RUFORUM Working Document Series (ISSN 1607-9345), 2022, No. 20: 67-83.
Available from http://repository.ruforum.org

Research Application Summary

Reconnaissance of major challenges affecting poultry farming using participatory epidemiology methods in Jinja District, Uganda

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Abstract

Herein we report the results of a Participatory Epidemiology (PE) exercise conducted to explore major challenges affecting poultry farming in Jinja District, Uganda. Non probability sampling was used to purposively select 5 commercial poultry farms. Farm owners were interviewed at their farms using a questionnaire to capture data on type of poultry kept, management system, feeding, challenges, markets, input sources, and access to veterinary services. Systematic observations were conducted around the poultry farms to detect and record environmental factors which could precipitate disease occurrence. A total of 75 cloacal and 75 oropharyngeal swabs were collected from the flocks. The swabs were preserved with PBS and transported to NADDEC on ice and tested for New Castle Disease (NCD), Infectious Bursal disease (IBD) and Highly Pathogenic Avian Influenza (HPAI) using rapid antigen immunochromatographic kits. Two focus group discussions consisting of 16 and 14 members respectively were held using a checklist. PE tools such as proportional piling, seasonal calendar were used to elicit information. Our Findings revealed that Chronic respiratory diseases (CRDs), Coccidiosis and NCD were the major causes of mortality and morbidity of poultry flocks. Inadequate ventilation, poor feed quality, poor litter management and lack of professional veterinary advisory services were some of the possible factors responsible for occurrence and persistence of poultry diseases. Management practices that mitigate conditions that precipitate the occurrence of the above diseases are recommended. Participatory Epidemiology provides an important tool kit for field practitioners and is highly recommended for disease investigation and control under resource settings.

Key words: Chronic respiratory diseases, coccidiosis, newcastle disease, participatory epidemiology, poultry farming, Uganda

Résumé

Nous rapportons ici les résultats d'un exercice d'épidémiologie participative (EP) mené pour explorer les principaux défis affectant l'aviculture dans le district de Jinja, en Ouganda. Un échantillonnage non probabiliste a été utilisé pour sélectionner délibérément 5 fermes commerçantes avicoles. Les propriétaires de fermes ont été interrogés dans leurs fermes à l'aide d'un questionnaire pour saisir des données sur le type de volaille élevée, le système de gestion, l'alimentation, les défis, les marchés, les sources d'intrants et l'accès aux services vétérinaires. Des observations systématiques ont été menées autour des exploitations avicoles pour détecter et enregistrer les facteurs environnementaux susceptibles de précipiter l'apparition de la maladie. Au total, 75 écouvillons cloacaux et 75 écouvillons oropharyngés ont été prélevés dans les troupeaux. Les écouvillons ont été conservés avec du PBS et transportés au NADDEC sur de la glace et testés pour la maladie de New Castle (NCD), la bursite infectieuse (IBD) et la grippe aviaire hautement pathogène (HPAI) à l'aide de kits immuno-chromatographiques à antigène rapide. Deux groupes de discussion composés de 16 et 14 membres respectivement ont été organisés à l'aide d'une liste de contrôle. Des outils d'EP tels que l'empilement proportionnel, le calendrier saisonnier ont été utilisés pour obtenir des informations. Nos résultats ont révélé que les maladies respiratoires chroniques (MRC), la coccidiose et les MNT étaient les principales causes de mortalité et de morbidité des troupeaux de volailles. Une ventilation inadéquate, une mauvaise qualité des aliments, une mauvaise gestion de la litière et le manque de services consultatifs vétérinaires professionnels étaient quelques-uns des facteurs possibles responsables de l'apparition et de la persistance des maladies de la volaille. Des pratiques de gestion qui atténuent les conditions qui précipitent l'apparition des maladies ci-dessus sont recommandées. L'épidémiologie participative fournit une boîte à outils importante pour les praticiens de terrain et est fortement recommandée pour l'investigation et le contrôle des maladies dans les contextes de ressources.

Mots clés : Maladies respiratoires chroniques, coccidiose, maladie de Newcastle, épidémiologie participative, aviculture, Ouganda

Introduction

Poultry farming is widely practiced in Africa. Almost every homestead keeps poultry for food, income, religious and cultural purposes (Assefa *et al*., 2015). Poultry production has an important socio-economic role in developing countries (Alders, 2004). Poultry is an affordable source of animal protein, family income and self-reliance and financial inclusion for women. Selling of poultry and eggs is decided by women providing immediate income to meet household expenses (Aklilu *et al*., 2007; Graham *et al*., 2013; Alders *et al*., 2018). Poultry is one of the strategic commodities listed under Uganda's Vision 2040 and the NDPIII expected to spur the country's economic development through increased export earnings, food and nutrition security, household incomes and job creation (NPA, 2020; Uganda Vision 2040, 2007). The current poultry population stands at 47 million, (87.7%) of which are indigenous while the rest are exotic (Tainika and Duman, 2019). The poultry types are predominantly Chicken but Turkeys, Ducks, Guinea fowls and Quails are also kept (UBOS, 2020). The poultry sub sector in Uganda has been registering an annual growth of more than 11% since 2019 (UBOS, 2020). However, poultry diseases mainly NCD continue to constrain the growth of this important subsector (Tainika and Duman, 2019). Therefore, strengthening surveillance and response to major disease constraints is an important pathway for growth of the poultry subsector in Uganda. Strengthening field epidemiology capacity

for the animal health sector is one of the key action packages espoused in the Global Health Security Agenda (GHSA), the World Health Organization (WHO) Joint External Evaluation (JEE) and the International Health Regulations (IHR) (Nguku *et al*., 2014; Global Health Security Agenda Steering Group., 2018; Kamradt-Scott, 2019). In this regard, the Food and Agriculture Organization of the United Nations (FAO) together with Ministry of Agriculture Animal Industry and Fisheries (MAAIF), Makerere University and Texas A&M conduct an annual In-Service Applied Veterinary Epidemiology Training (ISAVET) course to address Emerging Infectious Diseases (EIDs) and Transboundary Animal Diseases (TADs) in Uganda. As part of the requirements to graduate from the course a 2-day field exercise to investigate and report key challenges affecting poultry farming using Participatory Epidemiology (PE) methods was conducted in selected sub counties of Jinja District, Uganda. PE is a branch of epidemiology that enables frontline animal health workers to rapidly detect and respond to disease events especially in resource poor settings or hard to reach areas where veterinary services are lacking (Ameri *et al*., 2009; Bugeza *et al*., 2017; Alders *et al*., 2020).The objective was to ground the trainees in the use of PE methods for rapid appraisal and reporting of disease challenges in farming communities in Uganda to facilitate planning and rapid response.

Materials and methods

Study area. The study was conducted in Jinja District on the 27th and 28th/4/2022. The district is located in the South Eastern part of Uganda. It has 7 administrative units comprising three sub counties and four town councils. The study was conducted in Buwenge sub –county, in Bwase, Kagoma, Kasarina, and Buwera parishes. The poultry population of Buwenge Town council is estimated at 9,600 layers, 10,500 indigenous chicken and 4,000 broilers (Buwenge TC data).

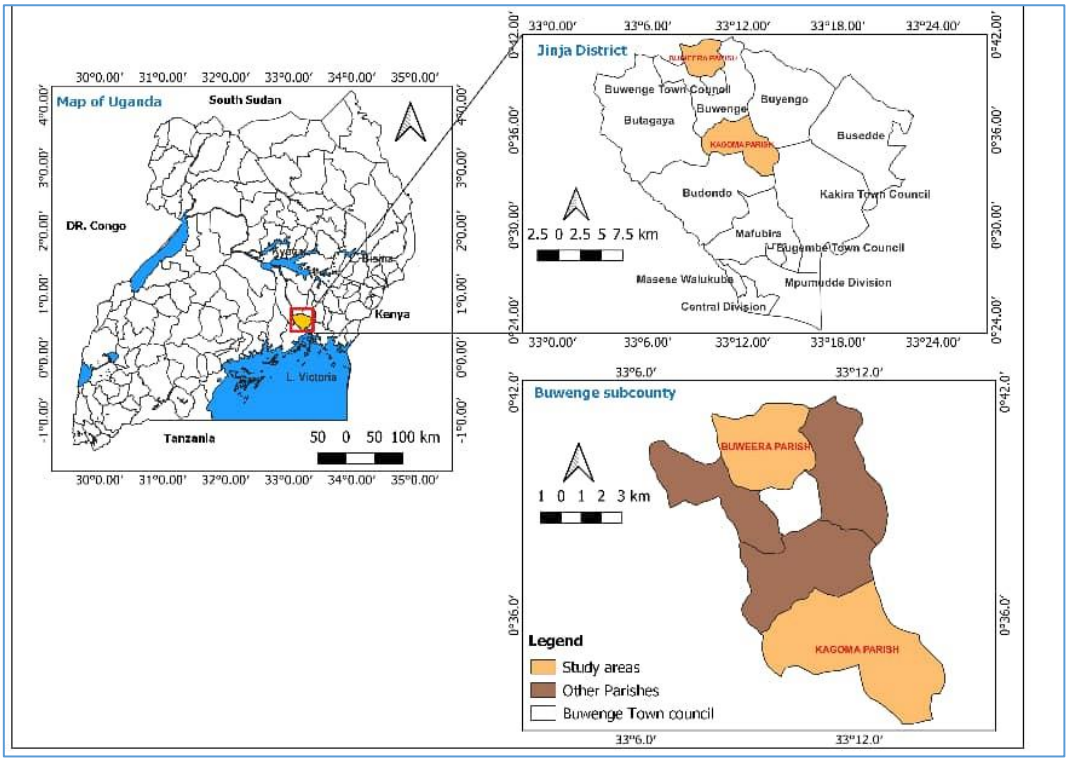

Figure 1. Map of Jinja District

Selection of farms. Non probability sampling was used to purposively select 5 major commercial poultry farms with the help of resident veterinary officers. The farms were selected because farm owners/farmer groups complained of chronic poultry diseases that did not respond to treatment and poor laying performance of their flocks. The number of layer birds ranged between 700 to 1500 commercial layers kept.

Sample collection and testing. At each of the farm visits, appropriate PPE was donned and disinfection done before and after entry to the farm was done by use of Virkon solution prepared by adding 10g of Virkon powder to 1 litre of water. At each farm about 10% of the birds in the flocks were randomly selected for sampling. A total of 75 cloacal and 75 oropharyngeal swabs were collected from resident flocks. Attribute data on the individual farms and on the chicken enterprises was also collected. The swabs were preserved with PBS and transported to NADDEC on ice. The samples were tested for 3 main diseases namely; NCD, IBD and HPAI which were highlighted by the district veterinary office as major challenges to poultry production. Samples were screened for AIV using the FASTest® AIV antigen rapid immunochromatographic kit, for NCD using the Newcastle disease test kit RG1503DD (Bionote, South Korea) and IBD using the Infectious bursal disease test kit RG1504DD (Bionote, South Korea) following the manufacturer's instructions. Results were recorded as positive or negative to denote presence or absence of antigens for the respective causative organisms, respectively.

Farmer interviews, farm observations and Focus Group Discussions (FGDs). Key informant interviews for the 5 selected farmers were conducted at their respective farms. The interviews were conducted using a pre designed questionnaire to capture data on type of poultry kept, management system, feeding, challenges, markets, input sources, and access to veterinary services. Systematic observations were conducted around the poultry farms to detect and record environmental factors which could precipitate disease occurrence. Two focus group discussions consisting of 16 and 14 members respectively were also held using a checklist and Participatory epidemiology (PE) tools including proportional piling, seasonal calendar were used to collect data. The most important type of poultry for income generation, main challenges of poultry keeping, main disease responsible for morbidity and main disease responsible for mortality were ascertained using the proportional piling tool while the seasonality of disease occurrence was ascertained using the Seasonal calendar tool.

Case definitions. The following case definitions were used to guide identification/ anamnesis of key poultry disease challenges

Avian Influenza

Suspected case: Sudden death OR swelling of head, eyes, legs, combs and wattles and any of: purple swollen combs and wattles or red streaks on legs, nasal discharge from nose and mouth, birds appear tired and refuse to eat, and coughing and sneezing. Community signs: Increase in deaths in wild migratory birds (MAAIF, 2022).

Probable case: Suspected case that tests positive by Avian Influenza using Bio-note Rapid Diagnostic Test (RDT) OR Suspected case with reddened combs and wattles or conjunctivitis or lesions in the trachea or oedematous and haemorrhages on shanks or gastrointestinal at post mortem (MAAIF, 2022).

Confirmed case: Cloacal, tracheal, nose and mouth swabs from avian that test positive for the virus by PCR (MAAIF, 2022).

Infectious Bursal Disease (IBD)
Suspected case: Prostration, diarrhoea, soiled vent feathers, vent picking and sudden death. At post mortem, muscular and proventricular haemorrhages, nephritis and cloacal bursal is swollen, oedematous, yellowish with lesions or haemorrhages . Community signs: Sticky discharge from the mouth and sudden death in young birds (MAAIF, 2022).

Confirmed case: Antigen-capture enzyme linked immunosorbent assays (ELISA's) using plates coated with IBDV-specific antibodies OR viral RNA detected by reverse-transcription polymerase chain reaction (RT-PCR) (MAAIF, 2022).

Newcastle Disease
Suspected case: Onset of greenish diarrhoea, nervous signs (tremors, paralysed wings and legs, twisted necks or torticollis, circling, spasms, and paralysis), respiratory signs (difficulty breathing, gasping, coughing, sneezing and rales), swelling and redness of the eyelids and comb with or without any one of the following: drop in egg production, loss of appetite (birds reduce or stop eating), decreased weight (MAAIF, 2022).

Probable case: Haemorrhage in the proventriculus, pathognomonic sign found on post-mortem of stomach lining (MAAIF, 2022).

Confirmed case: Preferred method of diagnosis is virus isolation and subsequent characterization (MAAIF, 2022).

Results

Poultry enterprise is among the major farming enterprises in the district and mainly among small land holdings. Other enterprises include cattle rearing, goats, sheep and piggery as shown in Table 1.

In terms of income, commercial layers were considered the important poultry enterprise followed by Kuroilers, whereas ducks and geese were considered the least important. The commercial layers were managed under deep litter intensive management system but litter management practices were found to be inappropriate (long interval of changing/raking). In terms of disease control farmers relied on local veterinary drug shops to obtain vaccines and largely followed vaccination schedules provided by the poultry suppliers. Access to professional veterinary services was largely lacking or irregular. High feed prices and poor quality of feed ingredients were some of the challenges related to feeding that farmers experience. New Castle disease, Coccidiosis and chronic respiratory diseases were some of the main disease challenges reported by farmers. Apart from the general lack of PPE for the farm workers, the farms generally observed basic biosecurity practices key of which included, bird proofing, restricted access, disinfection and proper disposal of dead birds.

Table 1. Findings from individual farmer interviews

Parameter	Farmer #					Score	Rank
	1	2	3	4	5		
Social demographics							
Sex	Male	Male	Male	Male	Female		
Sub County	Buwenge	Buwenge	Buwenge	Buwenge	Buwenge		
Parish	Kagoma	Buwera	Kagoma	Bwase Zone	Kamwani		
Village	Hospital zone	Buwera East	Kabi zone	Bwase	Kabi zone		
Experience (Years)	29	1	22	25	10		
Most important poultry type according to income generation ranked using simple ranking technique (1= most important, 5 = least important)							
Layers	1	1	1	1	1	5	1
Turkeys	2	4	4	3	2	15	3
Indigenous	4	2	3	5	3	17	4
Kuroiler	3	3	2	2	4	14	2
Ducks/geese	5	5	5	4	5	24	5
Husbandry practices							
Management system	Intensive	Intensive	Intensive	Semi Intensive	Intensive		
Feed store	Present	Present	None	Present	Present		
Water source	Tap water	Tap water/ BH	Tap water	Tap water	Tap water		
Drinking system	Jerrycans	Jerrycans	Jerrycans	Jerrycans	Drinkers		
Change of litre	Monthly	Monthly	3 months	3 months	2 months		
Previous disease outbreak	Gumboro	Yellow diarrhea	Chronic cough	No response	No response		
Vaccination Schedule	Monthly	Not sure	Suppliers schedule	Suppliers schedule	No response		
Source of vaccine	Vet drug shops	Vet drug shops	Vet drug shops	Vet drug shops	Vet drug shops		
Access to vet services	Unreliable	Unreliable	None	Unreliable	Unreliable		

Feed challenges ranked using simple ranking technique (1= most important, 4= least important)							
High price	1	1	1	1	1	5	1
Unreliable supply	2	3	2	3	2	12	2
Lack feed mixing machine	4	4	3	4	4	19	4
Poor quality raw materials/ ingredients	3	2	4	2	3	14	3
Disease challenges ranked using simple ranking technique (1= most important, 8 = least important)							
Coccidiosis	1	5	6	3	1	16	2
E. coli	2	7	7	7	8	31	7
NCD	3	2	4	1	2	12	1
Gumboro	4	6	5	2	3	20	4
Yellow Diarrhea	6	1	2	6	6	21	5
Weakness	8	3	8	8	7	34	8
Chronic cough	5	4	1	4	4	18	3
White Diarrhea	7	8	3	5	5	28	6
Biosecurity Practices							
Access of wild birds	No	No	No	No	No		
Buying local birds	No	No	No	No	No		
Movement control	Restricted	Restricted	Restricted	Restricted	Not restricted		
Free range bird proof	No	Yes	No	No	No		
Disposal of dead birds	Burry	Burry	Burry	Fed to pigs	Burry		
Disinfection	Yes	Yes	No	No	Yes		
PPE	No	No	No	No	No		

Table 2. Disease predisposing factors

No.	(a) Farm demographics	Farmer #			Remarks
	Parameter	1	2	3	
1	Sub County	Buwenge	Buwenge	Buwenge	
2	Parish	Kagoma	Buwera	Kagoma	
4	Type of chicken	Layers	Layers	Layers and Kuroilers	
5	Poultry Management system	Intensive	Intensive	Intensive	
6	Other poultry kept concurrently	Local chicken and turkey but housed (Intensive)	Local chicken, turkey and ducks on free range system (Highly interactive)	None	Risk of disease transmission between species
	(b) Possible disease predisposing factors				
1	Odour (Ammonia smell)	Absent	Absent	Highly Present	
2	Environmental hygiene	Clean	Clean but dump	Clean	
3	Feed storage	On ground (Not on pallets)	On ground (Not on pallets)	On ground (Not on pallets) and exposed to rains	
4	Ventilation	Insufficient	Insufficient	Insufficient	
5	Feed and water contamination	High	High	High	
6	Window mesh appropriateness	Big size reinforced with chicken mesh size.	Chicken mesh size but torn and half built.	Big size and chicken mesh size	The big size can allow passage for small birds
7	Litter management	Fair	Poor	Poor	Litter is not routinely shovelled to allow for drying
8	Feed spillage	High	High	High	Birds do not eat enough, and risk of consuming feed contaminated with droppings

9	Waste management and disposal	Good	Poor and dump	Not seen	Poorly disposed litter is a source of pathogenic agents
10	Adequacy of laying boxes	Few	Few	Few	Few laying boxes lead to high traffic
11	Eggs management	Soiled	Fair	Good	Poor egg hygiene led to spoilage and are a source of brooder infections
12	Biosecurity-Footbath	Absent	Non functional but seen and vandalised	Absent	Risk of introducing infectious diseases
13	Biosecurity-Disinfection sprays	Present	Absent	Absent	Risk of introducing infectious diseases
14	Biosecurity-Physical barriers/ fencing	Present	Present	Present	
15	Biosecurity-SOP's (Specific attendants)	Absent	Present	Present	Unrestricted entry to poultry units can lead to introduction of pathogens
16	Probable disease challenges	Coccidiosis Chocolate brown droppings observed	Coccidiosis Chocolate brown droppings observed	Mycoplasma galliseptum, Infectious bronchitis, Larygotracheitis, Infectious coryza, Coccidiosis, Chocolate brown droppings observed	Cloacal and Oropharyngeal swabs collected for lab confirmation
17	Antibiotic Usage	Anticox, Oxytetracycline 25%, Oxyvet 50S, Amprolium 20S, Norocleanse	Not seen	Tylonor 20 (A lot of bottles), Tetranor, Oxystar 20%	Antibiotics are widely used. Potentially lead to resistance

Table 3. Summary of FDG findings

Parameter	FGD1	FGD2	Total Score	Rank	Description of disease syndrome
Location	Buwenge T/C	Kyerinda			
No. of participants	16	14			
Gender (M, F)	9,7	5,9			
Ranking of most import poultry type according to income generation using Proportional piling (*Rank 1= most important, 5 = least important*)					
Layers	1	2	3	1	
Kuroilers	2	1	3	1	
Local chicken	3	3	6	2	
Broilers	4	4	8	3	
Turkeys	5	5	10	4	
Challenges of keeping poultry using Proportional piling (*Rank 1= most important, 5 = least important*)					
Limited knowledge on diseases	1	1	2	1	
Poor access to veterinary services	2	2	4	2	
High drug prices	3	4	7	3	
High cost of feeds	4	3	7	3	
Low prices of farm outputs	5	4	9	4	

Theft	5	5	10	5	
Main disease syndrome causing morbidity using Proportional piling (*Rank 1= most important, 5 = least important***)**					
Cough	1	1	2	1	Wheezing sound, mucus from nostrils, Unthriftness
Diarrhoea	2	2	4	2	Red or brown westerly droppings, Soiled vent, ruffled feathers, poor weight gain, low egg production
Drooping wings in Chicks	4	4	8	3	Unthriftness, loss of appetite, ruffled feathers, drooping wings, death
Kajambiya	5	6	11	5	Loss of appetite, ruffled feathers, lowered wings, folding of the heads into the wings
NCD	3	5	8	3	Cough, paralysed legs, green droppings, massive death
Infectious Coryza	6	3	9	4	Cough, swollen eyes, no response to antibiotic treatment
Chicken pox	7	7	14	6	Swollen combs and wattles, no response to treatment
Paralysis of legs	8	8	16	7	Recumbency, paralysis in one or both legs
Main disease syndrome causing mortality using Proportional piling (*Rank 1= most important, 5 = least important***)**					
Cough	2	4	6	3	
Diarrhoea	1	2	3	1	
Kajambiya	5	3	8	4	
NCD	3	1	4	2	
Chicken pox	4	5	9	5	

Mixing of species, Ammonia pollution, poor feed storage, insufficient ventilation of poultry units, heavy feed and water contamination, poor litter management, absence of foot bath/or disinfectant sprays at farm entrances were some of the disease predisposing factors observed. We also observed that several antibiotics were used to treat nonspecific illnesses in poultry flocks. Apart from the general lack of PPE for the farm workers, the farms generally observed basic biosecurity practices key of which included, bird proofing, restricted access, and proper disposal of dead birds.

Layer poultry and local chicken were also listed as the most important type for income generation relative to the other poultry types. Limited knowledge on poultry diseases and lack of access to veterinary services were some of the challenges faced by poultry farmers while cough, diarrhea, drooping wings, NCD and infectious coryza were some of the syndromes described by farmers as the most observed disease challenges causing morbidity. Diarrhea, NCD and chronic cough were the commonest disease challenges responsible for poultry mortality.

Participatory epidemiology disease surveillance exercises

(a) (b) (c) (d)

Figure 2. Participatory epidemiology Exercises conducted during FGDs (a-c) and free ranging mixed species of poultry (d)

The season calendar show the relative occurrence of priority poultry diseases in Buwenge sub county according to season. According to the farmers, chronic cough, flue and NCD occurs more in the dry season compared to the wet season while diarrhea occurs more in the wet season as compared to the dry season.

Occurrence of selected diseases in flocks

Table 4. Serological outlook for main poultry diseases

Parameter			Disease		
Farmer #	No. of samples	Sample ID range	HPAI	IBD	NCD
1	22	A1-A10; B1-B10; C1-C2	Negative	Negative	Negative
2	20	D1-D20	Negative	Negative	Negative
3	13	E1-E13	Negative	Negative	Negative
4	20	F1-F20	Negative	Negative	Negative

No HPAI, IBD and NCD antigens were detectable in the samples collected.

Discussion

Poultry is a vital pathway for rapid economic transformation and facilitate financial inclusion of peasant agrarian societies in sub Saharan Africa (Ekunwe *et al*., 2006). Poultry and poultry products constitute a major source of food, and income for many small-holder rural households in Uganda. In addition, manure generated from these enterprises is vital for crop production under mixed crop-livestock systems and can also be sold for income. Our study revealed that commercial layers were the main poultry type kept for household income security followed by commercial Kuroiler and broiler species (Table 1 and 3). For food and nutritional security other species like indigenous chicken, ducks and turkeys are kept. These species are also kept as a means of diversifying income opportunities but also as a coping mechanism to epidemic diseases of poultry and other environmental shocks (Ekou, 2013). Poultry farming was a preferred farming enterprise on account of the small land, labor and capital requirements compared to other livestock ,yet the returns on investment are realized in a relatively shorter time (Ekunwe *et al*., 2006; Tainika and Duman, 2019).

The main management system for the commercial layers was the deep litter intensive management system. Whereas the deep litter system is not a very efficient for egg production (compared to the cage system) , it is a suitable and a cost-effective method of raising poultry under poor resource settings (Majaro, 1983; Rajendran and Mohanty, 2003). However, if well managed, through weather and predator proofing, improved sanitation, disinfection and biosecurity practices such as "all-in all-out principle", vaccination and prophylaxis, this system offers an opportunity for poor farmers to engage commercial poultry production as the afore mentioned practices reduce incidence of disease (Permin *et al*., 1999).

Provision of quality feed forms the foundation of successful poultry enterprise because in addition to providing the nutrients required for growth and production, nutritious feed is also vital in reducing incidence of diseases by enhancing immunity. Nutritional deficiencies have been shown to impact severally on the birds ability to mount effective immune responses to different diseases (Klasing, 2007; Alders *et al*., 2018). However, our findings indicated that apart from the high cost of feeds, there was an unreliable supply of feed inputs but those available were also of poor quality (Table 1). This compromises the quality of available feed and could have a bearing on the health status of the birds, their productivity and ultimately profitability of the enterprises.

Endemic poultry diseases are key constraints to poultry production especially in resource poor settings with limited access to veterinary services. Similarly, individual farmers reported previous occurrence of chronic respiratory diseases (CRD), Coccidiosis and Newcastle disease (NCD) as key disease challenges responsible for morbidity and mortality in their flocks, despite the fact that NCD wasn't detected in collected samples at the time of the study (Table 4). Rajendran and Mohanty, 2003 documented similar disease constraints in their study of cage and deep liter poultry farms in India. These findings were further verified in the FDGs (Table 3 and Figure 2 (a) and 2(b)) and the laboratory screening tests (Table 4) as none of the other suspected diseases were detected. During the FGDs farmers reported key disease syndromes namely cough, diarrhea and drooping wings which are consistent with those in birds with chronic cough, coccidiosis and NCD, respectively.

The reports of chronic respiratory infections are also related to the poor ventilation of poultry

houses, presence of free ammonia on some of the farms (Table 2). The presence of free ammonia is in turn related to poor litter management. Exposure to free causes irritation of mucous membranes of the eyes and the respiratory system and increases susceptibility to respiratory diseases. Ammonia may also affect food intake, food conversion efficiency and growth rate (Wathes and Kristensen, 2000). Modification of the poultry units to provide adequate ventilation and regular spreading of the litter could improve ammonia loss by more than 50% and therefore help alleviate the chronic respiratory conditions (Nicholson *et al*., 2004). Other researchers have recommended the use of an acid scrubber, use of compost filters, and changing manure surface application to incorporation practices for in-house stage, outdoor stage and the land application respectively to mitigate ammonia contamination in poultry liter management systems (Wang *et al*., 2019). The combined use of low crude protein (LCP) diets, acid scrubber, compost biofilter and manure incorporation achieves high NH3 mitigation efficiency in both broiler and layer litter management systems (Wang *et al*., 2019).

The reports of coccidiosis coincide well with the observed poor litter management practices (Table 2) as the later precipitate's multiplication of coccidia oocysts (Lawal *et al*., 2016). This observation is also consistent with the farmers assertion that Coccidiosis is observed more regularly in the wet than in the dry season according to the seasonal calendar (Figure 2 (c)). Coccidiosis is caused by enteric parasites belonging to the genus Eimeria and are a major cause of morbidity and mortality. The disease causes serious economic losses especially in young poultry. The disease is commonest in the rainy season when moisture along with suitable temperature for sporulation of oocysts are most prevalent.

Litter management practices were found to be inappropriate because the farmers took long intervals of time between of changing or raking the litter. Irregular raking or changing of litter results into accumulation of ammonia and contamination with droppings, water and feed. Moist litter provides adequate conditions for multiplication of important parasites like coccidia and gastrointestinal nematodes (Majaro, 1983). Good litter management ensures that the lifecycles of these parasites are broken thereby stemming transmission. Good litter management practices include regular raking, adequate ventilation and decontamination of feeders and drinkers (Geetha and Palanivel, 2018).

Farmers also reported NCD as one of the major diseases responsible for morbidity and mortality. NCD is a viral disease of poultry that caused by viruses belonging to the Paramyxoviridae family (Alders *et al*., 2018). Several strains of the NCDV are responsible for this highly infectious and virulent disease although the velogenic strains are the commonest. Infection is acquired via the fecal oral route but the respiratory route is also involved especially in intensively managed birds (Awan *et al*., 1994; Geresu *et al*., 2016). The disease is severe and presents with respiratory, nervous system gastrointestinal and reproductive impairment (Geresu *et al*., 2016). The seasonal occurrence of chronic cough and NCD in the dry season as observed by farmers (seasonal calendar) may also be related to airborne transmission since heavy winds are reportedly blowing and climatic stress (Awan *et al*., 1994). The inadequate bird proofing that was observed could also serve as an exposure factor to wild birds scavenging for feed in the dry season. These findings are consistent with the observations of Musa *et al*., 2009 who reported high dry season prevalence of NCD antibodies in poultry in Plateau State, Nigeria.

It was also observed that some farmers kept mixed species of poultry like turkeys, ducks, indigenous and exotic chicken and ducks for nutrition and income security (Figure 2 (d)). However, it is important to note that while species such as ducks, geese, pheasants, quail, and guinea fowl experience a milder and covert form of NCD, these could act as a source of the disease for more susceptible species such as the Chickens, turkeys, pigeons, and parrots (Alders *et al*., 2018). NCD can be controlled by ensuring good farm biosecurity practices and through vaccination (Geresu *et al*., 2016).

The limited knowledge of poultry diseases reported by the farmers, poor access to veterinary services and the high cost of drugs and vaccines constrains disease control efforts by farmers. Structural adjustments in the delivery of veterinary services severely reduced the number of public veterinarians in many developing countries (Graham *et al*., 2013). Therefore, farmers rely on local veterinary drug shops to obtain vaccines and follow vaccination schedules provided by the poultry suppliers. The local veterinary drug suppliers are rarely qualified veterinary practitioners and are mainly profit motivated. As such they do not provide professional advice but rather sell products that farmers demand for. These products are seldom prescribed by a veterinarian. This is related to the widespread use of antibiotics to treat nonspecific ailments of poultry as observed on individual farms (Table 2). The absence of laboratory services for confirmatory diagnosis of poultry diseases exacerbates the situation. Functional veterinary laboratory diagnostic services are absent in many countries of the developing world severely constraining disease control efforts (Graham *et al*., 2013). The widespread use of antibiotics without proper diagnosis and prescription is not only wasteful but poses the attendant risk of residues in eggs and meat. These residues are the precursor to antibiotic resistance which is a major public health concern especially in the absence of veterinary oversight and monitoring (Graham *et al*., 2013).

Study limitations. The sample size was too small and therefore results are not generalizable. In addition, the study only concentrated on large commercial poultry farmers. As such the views and opinions of smaller subsistence farmers are not represented in this study. Nevertheless, the findings provide a bird's eye view of the constraints faced by the poultry farmers and form a basis for further structured studies.

Conclusions and recommendations

CRD, NCD and Coccidiosis, poor quality feeds, inadequate ventilation due to poor poultry design and poor litter management practices were the major disease challenges identified. Provision of adequate nutritious diets, adherence to vaccination schedules, strengthening biosecurity practices, improvement of ventilation of poultry houses, and consulting veterinary extension workers for diagnostic, preventive and curative advisory services are recommended. Participatory Epidemiology provides an important toolkit for rapid appraisal and designing practical solutions to challenges faced by farmers in resource poor settings.

Acknowledgement

We acknowledge the FAO, MAAIF for organizing the ISAVET training and the MOBIP-RAWM project funded by the EU and implemented under NARO/NaLIRRI for facilitating the publication of the work.

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