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Assessment of implementation of biosecurity measures and its impacts on Newcastle disease in some poultry farms and live bird markets in Sokoto State, Nigeria

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ABSTRACT

There is considerable global concern over the outbreaks of Newcastle disease (ND) affecting domestic poultry flocks around the world including Nigeria. There have been little investigations on the biosecurity measures taken by poultry stakeholders in relation to the rate of ND in Sokoto State, Nigeria. Thus, this study evaluated the biosecurity practices in commercial poultry farms and live bird markets in Sokoto State, Nigeria. Data were collected through questionnaire administered to commercial farmers, flock owners at live bird markets as well as other poultry value chain intermediaries. A traffic light system model was used to test for relative risks based on the biosecurity measures put in place at the farm and live bird markets. The result indicates that both commercial farms and live bird markets were at high risk (56.9% and 77.3% respectively) of ND virus infection. The high risk practices identified include unsafe disposal of poultry carcasses (50%), locating farms on high ways (75%), absence of high pressure sprayer at gate (100%), presence of water body (37.5%), raising different species of birds (25% for farms and 100% for live bird markets), presence of multi age groups (100%), feed spillage (100%), fly and rodent infestation (100%), lack of personal protective equipment (50% for farms and 100% for live bird markets), absence of changing room (87.5%), poor handling of sick birds (75% for farms and 100% for live bird markets), inadequate washing and disinfection of hands and equipment (100%). Using chi square, presence of fence, washing and disinfection of pen, washing and disinfection of equipment, always allowing visitors to enter farm, borrowing of equipment, sale of runt and sick birds, isolation of sick/new birds, culling of diseased birds, safe and clean store for feed, observing signs of ND in the last 3 months showed significant statistical difference ($P<0.05$) between live bird markets and poultry houses. Thus, that may contribute to the risk of environmental contamination and disease transmission. Outreach and biosecurity awareness raising initiatives should be specifically developed for all the poultry value chain stakeholders with the objective of improving general poultry management and thus preventing ND and other poultry diseases.

Keywords: Poultry; biosecurity; commercial farms; live bird markets; Sokoto

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INTRODUCTION

Poultry production has witnessed a rapid growth in the last decades as a commercial enterprise involving hundreds of thousands of birds and has given rise to new challenges especially those of disease control (Hassan *et al*., 2016). In developing countries, poultry production is being subjected to great pressure to meet the demand for animal protein required by the increasing human population, and also to have surplus for international trade (Tamiru *et al*., 2014). The production mostly includes the broilers, layers and cockerels as well as village poultry which consist of edible domestic birds including chickens, ducks, guinea fowls, geese, pigeons, turkeys and quails among others which are mostly raised under the free-range extensive husbandry systems especially in the sub-urban and rural areas (Copland and Adlers, 2005). In Africa, village poultry production system has influenced human civilization in several aspects which include economic, nutritional and socio-cultural aspects of livelihoods of poor rural households (Mulugeta *et al*., 2013). Poultry products have ensured household food security as it supplies high quality animal protein from meat and egg used as food, petty cash derived from sales of poultry products, poverty alleviation and create jobs for rural dwellers (Radfar *et al*., 2012). Village poultry are also shared as gift among relatives and friends; they are also used as sacrifices during religious and cultural festivals (Adlers *et al*., 2012). Compared to a number of other livestock species, fewer social and religious taboos are related to the production, marketing and consumption of poultry in developing countries of Africa including Nigeria (Radfar *et al*., 2012). In Nigeria, village poultry represents about 84% (115.8 million) of the 137.6 million poultry population while the commercial exotic poultry is 16% (21.7 million) (Alemu *et al*., 2015). The production system is oriented towards profitability and the effort to reduce cost of production may impact negatively in the system through the neglect of important pivotal elements of poultry preventive medicine (Maduka *et al*., 2016). Communicable diseases and problems related to feeding constitute the major constraint to profitable chicken production in the locality (Haruna *et al*., 2007).

Biosecurity refers to principles and practices engaged in reducing the chance of introduction and spread of pathogens within and between farms by preventing infectious agents from entering (bioexclusion) or exiting (biocontainment) the farm and the principal elements are segregation, traffic control, cleaning, and disinfection (Charisis, 2008; Fasina *et al*., 2012). An effective biosecurity has conceptual, structural, and operational frameworks which involve housing design and construction with management procedures that keep the flock free from infectious diseases (Shane, 2005; Halvorson, 2011; Siekkinen *et al*., 2012). There have been reports of breaches in biosecurity measures in poultry production systems in parts of Nigeria because of lack of awareness and failure to implement components of biosecurity (Geidam *et al*., 2011; Wakawa *et al*., 2012; Augustine *et al*., 2014). These result in frequent outbreaks of diseases which drastically reduce profit or lead to capital loss in the industry (Haruna *et al*., 2007; Maikasuwa and Jabo, 2011). The operational cost of biosecurity is usually low and there is a high benefit- cost ratio (Fasina *et al*., 2012; Siekkinen *et al*., 2012; Akintunde and Adeoti, 2014). However, the inadequate implementation of biosecurity measures may be due to insufficient motivation and lack of understanding of its economic benefits (Laanen *et al*., 2014).

Newcastle disease is one of the greatest constraints to the development of poultry production in Nigeria (Joseph *et al*., 2014). Outbreaks of ND are still being experienced by poultry farmers despite routine vaccinations, possibly due to inadequate biosecurity practices

(Maikasuwa and Jabo, 2011). In Sokoto State, 32.9% seroprevalence rate of ND was reported (Jibril *et al*., 2013). The present study therefore aimed at investigating and assessing biosecurity status in commercial and live bird markets in the study area.

MATERIALS AND METHODS

Study Area

The study was carried out in Sokoto State. The state is located in the extreme northwest of Nigeria between latitudes 12°N and 13°58'N and longitudes 4°8'E and 6°54'E. The state is divided into 4 agricultural zones, namely: Isa (Isa, Goronyo, Sabon Birni, Wurno and Rabah); Gwadabawa (Gwadabawa, Illela, Gada, Binji, Tangaza, Gudu and Silame); Tambuwal (Tambuwal, Kebbe, Yabo, Shagari) and Sokoto (Sokoto North, Sokoto South, Wamakko, Kware, Dange, Bodinga and Tureta) (Mohammed and Baba, 2013). The state shares boarders with Niger Republic to the North, Kebbi State to the south and Zamfara State to the east (NPC, 2006).

Study Design

The study was designed to be cross- sectional. List of commercial poultry farms registered under the state were obtained from ministry of animal health and fisheries, Sokoto, to be visited together with the live bird markets in the selected areas. Copies of the designed questionnaire were administered through one-on-one interview with commercial (exotic layers, pullets, broilers,) poultry farmers, flock owners and intermediaries for data collection after creating awareness to them on the purpose and seeking for their willingness and consent.

Study Population

All poultry farms and live bird markets within the four agricultural zones (Sokoto, Gwadabawa, Tambuwal and Isa) of the state had equal chances of being selected in this study. Convenient sampling was performed to select one local government from each zone and one town each from the selected local governments based on popularity and number of poultry being brought to the market (Illela in Gwadabawa zone, Sokoto North in Sokoto zone, Tambuwal in Tambuwal zone and Wurno in Isa zone). Selected markets were as follows:

1. Illela market
2. Sokoto meat and vegetable market
3. Tambuwal market
4. Wurno market

While for the commercial poultry farms, two farms were visited from each of the selected local governments. A total of 4 markets and 8 farms were surveyed and 1,904 personnel were interviewed considering their role in poultry handling and Newcastle disease transmission.

Questionnaire Development/Administration and Data collection

A close ended questionnaire was designed on biosecurity measures practiced by the targeted respondents which was filled through interview according to the provided answers. The questionnaire comprised of name of the farm/ live bird market, address of the farm/ live

bird market, type of poultry raised, location of farm, fencing, mixing of different types of birds, and access to wild birds, presence of insects or rodents, wearing personal protective equipment for staff, handlers or visitors etc.

Also, knowledge of intermediaries' roles in Newcastle disease transmission was assessed using similar questionnaire. Intermediaries included poultry haulers, litter haulers, feed haulers, traders, input providers (people that link poultry haulers with the other mentioned categories), vaccinators (para veterinarians) and veterinarians. The intermediaries, poultry farmers and flock owners were 1,904 in number. The questions asked were knowledge on A. existence of the disease B. its modes of transmission, and C. its preventive measures. Lack of knowledge on all was considered as 'don't have the knowledge', knowledge on A and either B or C was considered as 'partially have the knowledge' and knowledge on all (A, B and C) was considered as 'have the knowledge'.

Newcastle Disease Risk Status Assessment Using Traffic Light System Method

A traffic light system used to classify level of biosecurity was used in this study to assess ND risk status in the surveyed areas. Prevalence of biosecurity factors greater than 35% (class 3) were classified as high risk (red light), prevalence of biosecurity factors between 10% and 25% (class 2) as medium risk (yellow light) while prevalence of biosecurity factors less than 10% (class 1) as low risk (green light) based on the answered questionnaires and scoring of biosecurity using traffic light system according to (Saul *at al.,* 2023).

Data Management and Analysis

Data from the questionnaire administered during the study were computed and expressed using tables and charts and percentages. Chi-square test of association was used to determine the association between farm with market characteristics and biosecurity. SPSS version 22 statistical software was used for analysis**.**

RESULTS

Biosecurity Practices

A total of eight (8) farms and 12 markets were visited and 1,904 personnel were interviewed. The outcomes of the biosecurity practices among poultry farms and live bird markets are as shown in table 1, figure 2 and figure 3 below in which 75% of the commercial farms visited were located on the major roads usually linking one town to another while only 50% among the live bird markets were on the major roads. All the commercial farms (100%) were fenced and 50% of the live bird markets were fenced. 87.5% of commercial farms and 25% of live bird markets had gates at the entrance. However, none of the farms or markets had provision for pressure sprayer or staff/visitors' bathrooms at their gates. Furthermore, 37.5% and 25% of the farms and markets respectively had water bodies around. Different types of poultry were identified in all the markets (100%) but only chickens were raised in the visited farms (25%). All the farms (100%) and the markets (100%) contained birds of different age groups and feed spillage were also observed in all cases (100%).

Table 1: Response to the implementation of biosecurity practices in Sokoto state, Nigeria

S/N	Biosecurity Measures	Commercial Farms	Live Bird Markets	P- value
1	Located on Major Road	75%	50%	0.8286
2	Fence	100%	25%	0.0339
3	Gate	87.5%	25%	0.1296
4	High Pressure Sprayer at Gate	0	0	-
5	Staff/Visitors' Bathroom	0	0	-
6	Body of Water	37.5%	25%	1.0000
7	Different Types of Birds	25%	100%	0.0662
8	Different Age Groups	100%	100%	-
9	Feed Spillage	100%	100%	-
10	Wild Birds	50%	75%	0.7842
11	Other species of Animals	75%	100%	0.7842
12	Fly Infestation	100%	100%	-
13	Rodent Infestation	100%	100%	-
14	PPE for Staff	50%	0	0.2790
15	PPE for Visitors	0	0	-
16	Changing Room	12.5%	0	1.0000
17	Poor Handling of Sick Birds	75%	100%	0.7842
18	Washing and Disinfection, Pen	100%	0	0.0049
19	Washing and Disinfection, Hand	50%	0	0.2790
20	Washing and Disinfection, PPE	50%	0	0.2790
21	Washing & Disinfection, of Equipment	100%	0	0.0049
22	Sanitation station	0	0	-
23	Visitors allowed to enter:			
	Always:	12.5%	100%	0.0220
	Sometimes:	37.5%	0	0.4795
	Never:	50%	0	0.2790
24	Lending / Borrowing Equipment	0	100%	0.0049
25	Slaughter- slab	12.5%	100%	0.0228
26	Slaughter- slab drained	0	0	-
27	Slaughter- slab cleaning	0	0	-
28	Sale of runt/ sick birds	0	100%	0.0049
29	Utilization of rodenticide	12.5%	50%	0.0662
30	Utilization of insecticide	0	0	-
31	Carcass disposal options:			
	Disposal on landfills	50%	50%	1.0000
	Dogs/ cats feeding	12.5%	25%	1.0000
	Incineration	25%	0	1.0000
	Burial	12.5%	0	1.0000
	Disposal into water canals	0	25%	0.7119
	In plastic bag into waste bin	0	0	-
	Sale for fertilizer use	0	0	-
32	Isolation of sick/ new birds	37.5%	0	0.0422
33	Culling of diseased birds	75%	25%	0.0385
34	Safe and clean store (feed)	50%	0	0.0339
35	Safe and clean store (fertil)	0	0	-
36	Clean surrounding	50%	0	0.2790
37	Signs of ND observed during the last 3 months	37.5%	50%	0.0378

Furthermore, 50 and 75% of the farms and markets respectively had the presence of wild birds while the farms and the markets had 75 and 100% of other species of animals respectively. Fly and rodent infestations were recorded in all cases (100%).

Only 50% of the farms had PPE for their staff while there was no provision of such in the live bird markets (0%). Neither the farms nor the markets had PPE for visitors and no provisions for sanitation stations in either case. All the farms do wash and disinfect their poultry pens (100%) in contrast to the live bird markets (0%). Also, 50% and 0% of the farms and the markets respectively wash and disinfect their hands and PPE.

Chi square showed significant statistical association between live bird markets and poultry houses in some aspects of biosecurity viz: Presence of fence, washing and disinfection of pen, washing and disinfection of equipment, always allowing visitors to enter farm, borrowing of equipment, sale of runt and sick birds, isolation of sick/new birds, culling of diseased birds, safe and clean store for feed, observing signs of ND in the last 3 months with P-value< 0.05.

Knowledge of Intermediaries' Roles in Newcastle Disease Transmission

Figure 1 below shows the knowledge of intermediaries' role in ND transmission. Whereas for the Poultry haulers, 53.6% didn't have the knowledge, 41.2% had the knowledge and 5.2% had partial knowledge; litter haulers: 98% didn't have the knowledge, 0% had the knowledge and 2% had partial knowledge; feed haulers: 50% didn't have the knowledge, 30% had the knowledge and 20% had partial knowledge; traders: 78% didn't have the knowledge, 15% had the knowledge and 7% had partial knowledge; input providers: 49% didn't have the knowledge, 31% had the knowledge and 20% had partial knowledge; vaccinators: 40% didn't have the knowledge, 50% had the knowledge and 10% had partial knowledge and for the veterinarians: 100% were knowledgeable on their role in ND transmission.

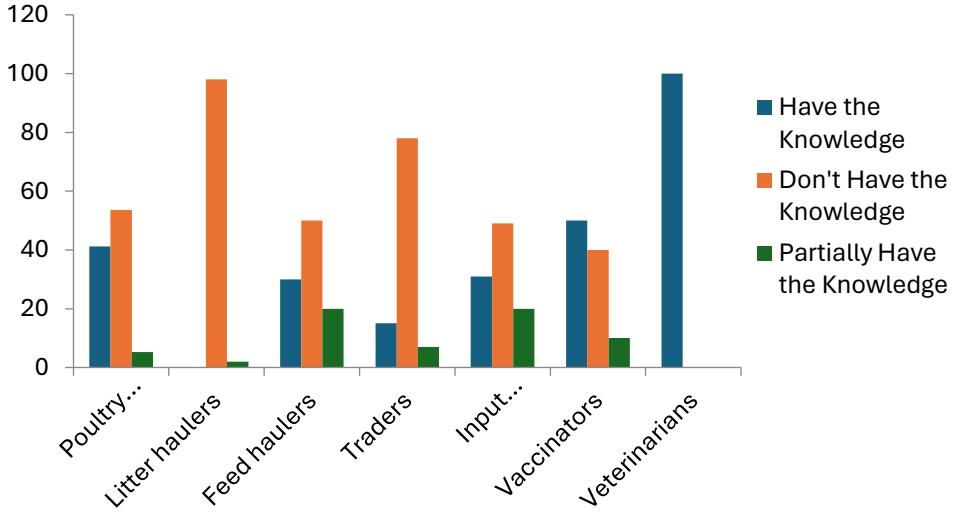

Figure 1: Knowledge of intermediaries' roles in Newcastle disease transmission

Newcastle Disease Risk Status Assessment Using Traffic Light System

Figures 2 and 3 as shown below indicates that 56.98% (approximately 57.0%) and 77.33% (approximately 77.3%) of the commercial farms and live bird markets respectively were at high risk of contracting ND while 43.02% (approximately 43.0%) and 22.67% (approximately 22.7%) respectively were at the medium level. While 0% of both commercial farms and live bird markets were at low risk.

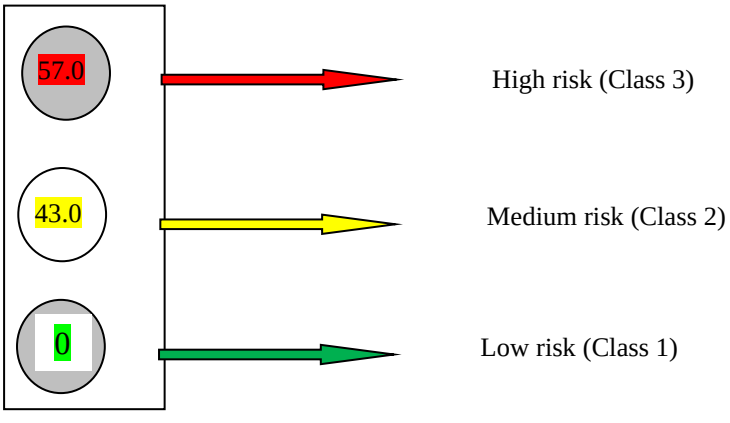

Figure 2: Risk status assessment using traffic light system model in poultry farms, Sokoto state, Nigeria

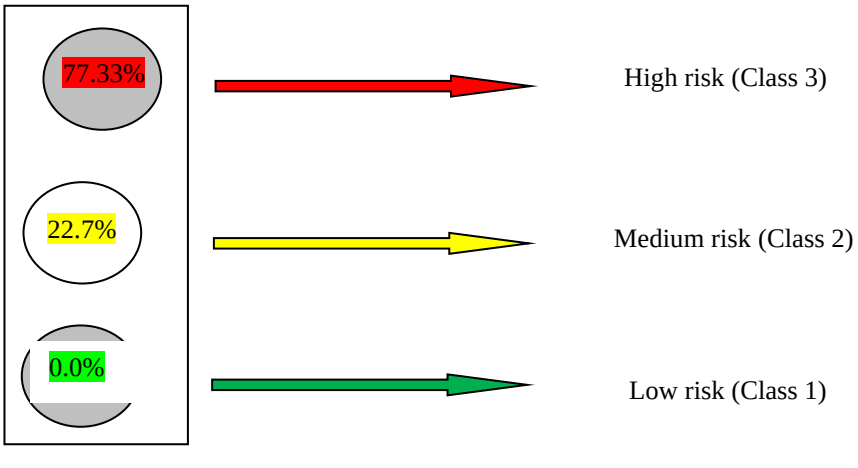

Figure 3: Risk status assessment using traffic light system model in live bird markets, Sokoto state, Nigeria

DISCUSSION

In this study, the data identified serious biosecurity flaws regarding pest control, traffic control, cleaning and disinfection and waste disposal. Usual means for carcass disposal included feeding to dogs and throwing dead birds on landfills contributing to the risk of environmental contamination and disease transmission. On-site composting has been shown to be a successful practice (US EPA, 2006); however, in the absence of supporting legislation and appropriate means, currently it is not feasible for this type of production. Moreover, at the poultry live bird markets the owners reported that the selling of diseased poultry for human consumption was a common practice.

Compliance with recommended biosecurity practices did not greatly vary from live bird markets to farm-based commercial production except for the presence of fence, washing and disinfection of pen, washing and disinfection of equipment, always allowing visitors to enter farm, borrowing of equipment, sale of runt and sick birds, isolation of sick/new birds, culling of diseased birds, safe and clean store for feed, observing signs of ND in the last 3 months with P-value< 0.05 using chi square. At present, there is a growing body of evidence that suggests that the implementation of biosecurity measures is the cheapest and most effective means of disease prevention and can realize significant financial benefits (Fasina *et al*., 2007). Most small commercial producers strive with financial constraints. The lack of proper technology and biosecurity leads to low feed conversion rates, poor poultry health, high losses and waste of feed.

The main risk factors in small-scale commercial farms may be because of uncontrolled livestock and poultry movement within and outside the country owing to the lack of enforcement of animal disease control laws and regulation, including registration and licensing of poultry farms and hatcheries. Increased close contact between poultry and human, and lack of organized poultry marketing that encourages open live poultry markets and consequent interspecies mixing and poor sanitary conditions are responsible for the high risks among free-range flocks (Musa *et al*., 2009).

The traffic light system model results indicate that both commercial farms and live bird markets operate management systems with minimal biosecurity, apparently increasing the vulnerability to ND. These high risks are mostly associated with source of water and feed, poor handling of litter, drinkers, feeders and environment which could create favorable conditions for introduction and mutation of NDV. This is in agreement with the work of Otte *et al*. (2007) which rated the risk of infection for commercial poultry farms to be combination of risk 'mitigation' (isolation of birds to confinement) and risk 'propagation' (traffic into the farm with feed) measures. Accordingly, in free-range flocks, the risk 'mitigation' measures may not outweigh risk 'propagation' practices and the consequent frequent introduction of low infection. However, this maintains the immunity of the free-range flocks, preventing infection and reducing the opportunity for viral mutation and development of high infection.

The risk factors and status of biosecurity measures against NDV listed in this study indicate related variations in poultry production system across the zones in Sokoto state. Inability of the participatory farms and flocks to attain the Green (Risk Class 1) status signifies inadequate sanitary procedures to effect risk reduction in ND and other infectious diseases. Commercial poultry farms generally require infection- free high-volume ventilation to reduce heat and regulate humidity to achieve low risk level of ND and other diseases (Jones *et al*., 2005).

Biosecurity procedures such as cleaning, disinfecting, separate overalls change of outdoors shoes before entering the flock houses, restriction of visitors should be implemented by all poultry keepers. Good biosecurity levels on the farms and in the flocks will ultimately lead to lower costs in the production cycle, and flock welfare will be enhanced. Biosecurity on small-scale poultry farms should emphasize the creation of physical barriers against infection, but because the keepers of free-range flocks cannot act alone, community-led initiatives are necessary.

CONCLUSION

The inability of most of the participatory poultry farms and flocks to attain the green light (Risk Class 1) status signifies inadequate biosecurity procedures to effect risk reduction in ND and other infectious diseases. The data identified serious biosecurity flaws and that may contribute to the risk of environmental contamination and disease transmission. The findings may assist policymakers in advanced planning in coordination with the private sector, for promoting socially equitable ND control and prevention strategies for resource-limited circumstances.

Biosecurity procedures such as cleaning, disinfecting, separate overalls change of outdoors shoes before entering the flock houses and restriction of visitors should be implemented by all poultry keepers. There should be partnership between the public and private sector in order to have an adequate cost-effective biosecurity measure and be engaged in decision-making. In addition, outreach and biosecurity awareness raising initiatives should be specifically developed for all the poultry value chain stakeholders with the objective of improving general poultry management and thus preventing ND and other poultry diseases.

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