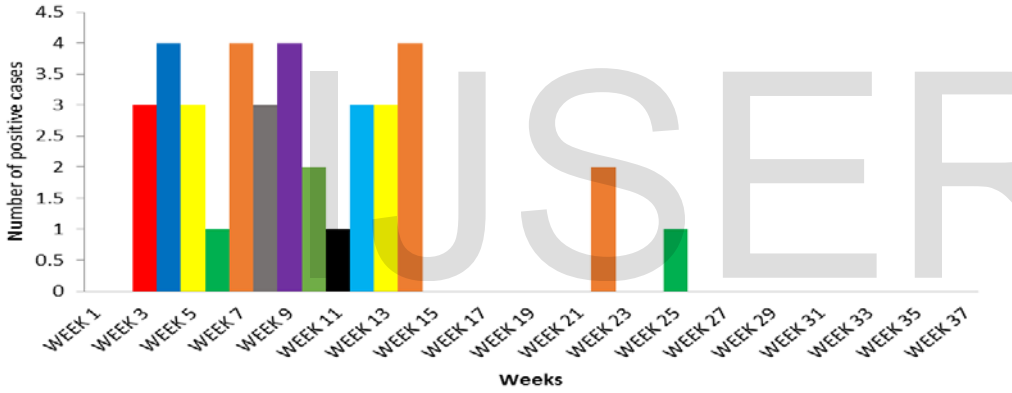

Fig. 4: Epidemic Curve of HPAI Resurgence in Nigeria from 1st January to September, 2017
Source: Epidemiology Division, Department of Veterinary and Pest Control Services, FMARD, 2017.

The above information (Fig. 4), signifies that the outbreaks occurred most in week's 3 to 14 of the year and later on in week's 22 and 25.

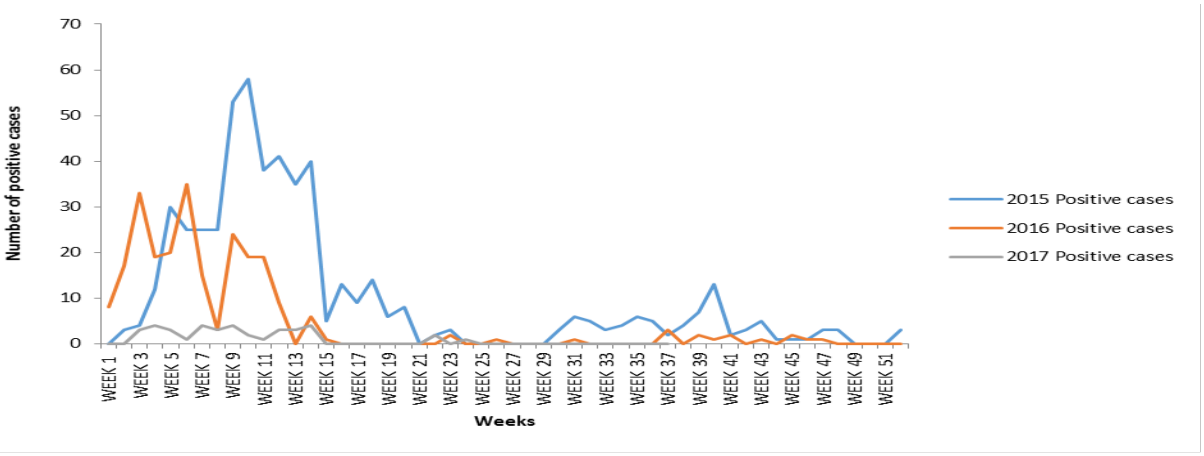

Fig. 5: Weekly trend of HPAI H5N1 cases in Nigeria (2015-2017)
Source: Epidemiology Division, Department of Veterinary and Pest Control Services, FMARD, 2017.

The epidemic curves of the years (2015-2017) in the country indicates that the outbreaks of HPAI H5N1 usually occurs most between week's 1 and 14 of the year indicating the seasonality of the outbreaks that is from January to April.

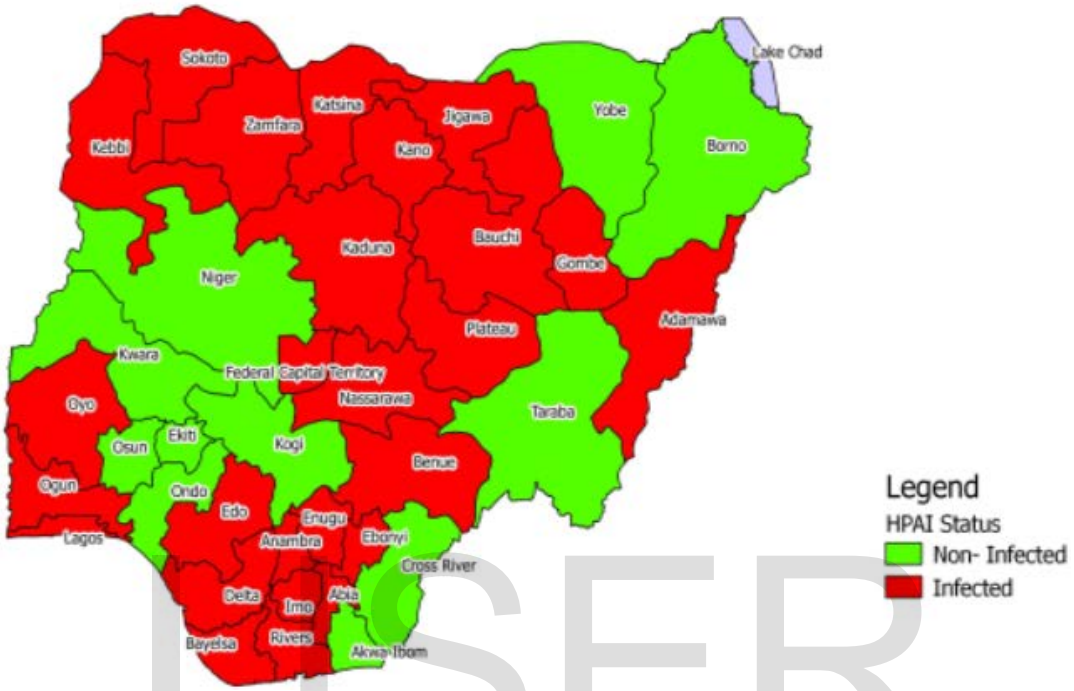

Fig. 6: States status on HPAI H5N1 in Nigeria
Source: Epidemiology Division, Department of Veterinary and Pest Control Services, FMARD, 2016.

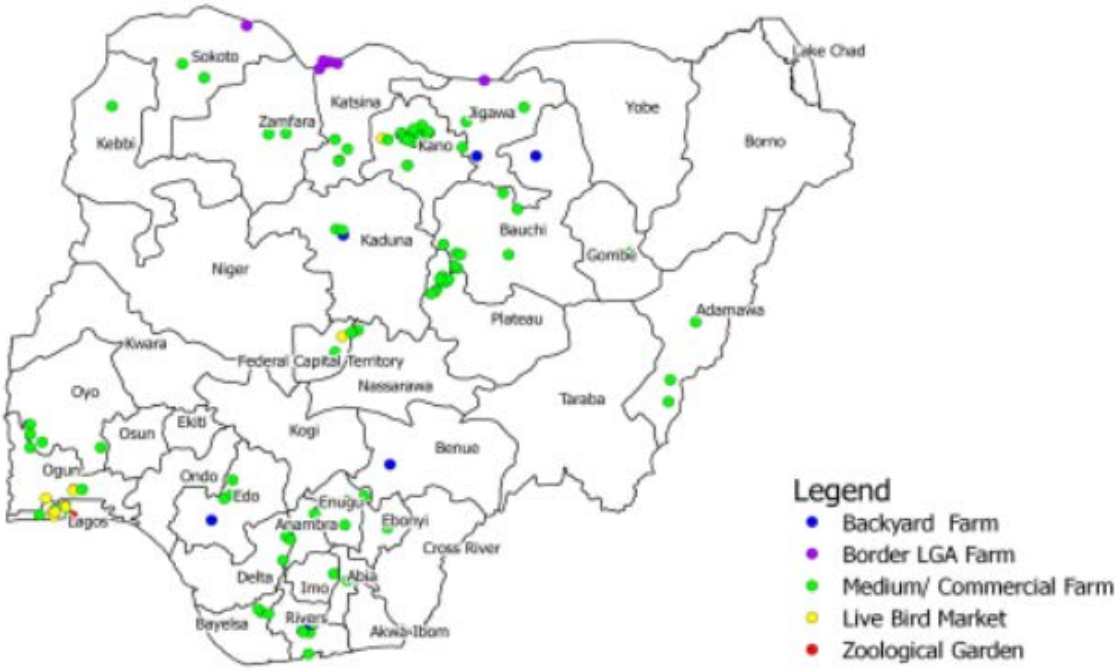

Figure 6: Spatial Distribution of HPAI H5N1 Positive cases in Nigeria.
Source: Epidemiology Division, Department of Veterinary and Pest Control Services, FMARD, 2016.

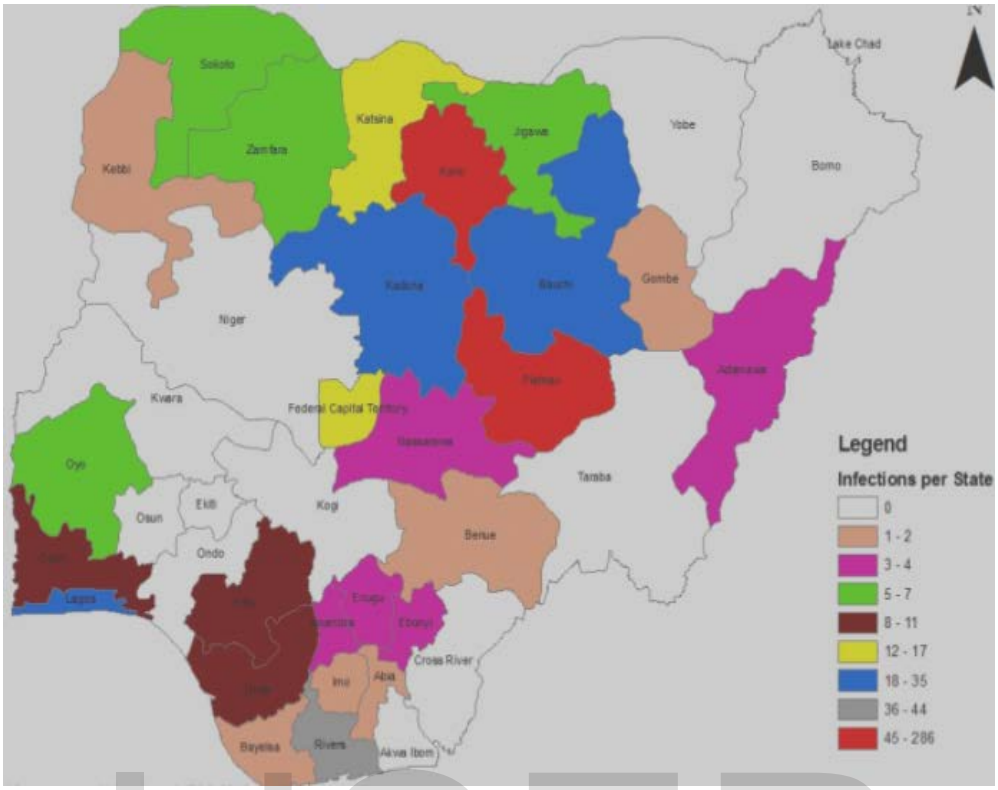

Fig. 7: Geographical Distribution of HPAI (H5N1) Positive Cases in Nigeria
Source: Epidemiology Division, Department of Veterinary and Pest Control Services, FMARD, 2016.

4 DISCUSSION

Our study revealed the total loss encountered by farmers [estimated direct loss (DL)] at ₦8,201,528,053.00 (US$ 26,842,731.08). Based on our findings, this loss was more than the DL calculated in reports by an OIE-commissioned assessment in September 2007, stating that initial losses in Nigeria from January-October 2006 was estimated to total US$ 8.4 million and much less than the estimated continued DL calculated by OIE (US$ 113 million) annually (OIE, 2007). On the whole, the total economic cost due to the HPAI crisis including direct and indirect losses is estimated by the UNDP Nigeria at about N1 billion (US$7.9 million) (UNDP, 2006) while this study has revealed a production loss of ₦1,549,974,667.00/ $5,072,902.62 with a cumulative loss of ₦9,751,502,720.00 / $31,915,633.70 (direct and indirect losses). The loss in poultry production was in terms of egg production based on the number of layers culled during the outbreaks and the 3months statutory duration that has to elapse before farmers are allowed to restock their farms. Part of the data on the specie of birds and ages was not available, aside those layers that died that were not categorically specified among the dead birds and the cases that were not reported due to the issue of delayed compensation indicating that the production loss could have been higher than what was obtained.

A study by Diao *et al*., 2009, projected direct losses of 4% of the Nigerian poultry population, with substantial economic impacts as poultry production declined by 21% and chicken prices increases by 12%. Meanwhile, our analysis has revealed a 2.5% direct losses of birds (those that died and those that were culled) from the country's poultry population. This has proven that the current HPAI resurgence in the country is more severe than the previous outbreaks where less than 1% and 0.3% of the poultry population in the 2006 and 2007 episodes respectively were affected, further revealing the economic implications of the current outbreak and the need for more drastic measures to curtail the current outbreak.

Study by Fasina *et al*., (2008), estimated losses based on a 'mild' scenario of outbreaks affecting 10% of the commercial flock, and a 'severe' scenario in which 70% of the commercial flock is affected. Analysis by Fasina *et al*., (2008), indicates that had AI intervention not been carried out, the average cost of HPAI to the Nigerian economy over the 5-year period (2006-2010) would have amounted to US$ 144.97 million under the high mortality path. Studies by You and Diao, (2007), estimated the total cost of HPAI at US$ 244 million for a mild case scenario whereby 10% of the commercial flock would be affected and US$690 million for a severe scenario (You and Diao, 2007). There was 30% chance that the economic damage caused by HPAI would be above US$ 173.61 million under the most disastrous scenario and 90% chance that it would be greater than US$ 53.36 million. The

incremental benefit of the intervention over the five-year period would amount to US$ 63.7 million with US$ 27.22 million as incremental net benefit gained by the intervention (You and Diao, 2007). Hence, indicating the necessity of strict adherence to the intervention measures on ground. In another study which assessed the intervention against avian influenza in Nigeria by Fadiga *et al*., 2014, with the overall intervention costs US$ 41 million, which was yearly disbursed in various amounts from 2006-2010 period; the key output variables (incremental net benefit, disease cost, and benefit cost ratio) were estimated for each randomly drawn risk parameter with a 12% annual discount rate, the results show that the intervention was economically justified under the endemic scenario with high mortality risk.

Due to the high population growth in Africa (WHO, 2010) and growing income, the demand for eggs and poultry meat has significantly increased in recent years across large parts of the continent. According to estimates by the USAID (United States Agency for International Development), this trend is very likely to continue over the next few years. Therefore, the consumption of poultry and eggs will increase by 200% between 2010 and 2020 for at least some countries in sub-Saharan Africa (Obi 2003; USDA, 2013). Our study revealed that quite a substantial amount of eggs were destroyed as a result of the current HPAI H5N1 resurgence in the country with the current situation on ground, coupled with losses in productions (egg and poultry meat), this seems to lower the chances of Africa to meet the demands of the growing population particularly Nigeria that happens to have the second largest poultry industry in Africa. Aside loss in production, one of the consequences of the AI outbreaks reported by UNDP in (2006), was that even in non-affected farms, there was a 45% drop in the flock size (as farmers were cutting down flocks due to lack of funds to feed the birds), thereby leading to decline in the level of feed usage by 55%. The decrease in flock size by 45% by the non-affected farms was mainly due to lack of funds to feed the birds as a result of the drop in poultry sales which forced many farmers to reduce flock sizes (UNDP, 2006). This may not be far from what is happening in the country at the moment as a result of delayed payment of compensation to the farmers. Associated businesses such as those trading in poultry products are estimated to have lost close to N 61.7 million (US$ 0.5 million) (UNDP, 2006).

Part of the indirect losses encountered during this outbreak and which was not estimated was the loss of employment by poultry employees. In 2006, the UNDP rapid assessment survey revealed that 80% of workers in the affected farms and 45% of those working in non-affected farms have lost their jobs as a result of the HPAI outbreak (UNDP, 2006). Also, most of the farmers that outbreaks occurred in their farms are yet to be compensated, which has hindered restocking especially when the farmer in view has gone bankrupt. This happens to be one of the major challenges of the outbreak resulting in loss of livelihood by the farmer and his employees where applicable (semi-commercial and commercial farms) coupled with the current economic recession in the country. Muteia *et al*., (2011), revealed the impact of AI on the livelihood of farmers which varied across regions and poultry production sectors. Results of the farm survey suggests that the severity of impact on farm income is higher among the smallholders especially in the north-east geopolitical zone while the majority of the farms surveyed lost more than 50% of their monthly poultry income at the onset of the avian influenza crisis and about 21% lost between 80 to 100% of their annual poultry income. Production losses in other sectors result from reduced demand for the principal inputs used in poultry production, including feed, pharmaceuticals and transport services. Reduced returns to factors used for poultry production also translates into lower investment, income and employment, which again reduce demand for consumer and investment goods (UNDP, 2006). As part of the production losses, manure destroyed on farms that were infected which could have been used for the purpose of farming and gardening were destroyed, many farmers depend on this type of manure for farming in the surrounding villages because it is cheaper and more readily available and it is also used in the cities for gardening. Highly Pathogenic Avian Influenza (HPAI) leaves many producers struggling to cover fixed costs and will also have lasting effects as it will take significant time to repopulate barns and get them back into full production. In addition to the lost revenue, HPAI also has many other adverse consequences on economic activity up and downstream such as lost business for feed suppliers, veterinarians providing health services, truck transportation, financial institutions, and decreases in government tax revenues (DIS, 2015). In the United States of America, the state of Iowa due to the outbreaks of HPAI recorded 8,444 fewer jobs, US$ 1.2 billion in lower Output, $426.9 million in lower Value-Added while the total federal tax receipts are estimated to decrease by US$ 97.9 million and the total state and local tax receipts are estimated to decrease by US$ 47.2 million (DIS, 2015).

The epidemic curves have indicated the seasonality of the occurrence of HPAI H5N1 outbreaks in the country which usually occurs most from January to end of April on a yearly basis. This is also a guide that strict biosecurity measures should be adhered to during this period to limit or prevent the transmission of the virus as it relates to its mode of transmission which mainly occurs through contact with contaminated surface. The number of outbreaks in 2017 has reduced drastically which may be due to the fact that the disease is gradually being eliminated or as a result of underreporting of outbreaks by farmers as a result of delayed compensation which has made other farmers to resort to other measures instead of reporting outbreaks. Unlike the previous outbreaks (2006-2008) where compensation was paid within reasonable time span, this resurgence has witnessed delayed compensation for a very long period of time which has resorted in creating doubts between the farmers and the government, hence the under reporting of the HPAI H5N1 outbreaks in the country. Most of the birds that were culled were

layers followed by broilers. Other birds that were culled even though they were few in number compared to the number of layers and broilers culled include cockerels, local chickens, guinea fowls, ducks, geese, turkeys, pigeons, peacocks and ostriches. The major risk factors for the spread of HPAI identified in Nigeria are: weak enforcement of movement control of poultry and poultry products by most states; delayed compensation payments to the affected farms/farmers; unregulated activities of egg merchants (considered as highest risk factor for the spread of the disease), poultry manure merchants, Live Birds market operators (transporters, sellers and processors), toll feed millers, transporters of poultry and poultry products, and commercial breeders and providers of Day Old Chicks and pullets; sale of dead birds "morta" and processing of such birds for human consumption; exchange of crates (both paper and plastic) by egg vendors and poultry farmers without adherence to biosecurity measures; on-farm interaction of poultry farmers or attendants leading to exchange of pathogens; poor record keeping by poultry farms/farmers; and lack of adherence to biosecurity by farm workers/attendants.

5 CONCLUSION

This study revealed a major economic loss (direct losses) by the farmers due to HPAI H5N1 with ripples of effects resulting in indirect losses as a consequence of the outbreak resurgence in the country. Majority of the compensation is yet to be paid to the farmers (₦1, 767,794,498 / US$5,783,721.57) which constitute the greater part of the challenges the farmers are facing in terms of restocking and employment of labour. There is need for strict biosecurity, timely and due compensation to the farmers and the need to establish strong cooperatives by these farmers to handle such issues in the face of crisis.

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