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Biosecurity Status in Small and Medium Scale Poultry Farms in Ethiopia

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Abstract: The study aimed to assess biosecurity status and the effect of chicken house structure, types of drinkers and feeders used on the incidence of disease outbreak in small- and medium-scale farms with a capacity of less than 1000 birds and between 1000 and 10, 000 birds, respectively. For the study total of 203 respondents were selected using a snowball sampling method and data collected using a mixture of structured questionnaires and observation checklist. Respondents grouped into the small (n=125) and medium (n=78) scales. Medium scale farms implemented about half of the biosecurity aspects assessed with a high level of efficiency (>75%) than the small counterparts. The biosecurity score of medium scale commercial farms (0.69±0.108) significantly ($p<0.001$) higher than the small scale farms (0.58±0.120). The majority of the respondents both in small scale farms (65.9%) and medium scale farms (75.6%) were using chicken houses with concrete floors. In small scale commercial chicken production, the incidence of disease outbreak was significantly ($p<0.001$) higher in farms using an earthen floor house (83.3%) than farms using concrete floor chicken house (33.3%). Similarly, in the medium scale commercial chicken production, the incidence of disease outbreak was significantly ($p<0.05$) higher in farms using an earthen floor chicken house (57.9%) than farms using concrete floor (22.0%). On the other side, in the small scale commercial chicken production, the incidence of disease outbreak was significantly ($p<0.05$) higher in farms using drinkers modified from locally available materials (67.6%) than farms using factory-made drinkers (45.1%). Similarly, in the medium scale commercial chicken production, the incidence of disease outbreak was significantly ($p<0.01$) higher in farms using drinkers modified from locally available materials (55.0%) than farms using factory-made drinkers (22.4%). In small scale commercial chicken farms, the incidence of disease outbreak for the types of feeders used was factory-made (40.0%), locally made-same to the standard (65.1%) and modified from locally available materials (50.0%) and these results differed significantly ($p<0.05$). The average mortality of layer chickens in the small scale farms (7.4±7.2) significantly ($p<0.05$) higher than the medium scale farms (4.7±4.1), whereas no significant difference was observed in other chicken types and age groups. The loose implementation of biosecurity aspects, use of inappropriately constructed chicken houses, feeders and drinkers were potential disease risk factors that should be addressed through training designed for the purpose.

Key words: Biosecurity · Small Scale Commercial · Medium Scale Commercial · Poultry Farms

INTRODUCTION

Globally, the poultry sector has undergone rapid changes during the past decades following the introduction of modern intensive systems of production [1]. Similarly, in Ethiopia, the commencement of modern poultry production and the extension system was dated back to the early 1950s during the introduction of exotic chicken breeds for research and development [2]. Since then, it is widely practiced in urban and peri-urban areas of the country although the growth is sluggish [3]. Despite the slow growth, the on-going commercial chicken production system can be categorized into three subsectors, namely small scale commercial, medium scale commercial and large scale commercial with a stock size of 50-1000, 1001-10, 000 and above 10, 000 chickens, respectively [4].

In modern intensive systems of poultry production, a large number of birds are housed in relatively small areas and a confined environment places a high premium on

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health care, hygiene and management that could be addressed under the concept of biosecurity [5]. Poultry biosecurity is procedures that prevent the introduction and spread of diseases and financial losses resulting from costs related to mortality, reduced production, poor feed conversion and costs of treating infected birds [6, 7]. A comprehensive biosecurity program should include isolation, traffic control and sanitation [8, 9]. Isolation can be considered in terms of time, that is; "time between in-out and restocking a chicken house", the distance between farms or houses in a farm and physical barriers such as fences, showers, footbath all of which limit the spread of disease agents [8]. Prabakaran [10] also conceptualizes that isolation is a proper layout of houses, appropriate designing to prevent any entry of rodents and the designing of feeders and drinkers to avoid spillage. Traffic control includes restricting the movement of humans, equipment and animals onto the farm, off the farm and movement patterns within the farm. Sanitation on the other hand refers to the cleaning and disinfection of poultry houses, materials and equipment entering the farm and the cleanness of the personnel on the farm [9].

In this regard, unlike large scale farms that operate in areas identified for the purpose, most small and medium scale farmers carry out their production in residential areas or areas closet to other agricultural operations difficult to ensure the health of the farm because of the presence of unfavorable situation to implement strict biosecurity [11]. It is, therefore, this study was aimed to assess the biosecurity status and the effect of chicken house structure, types of drinkers and feeders used on the incidence of disease outbreaks in small and medium scale farms.

MATERIALS AND METHODS

Selecting the Study Sites: In the present study, the sites were selected based on the availability and accessibility of poultry multiplication centers and breeder farms in and around, to the nearby source of chicken breeds, feed and other inputs were taken into consideration. Accordingly, a total of seven sites (Bishoftu, Adama, Hawassa, Kombolcha, Mekelle, Gondar and Bahir Dar) were purposely selected.

Sampling method In Ethiopia, most of the commercial poultry producers are informal who do not have a legal license issued by the concerning institution [4], making it difficult to find the complete list of households (hh) engaged in farming and select the sample following the probability sampling methods. Hence, to select the study respondents, snowball sampling was applied. It is a method where existing subjects are asked to refer to further subjects known to them [12]. From each site, 29 households and a total of 203 commercial chicken farmers were selected for the study and data were collected using a mixture of structured questionnaires from September 2017 to March 2018.

Data Analysis: The data collected through a surveying of the small and medium scale commercial chicken farming households were entered into SPSS software package version 20. Descriptive statistics such as frequency and percentage were computed to evaluate the proportion of biosecurity aspects implemented among scales of the farms. Using the method adapted from Van Steenwinkel *et al*. [13] each indicator of biosecurity was equally valued as 1 (aspects being performed) and 0 (aspects not performed) and the sum were divided into groups, each expressing different aspects of farm biosecurity to offer an average score for a farm. Then the biosecurity scores (BS) of farms were summarised as means and standard deviations and a *t-test* was performed to determine the extent of flock size influenced the BS of farms. Chi-square (χ^2) test was also computed to determine the relationship of chicken house structure (floor type), type of drinkers and feeders used with the incidence of disease outbreak in both small and medium scale of chicken production.

RESULTS AND DISCUSSION

Biosecurity Aspects: The level of implementation of the biosecurity aspects assessed during this study is presented in (Table 1). Small scale farmers who implemented >75% of the biosecurity aspects include wild bird proof, availability of clean water, vaccination against economically important diseases, regular cleaning and disinfection of feeders and drinkers and cleaning and disinfection of chicken house between batches. In addition to these, the medium scale farmers implemented fenced farm compounds, presence of footbath at the entry point, using on-farm cloths and foot wears and appropriate disposable of dead birds. The biosecurity aspects implemented by the small and medium scale farmers decreased to 50-75% include restricting the entrance of visitors, provision of prophylactic medication and all-in all-out management system. Apart from these, the biosecurity aspects such as

using on-farm clothes and foot wears and appropriate disposal of dead birds were implemented by small scale farms and locating the farm at appropriate site and hand washing before and after handling chicken by the medium scale farmers.

The biosecurity aspects implemented by the small scale and medium scale farmers further dropped to <50% comprise rodent proof, presence of feed storage unit, shower before handling chicken and obtaining training on chicken farm biosecurity. In addition to these, the small scale farms implemented locating the farm at an appropriate site, fenced farm compound and hand washing before and after handling chicken. Among the biosecurity aspects, isolation of sick birds in a separate room was the least practiced by small scale farmers (13.6%) and medium scale farmers (24.4%) though most farmers reported that it was a common practice to isolate sick birds at either corner of the same shed in which the stock is housed. From the results, it is possible to understand that medium scale farms implemented about half of the biosecurity aspects assessed with a high level of efficiency than the small counterparts. Similarly, Negro-Calduch *et al*. [14], in their study conducted on commercial broiler farms in central Egypt noted that important biosecurity measures were rarely implemented in small scale commercial production units. There have been reports of biosecurity enhancement in farms with larger farm areas and flock sizes [5, 15]. This is because large scale poultry farms need to avoid or mitigate the potential larger losses caused by disease outbreaks [16].

The results also showed that the biosecurity score of medium scale commercial farms (0.69±0.108) significantly ($p<0.001$) higher than the small scale farms (0.58±0.120) (Table 2). However, the biosecurity score of medium scale farms of the present study is lower than commercial farms keeping 1001–2000 chickens in Nigeria (0.80±0.10) [16]. These authors also reported that a decrease in biosecurity score is remarkable when the commitment of farmers to adopt a particular biosecurity measure dropped to <60%. A high level of biosecurity has been demonstrated repeatedly to minimize the risk of disease entering into poultry farms. In this regard, Martindah *et al*. [17] noted that biosecurity activities are management changes, which may be low cost but require commitment from owners and farm workers to implement. Fasina *et al*. [18] were conducted a study to analyse the cost-benefit of biosecurity measures on infectious diseases in Egypt farms and they confirmed that the implementation of all biosecurity measures with a desirable level generated a high benefit-cost ratio of (8.45). However, inadequate understanding of the relevance of biosecurity practice remains a hindrance to biosecurity compliance in commercial poultry production.

Chicken House Structure of the Small and Medium Scale Chicken Farms: The result showed that the majority (65.9%) of the small and (75.6%) of medium scale producers had a chicken house with a concrete floor. In both the small and medium scale production, the wall of the chicken house was made from a block, wood with mud and sheet metal nearly the same proportion. However, all respondents both in the small and medium scale commercial chicken production had a chicken house of a roof covered with sheet metal (Table 3). Similarly, Mbuza *et al*. [19] reported that in Rwanda 63% of broiler poultry farmers had constructed permanent structures (concrete floor, brick walls and iron sheet roofing).

Effect of Chicken House Floor, Feeder and Drinker Type on Disease Outbreak: The effect of chicken house floor, feeder and drinker types on the incidence of disease outbreak in small and medium scale farms is presented in (Table 4). In small scale commercial chicken production, the incidence of disease outbreak was significantly ($p<0.001$) higher in farms using an earthen floor house (83.3%) than farms using concrete floor chicken house (33.3%). Similarly, in the medium scale commercial chicken production, the incidence of disease outbreak was significantly ($p<0.05$) higher in farms using an earthen floor chicken house (57.9%) than farms using concrete floor (22.0%). On the other side, in the small scale commercial chicken production, the incidence of disease outbreak was significantly ($p<0.05$) higher in farms using drinkers modified from locally available materials (67.6%) than farms using factory-made drinkers (45.1%). Similarly, among the medium scale commercial chicken producers, the incidence of disease outbreak was significantly ($p<0.01$) higher in farms using drinkers modified from the locally available materials (55.0%) than farms using factory-made drinkers (22.4%). In small scale commercial chicken farms, the incidence of disease outbreak for the types of feeders used was factory-made (40.0%), locally made-same to the standard (65.1%) and modified from locally available materials (50.0%) and these results differed significantly ($p<0.05$) while no significant difference was observed for the types of feeders used in medium scale farms.

Table 1: Biosecurity aspects implemented by small and medium scale commercial chicken farms (%)

Biosecurity aspects	Small scale	Medium scale	Overall
Locating the farm at appropriate site	42 (33.6)	41 (52.6)	83 (40.9)
Fenced farm compound	55 (44.0)	59 (75.6)	114 (56.2)
Presence of footbath at the entry point	92 (73.6)	75 (96.2)	167 (82.3)
Restricting the entrance of visitors	70 (56.0)	52 (66.7)	122 (60.1)
Wild bird proof	96 (76.8)	66 (84.6)	162 (79.8)
Rodent proof	60 (48.0)	33 (42.3)	93 (45.8)
Presence feed storage unit	47 (37.6)	32 (41.1)	79 (38.9)
Hand washing before and after handling chicken	57 (45.6)	50 (64.1)	107 (52.7)
Shower before handling chicken	34 (27.2)	29 (37.2)	63 (31.0)
Using on-farm cloths & foot wears	75 (60.0)	66 (84.6)	141 (69.5)
Availability clean water	115 (92.0)	70 (89.7)	185 (91.1)
Cleaning & disinfection of chicken house between batches	104 (83.2)	74 (94.9)	178 (87.7)
Regular cleaning & disinfection of feeders & drinkers	114 (91.2)	77 (98.7)	191 (94.1)
All-in all-out management system	93 (74.4)	53 (67.9)	146 (71.9)
Isolation of sick birds in a separate room	17 (13.6)	19 (24.4)	36 (17.1)
Vaccination against economically important diseases	123(98.4)	78 (100.0)	201 (99.0)
Provision of prophylactic medication	80 (64.0)	55 (70.5)	134 (66.5)
Appropriate disposable of dead birds	76 (60.8)	62 (79.5)	138 (68.0)
Obtaining training on chicken farm biosecurity	43 (34.4)	32 (41.0)	75 (36.9)

Table 2: The effect of the scale of the chicken farm on biosecurity scores (BS)

Scale of the chicken farm	Biosecurity score (Mean ± SD)
Small scale commercial	0.58 ± 0.120^{b}
Medium scale commercial	0.69 ± 0.108^{a}

[a, b]: Means within a column with no common superscript are significantly different at P<0.001.

Table 3: Chicken house structure of the small and medium scale commercial farms (%)

Chicken house structure		Small scale	Medium scale	Overall
Floor	Concrete	81 (65.9)	59 (75.6)	140 (69.7)
	Earthen	42 (34.1)	19 (24.4)	61 (30.3)
Wall	Block	47 (37.9)	28 (35.9)	75 (37.1)
	Wood with mud	40 (32.3)	25 (32.1)	65 (32.1)
	Sheet metal	37 (29.8)	25 (32.1)	62 (30.7)
Roof	Sheet metal	125 (100.0)	78 (100.0)	203 (100.0)

Table 4: The effect of chicken house floor, feeder and drinker types on the incidence of disease outbreak in small and medium scale farms

The scale of chicken farm	Variables		Diseases outbreak "Yes" (%)	P-value
Small Scale commercial	Chicken house floor type	Earthen	35 (83.3)	0.000***
		Concrete	27 (33.3)	
	Drinker type	Factory-made	41 (45.1)	
		Modified from the locally available materials	23 (67.6)	0.025*
	Feeder type	Factory-made	24 (40.0)	0.042*
		Locally made, same to the standard	28 (65.1)	
		Modified from the locally available materials	9 (50.0)	
Medium Scale commercial	Chicken house floor type	Earthen	11 (57.9)	0.003**
		Concrete	13 (22.0)	
	Drinker type	Factory-made	13 (22.4)	0.006**
		Modified from the locally available materials	11 (55.0)	
	Feeder type	Factory-made	9 (22.0)	0.224
		Locally made, same to the standard	8 (42.1)	
		Modified from the local materials	6 (35.3)	

*, **, ***: Are significantly different at p<0.05, p<0.01 and p<0.001, respectively

Table 5: Disease outbreak and mortality of chicken in small and medium scale farms (M±SD)

Chicken type	Chicken age group	Small scale commercial	Medium scale commercial	P-value
Layer	Chicks (Wk 0-8)	6.30±6.01	5.41±4.41	0.261
	Growers (Wk 9-20)	3.73±4.97	4.74±3.84	0.144
	Layers (Wk 21-72)	7.4±7.2	4.7±4.1	0.036*
Broiler	Starter (Wk 0-21)	6.2±2.2	5.3±4.7	0.696
	Finishers (Wk 21-45)	6.9±8.3	2.7±4.1	0.165

*: Means within the rows are significantly different ($p<0.05$)

In a deep litter system, a chicken house with earthen floor and wood with mud and sheet metal wall structures triggers the infestation of vermin and rodents. Particularly, chicken houses constructed with mud floor is not recommended, as such house structure renders cleaning between batches very difficult and will harbor micro-organisms, eggs of parasites, etc., which may cause disease outbreaks in subsequent batches. The wall of the house could make from block or mud, but it should be thoroughly plastered in such a way that it avoids cracks forming [10]. Despite this, during the study, it has been observed that most of the chicken houses' walls made from mud were cracked; favorable for rodents and vermin hiding and difficult to carry out proper cleaning.

Literature has been noted the noticeable contribution of chicken houses having a concrete floor to minimize the incidence of economically important poultry diseases because of wet litter. Though there were multidimensional causal factors for wet litter, the earthen floor is a major predisposing aspect as water coming up through the floor by capillary action from the ground below particularly during the summer season [20, 21]. This in turn causes various diseases such as coccidiosis, footpad dermatitis, necrotic enteritis; affects animal welfare; food safety and reduction of production efficiency [20]. Unlike other livestock operations in which every portion of the floor of the house designed to serve a specific purpose, in poultry house all parts of the floor must serve a quadruple purpose (passageway for the care-taker, a feeding place for the hens, a comfortable place on which they stand or move about and finally a suitable medium for the collection of droppings. This magnifies the importance of a good floor with suitable litter material of the proper depth [21].

Mortality of Chicken among Different Age Groups of Small and Medium Scale Farms: The result of the present study revealed that the average mortality of layer chickens in small scale farms (7.4±7.2) significantly ($p<0.05$) higher than the medium scale farms (4.7±4), whereas no significant difference was observed in other chicken types and age groups (Table 5). The mortality reported in the present study was higher than the permissible level for both layer and broiler chickens. According to Prabakaran [10], the permissible mortality level for commercial layers - brooding phases (4%), growing phase (2-3%) and laying phases (6-8%) and 4% for commercial broilers over the entire growth phase up to marketable age. The present results were also higher than the reported values by Wondmeneh *et al*. [22] who noted the mortality of chicks of 3.9%, growers 3.5% and layers 3.2%; and broilers starter of 2.9% and finisher 3.5% in Ethiopia. This is partly justified by the result of the present study showed the presence of a significant ($P<0.01$) negative correlation between mortality of chicken and biosecurity scores ($r = -0.336$). Besides, the mortality of pullets in the farms (chicks and growers) of the current study was 10.1% and is higher than the 6-8% recorded by commercial chicken farms before 20 years ago in Ethiopia, Alemu and Tadelle [2].

CONCLUSION

The medium scale commercial chicken farmers implement most of the biosecurity aspects than the small scale counterparts. The mortality rate recorded both in small and medium scale chicken farms higher than the permissible level and the results report long years ago in the country render much work should be done to tackle the problem. Majority of the respondents both in small and medium scale commercial chicken production are using concrete floor houses that might contribute to reducing the mortality potentially occurred more than the result recorded in the present study. Both in small and medium scale commercial chicken production the incidence of disease outbreak is higher in the farms chicken rearing in earthen floor houses and using drinkers modified from locally available materials than those rearing in concrete floor houses and using factory-made drinkers. The loose implementation of farm biosecurity aspects, use of inappropriately constructed chicken house structures (floor structure), feeders and drinkers are potential diseases risk factors that should be addressed through training designed for the purpose.

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