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Original Research Article

Assessment of Knowledge and Practices of Biosecurity Status in Commercial Chicken Farms Found in Dire Dawa Town, Eastern Ethiopia

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Abstract: ***Background*:** Biosecurity in the poultry refers to a set of practices and measures taken to limit, control, or prevent the introduction and dissemination of infectious diseases in the poultry premises and facilities. ***Material and Methods*:** A survey was employed from January 2020 to October 2020 to assess the knowledge and practices of the biosecurity status of 36 commercial chicken farms established in Dire Dawa, Eastern Ethiopia, by interviewing farm owners using a structured questionnaire. The gathered data was summarized using frequency tables and analyzed with Pearson's chi-square test and Fischer's exact value using Stata 14 statistical software. ***Results and Discussion*:** From the assessed chicken farms, 25 (69.44%) had previous experience in rearing chickens. Among those owners, 9 (25%) refused to disclose their level of education, and 16 (44.44%) didn't receive training on chicken farm management. Among the 36 Dire Dawa chicken farms, 24 (66.67%) were located within 0-50 m from the main road and 29 (80.56%) farms were established within 500 m from the nearest farm and 21 (58.33%) placed within 0-20 m from residential areas. (Table 3). 30 (83.33%) participants disclosed their employees didn't receive training on biosecurity. From the chicken farms assessed, 26 (72.22%) had fences, 32(88.89%) had footbaths at the gate, 27 (75.00%) prohibited the entrance of visitors, 3 (8.33%) didn't exchange equipment with other farms, each of the 36 (100%) farms didn't used surface water for drinking or cleaning, 20 (55.56%) stay informed regarding disease outbreak in the area (Table 4). However, only 5 (13.89%) undertook a permanent rodent control strategy. Furthermore, 22 (61.11%) farms were easily accessed by wild birds, each of the 34 (94.44%) farms purchased day-old chicks, feed and shared trucks as well. Among the assessed farms, only 2 (5.56%) had signages to restrict people's access, 7 (19.44%) had isolation room for diseased chickens, 11 (30.56%) farm properly disposed dead birds, and 9 (25.00%) kept records. previous training (Fischer's exact value = 4.01; P = 0.037), and farm capacity (Fischer's exact value = 13.49; P = 0.000) were found statistically significantly associated with the biosecurity level of the farm (Table 6). The association between owners' gender, education level, experience, and biosecurity status was statistically insignificant (P > 0.05; Table 6) and farm capacity (Fischer's exact value = 13.49; P = 0.000) was found to be statistically significantly associated with the farm biosecurity status. ***Conclusion and Recommendations*:** The farm biosecurity measures were found to be good knowledge in farms run by civil servants, trained employees, owned premises, and large- and medium-scale. In conclusion, the higher poor biosecurity status in chicken farms calls for the implementation of good biosecurity practices in each farm as well as the provision of training to the farm owners through workshop and field days seminars by appropriate agents on the benefit of adhering strictly to biosecurity measures on farms.

Keywords: Knowledge, Biosecurity, Dire dawa, Chicken.

1. INTRODUCTION

Poultry production is a very important type of animal production [1]. Poultry are efficient in producing high-quality protein (meat and eggs) [2]. However, diseases remain the principal cause for failure in poultry production [3]. A successful animal production, including poultry requires the adoption of good biosecurity practices [4], which is the most effective and inexpensive disease control measure [5]. The recurrent global disease outbreak in poultry farms has made the practice of biosecurity an important practice to protect poultry farms from intentional and unintentional threat of any disease producing agents on the farms. Biosecurity in poultry refers to a set of practices and measures taken to limit, control, or prevent the introduction and dissemination of infectious diseases in poultry premises and facilities and [6, 7]. A biosecurity program uses a combination of physical barriers such as

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fences, meshes, wire, and directed actions to prevent the introduction of, or minimize the spread of infectious disease-causing agents such as the use of footbaths, carwash deep, and disinfection of farm equipment [2]. The three components of biosecurity measures are isolation, traffic control, and sanitation [8]. Van Limbergen *et al*., [4] and Sasaki *et al*., [9], disclosed that biosecurity is classified into internal and external. Biosecurity consists of conceptual, structural, and operational frameworks [10]. The conceptual category includes: the location of farms; structural: covering the building design and facilities to protect against entry of wild birds and predators; operational: covering the routine disinfection, sanitation, and work procedures those farm employees and visitors follow [11]. Performance of birds is influenced by the biosecurity measures of the farms [5].

Ethiopia has an estimated poultry population of about 56.53 million [12]. Poultry production is characterized by small scavenging flocks of local chickens and few farms in the commercial subsector with varying flock sizes [13]. Small and medium-scale producers constitute most of the commercial poultry production in Ethiopia [14]. Therefore far, there have been very few attempts on the assessment of biosecurity measures of commercial poultry farms [15, 16], and poultry markets [17], of Ethiopia. Haftom *et al*., [15], reported that out of 25 small scale poultry farms. 12 (44%) didn't employ all -in-all--all-out practice, 14 (56%) disposed dead birds by throwing, 16 (64%) kept different age groups together. The existing evidences depict failure to fully practice biosecurity measures in integrated and larger commercial scale types while virtually no or minimal routine application of biosecurity measures in the small-scale poultry production system [18].

Poultry production is important in Ethiopia as poultry plays a major role in poverty, alleviation, nutrition, and food security [14]. In Ethiopia, the chicken production system is classified into small, medium, large, and integrated large commercial scale production systems [18]. Ethiopia has small-, medium- and large-scale intensive broiler and layer farms located in and around Addis Ababa, Debre Zeit (the now Bishoftu), Modjo and Adama [19, 20]. Most small-scale poultry farms are located around Debre Zeit town in Oromia region and Addis Ababa. The main commercial poultry farms – Elflora, Agro Industry, Genesis and Alema – are located around Debre Zeit in Oromia [19].

In Ethiopia, the application of biosecurity measures is limited [19], and to date there is no information on the biosecurity status of commercial chicken farms in Dire Dawa city. Therefore, the objective of this study was to assess the biosecurity knowledge and practices of commercial chicken farms and to identify the indictors of good biosecurity status in commercial chicken farms in Dire Dawa.

2. MATERIALS AND METHODS

2.1. Study Area

Dire Dawa city is located in the eastern part of Ethiopia and 515 kilometres from Addis Ababa, the capital city of Ethiopia. The area lies between 950–1250 metres above sea level and the climatic condition is characterized by a warm and dry climate with a relatively low level of precipitation with mean annual relative humidity to be 48.2 %. The area has two rainy seasons; that are a small rain season (from March to April) and a main shower of rain (from August to September). The aggregate average annual rainfall is about 604 mm. On the other hand, the region is believed to have an abundant underground water resource, which makes it suitable for dairy farming. The monthly average maximum and minimum temperatures of the area are 32.4^0C and 19.1^0C, respectively [21]. Farmers near Dire Dawa use a mixed crop and livestock farming system. Moreover, Dire Dawa and its surroundings have variable and yet representative agro-ecologies of the country. These agro-climatic zones are inhabited by different plant and animal species [22].

Source: Abdurehman *et al*., [23].

2.2. Study Population

The target population of the study comprised of 45 commercial chicken farms in Dire Dawa that raise exotic breeds of chickens (predominantly Bovans and Lowmans) under small- (<1000 birds), medium (1000-10,000 birds) and large scale (>10,000 birds) [19]. These exotic chicken breeds are imported and are highly productive than the indigenous breeds of chicken.

2.3. Study Design and Sampling Technique

A cross-sectional population survey was employed from January 2020 to October 2020 to evaluate the biosecurity status adopted by commercial chicken farms at Dire Dawa town. The list of commercial chicken farms was obtained from Dire Dawa Administration Council of Livestock and Fisheries Development Office. These farms were observed in person during data collection and the owners were contacted and asked for their interest to participate in the biosecurity study. Verbal consent for participation was taken only from 36 farms while others refused to participate and reasons for refusal were not sought. The survey comprised face-to-face interviews of farm owners using a structured questionnaire. The interview was conducted by the researchers.

2.4. Questionnaire Development

A structured questionnaire was developed and used to collect data on the biosecurity adopted by small-scale, medium-scale, and large-scale commercial chicken farms in Dire Dawa. For the survey, owners' demography, farm characteristics, and relevant biosecurity practices were included in the questionnaire. Specific questions included were demography of commercial chicken farm owners (gender, occupation,

education level, experience in running chicken farms, and training received) and characteristics of the farms (premises, farm capacity, and farm type). Questions associated with the biosecurity assessment consisted in the conceptual framework such as distance from the main road between farms from residential areas, presence of standing water, house type, housing position, and materials used for house construction. In the structural framework questions included were presence of farm fences and gates, footbath, prohibition of vehicle entry, presence of tire bath/spray, prohibition of visitors, visitors sign on the log book, no purchase of day-old chicken, no purchase of feed, no sharing of trucks with others, permanent rodent control, wild bird has no access to stored fresh litter, presence of permanent wild bird control. At last, the questions included in the operational biosecurity framework were using of special cloth, foot wear, masker and hats, regular cleaning and disinfection, use of high pressure sprayers, proper disposal of dead chickens and no other animals in the farm, veterinary consultation, disinfection in cycle, prophylactic treatment and vaccination etc. In general, a total of 66 closed questions were designed to obtain data "yes" or "no" answers.

2.5. Data Collection

The questionnaire was pretested and checked in the ten chicken farms that were included in the survey and care has been taken to protect any confusion or misinterpretation of the questions. Personal face-to-face interview was employed with farm owners, managers, veterinarians, and employees. In addition, observation was made on the farms to assess the level of biosecurity at different levels.

2.6. Data Analysis

All collected data was entered into a Microsoft Excel spreadsheet, cleaned, and coded. Variables that assumed to have a similar influence on the potential risk of introduction of contagious disease on the farm were combined into a single variable, by producing a basic biosecurity score as the method described previously by [24]. The minimum and maximum biosecurity score obtainable on a farm was 0 and 72, respectively. The total sum assigned to the farm was divided by the maximum score that the farm could attain on the questions actually answered (72) and multiplied this proportion by 100 to obtain the percentage. A farm that gained >50% was considered having 'Good' biosecurity practices', and <50% as "Poor" biosecurity practice'. Statistical analyses were performed using STATA, version 13 statistical software. Pearson's chi-square or fisher's exact tests were used to estimate associations between demography of chicken farm owners and farm characteristics with biosecurity status. A variable is said to have a significant effect when $P<0.05$.

3. RESULTS

3.1. Demography of Farm Owners

From the 36 commercial chicken farm owners, 23 (63.88%) were males, 22 (61.11%) had higher education in various fields, 25 (69.44%) were traders, and 25 (69.44%) had previous experience in rearing chickens. Among those owners, 9 (25%) refused to disclose their level of education, and 16 (44.44%) did't receive training on chicken farm management. The demography of chicken farm owners is presented in Table 1.

Table 1: The demography of chicken farm owners involved in biosecurity evaluation

Farm owners demography	Category	Number of owners	Percent (%)
Farm ownership	Female	9	25.00
	Male	23	63.88
	Both female and male	4	11.11
Owner's educational level	Primary and secondary education	5	13.88
	Higher education	22	61.11
	Not disclosed	9	25.00
Primary occupation	Trader	25	69.44
	Civil servant	7	19.44
	Others	4	11.11
Previous experience in rearing commercial chickens	Yes	25	69.44
	No	11	30.56
Previous training in biosecurity	Yes	20	55.56
	No	16	44.44

3.2. Characteristics of Chicken Farms

As presented in Table 2, 28 (77.78%) were run on a rented premises while only eight (22.22%) were established on owned premises. A majority (83.33%) were categorized as small-scale chicken farms and in 22 (61.11%) of them only layers were reared.

Table 2: The frequency and percentage of chicken farms with various farm characteristics

Characteristics	Category	Number of farms	Percent (%)
Sources of Premises	Owned	8	22.22
	Rented	28	77.78

Characteristics	Category	Number of farms	Percent (%)
Farm capacity	Small-scale	30	83.33
	Medium-scale	4	11.11
	Large-scale	2	5.56
Farm type	Layer	22	61.11
	Broiler	9	25.00
	Both layer and broilers	5	13.89

3.3. Biosecurity Evaluation

3.3.1. Conceptual Biosecurity

Eight biosecurity indicators were used to assess the conceptual of biosecurity and summarization revealed a mean score of 2.7 points with a standard deviation (SD) of 1.86. Among the 36 Dire Dawa chicken farms, 24 (66.67%) were located within 0-50 m from the main road and 29 (80.56%) farms were established within 500 m from the nearest farm (Table 3). Furthermore, 21 (58.33%) were situated within 0-20 m from the residential area and 7 (19.44%) were placed within 21-200 m. All most of all (97.22 %), the premises constructed for chickens were modified open-sided with curtains and 17 (47.22%) of them were built in an east-west direction.

Table 3: The frequency and percentage of indicators of conceptual biosecurity

Biosecurity Indicators	Category	Number of Farms	Percent (%)
Distance of the farm from the main road (m)	0-50	24	66.67
	>50-100	5	13.89
	>100-300	4	11.11
	>300	3	8.33
Distance from the nearest farm (m)	<500	29	80.56
	≥500	7	19.44
Distance from the residential place (m)	0-20	21	58.33
	>20-200	7	19.44
	>200	8	22.22
No standing water near the farm	Yes	15	41.67
	No	21	58.33
Premise with modified open-side and curtains	Yes	35	97.22
	No	1	2.78
Housing position	East-West	17	47.22
	Others	19	52.78
Chicken house and hatcheries constructed of impervious material	Yes	16	44.44
	No	20	55.56
Biosecurity training to employee	Yes	6	16.67
	No	30	83.33

3.3.2. Structural Biosecurity

For the evaluation of the structural biosecurity, 21 biosecurity measurements were considered. From the chicken farms assessed, 26 (72.22%) had fences, 32(88.89%) had footbaths at the gate, 27 (75.00%) prohibited the entrance of visitors, 3 (8.33%) didn't exchange equipment with other farms, each of the 36 (100%) farms didn't used surface water for drinking or cleaning, 20 (55.56%) stay informed regarding disease outbreak in the area (Table 4). However, only 5 (13.89%) undertook a permanent rodent control strategy. Furthermore, 22 (61.11%) farms were easily accessed by wild birds, each of the 34 (94.44%) farms purchased day-old chicks, feed and shared trucks.

Table 4: The frequency and percentage of Awareness and Practice of Biosecurity Measures

Biosecurity Indicators	Yes (%)	No (%)
Presence of fence and gate	26 (72.22)	10 (27.78)
Presence of functional footbath	32 (88.89)	4 (11.11)
Prohibition of vehicle entry	13 (36.11)	23 (63.89)
Farm vehicle parked off the farm	8 (22.22)	28 (77.78)
Presence of tire bath/spray at the gate	4(11.11)	32 (88.89)
Prohibition of entry of visitors	27 (75.00)	9 (25.00)
Visitors sign on logbook	5 (13.89)	31 (86.11)
Number purchase of day-old chicken	2 (5.56)	34 (94.44)
Number purchase of feed	2 (5.56)	34 (94.44)
Number equipment exchange with other farms	33 (91.67)	3 (8.33)

Biosecurity Indicators	Yes (%)	No (%)
Number sharing of truck with others	2 (5.56)	34 (94.44)
Number pet animal present in the farm	32 (88.89)	4 (11.11)
Presence of permanent rodent control	5 (13.89)	31 (86.11)
Presence of permanent wild bird control	1 (2.78)	35 (97.22)
Chicken area not accessible to wild bird	14 (38.89)	22 (61.11)
Wild bird has no access to stored fresh litter	21 (58.33)	15 (41/67)
Wild bird has no access to stored food	19 (52.78)	17 (47.22)
No feeding of chicken outside and no access to feed by wild birds	31 (86.11)	5 (13.89)
Stay informed regarding outbreak of poultry disease in the area	20 (55.56)	16 (44.44)
Surface water not used for drinking of chicken	36 (100)	0 (0.00)
Surface water not used for cleaning	36 (100)	0 (0.00)

3.2.3. Operational Biosecurity

As presented in Table 5, farm workers of 12 (33.33%) farms didn't wear special clothes and 7 (19.44%) farms didn't use special foot wear while operating in the farm, 28 (77.78) did a phone call to the veterinarian when the chicken appeared sick, 26 (72.22%) didn't undertake regular laundry with cap and overalls and 22(61.11%) farms didn't store removed litter in a covered shed. However, only 2 (5.56%) had signage to restrict people access, 7 (19.44%) had isolation room for diseased chickens, 11 (30.56%) farms properly disposed dead birds, and 9 (25.00%) kept records.

Table 5: The frequency and percentage of knowledge on operational of Biosecurity Measures

Biosecurity Indicators	Yes (%)	No (%)
Use of special cloth	24 (66.67)	12 (33.33)
Use of special footwear	29 (80.56)	7(19.44)
Use of special masker	7 (19.44)	29 (80.56)
Use of special hat	7 (19.44)	29 (80.56)
Shower in and out	7(19.44)	29(80.56)
Regular laundering to cape and coveralls	10 (27.78)	26 (72.22)
Visitor has no access to poultry compartment	28 (77.78)	8 (22.22)
Visitors special cloth	1 (2.78)	35 (97.22)
Visitors special footwear	7(19.44)	29 (80.56)
Signage the farm	2 (5.56)	34 (94.44)
Multiple ages aren't kept together	33 (91.67)	3 (8.33)
Order of care is from youngest to oldest	33 (91.67)	3 (6.82)
Employee don't care for different age group	3 (6.82)	41 (93.18)
Partial depopulation	20 (55.56)	16 (44.44)
Presence of paved places of discharge	18 (50.00)	18 (50.00)
Regular cleaning and disinfection	20 (55.56)	16 (44.44)
Used cleaning water is not drained outside	19 (52.78)	17 (47.22)
High pressure sprayer used for cleaning	17 (47.72)	19 (52.78)
Staff has no contact with other farms	13 (36.11)	23 (63.89)
Dedicated worker to each chicken house	30 (83.33)	6 (16.67)
Proper disposal of dead chickens	11 (30.56)	25 (69.44)
Removed litter stored at cover shade	14 (38.89)	22 (61.11)
Apply insecticide on top of new litter	36 (100.00)	0 (0.00)
Two weeks of opening period after disinfection	26 (72.22)	10 (27.78)
Spilled feeds are cleaned up immediately	9 (25.00)	27 (75.00)
Stored food is not accessible to rodents	13 (36.11)	23 (63.89)
Presence of isolation room for diseased chicken	7 (19.44)	29 (80.56)
Sick birds are regularly examined	13 (36.11)	23 (63.89)
Making a call to veterinarian when chicken appeared sick	28 (77.78)	8 (22.22)
Regular sero-monitoring	1 (2.78)	35 (97.22)
Chickens are vaccinated for diseases known in the past	33(91.67)	3 (8.33)
Chickens are vaccinated only according to the manufacturer's instruction	27 (75.00)	9 (25.00)
Antibiotics are used only when birds are sick	24 (66.67)	12 (33.33)
Antibiotics are used according to the recommended dosage	25 (69.44)	11 (30.56)
Expired vaccines/drugs are never used	28 (77.78)	8 (22.2)
Presence of record keeping	9 (25.00)	27 (75.00)

3.3.4. Overall Biosecurity Scores and Biosecurity Measures

This study revealed the overall biosecurity scores for each farm. Thus, 9 (25%) farms got a score of >50%, therefore, their biosecurity practices were classed as 'Good'. The remaining 27 (75%) farms scored <50%, hence, their practices were graded as 'Poor'.

3.4. Assessment of the Association between Biosecurity Level and Owners' Demography and Farm Characteristics

From the characteristics considered, previous training (Fischer's exact value = 4.01; P = 0.037), and farm capacity (Fischer's exact value = 13.49; P = 0.000) were found statistically significantly associated with the biosecurity level of the farm (Table 6). The associations between owners' gender, education level, experience, and biosecurity status were statistically insignificant (P > 0.05; Table 6).

Table 6: Association between biosecurity level and owner's demography and farm characteristics

Variable	Categories	Number of farms	Biosecurity status		Chi-square or Fischer's exact value	P-value
			Good	Poor		
Farm ownership	Female only	9	2 (22.22)	7 (77.78)	0.51[a]	0.779
	Male only	23	6 (26.09)	13 (73.91)		
	Both male and female	4	1 (25.00)	3 (75.00)		
Owner's educational level	Elementary and high school	5	1 (20.00)	4(80.00)	0.18[a]	0.877
	Higher Education	22	6 (27.27)	16 (72.73)		
	Not disclosed	9	2 (22.22)	7(77.78)		
Experience in rearing chicken	Yes	25	6 (24.00)	19 (76.00)	0.29[a]	0.645
	No	11	3 (27.27)	8(72.73)		
Previous training on biosecurity	Yes	20	7(35.00)	13 (65.00)	4.01[a]	0.037*
	No	16	6 (37.5)	10 (62.5)		
Farm capacity	Small-scale	30	5 (16.67)	25 (83.3)	13.49[a]	0.000*
	Medium-scale	4	3 (75.00)	1 (25.00)		
	Large-scale	2	2 (100.0)	0 (0.0)		

†Businesses not linked to chicken; [a]Fisher's exact value; [b]Pearson's chi-square value; *Significant (p<0.05).

4. DISCUSSION

This survey provides baseline data on the demography of people owning chicken farms and an insight into the biosecurity practices conducted among chicken farms established in Dire Dawa town. Meanwhile, the limitations of this study were not able to assess the routine application and functionality and overlook the relative importance of each indicator to the overall biosecurity status.

The majority of farm owners 23 (63.88%) were males, 22 (61.11%) had higher education in various fields, 25 (69.44%) were traders, and 25 (69.44%) had previous experience in rearing chickens. Likewise, Ajewole and Akinwumi [25], and Kouam *et al*., [8], disclosed that the majority of small-scale broiler farmers were men. Kouam *et al*., [8], explained this age-wise variation was attributed to the requirement of high commitment for success.

Although the majority of owners in this study had higher education, 16 (44.44%) did't receive training on biosecurity. Kouam *et al*., [8], linked this with the negligence of government officials to provide training in biosecurity as they lack understanding on the usefulness of biosecurity in animal husbandry and this might also be partly the case in Dire Dawa town.

A majority (83.33%) were categorized as small-scale chicken farms with <5,000 birds rearing only 22 (61.11%) layers on rented premises In Egypt, 60% of broiler chicken farms were also small-scale [6]. Many commercial chicken farms in Dire Dawa were located near to the main roads (< 0-50 m) and in close proximity (<500 m). These present a danger of airborne transmission of diseases from animals transported along the public road and between poultry farms. Thus, to minimize such transmission, the distance to the nearest poultry farm should be at least 500 m and preferably >1 km [26]. Many poultry farms in Dire Dawa were located within 0-20 m from the residential areas. This indicates a biosecurity risk and considerable financial loss of the chicken farms as well as animal and public health problems through water/soil and air pollution [27].

In the present study, 25 out of 36 farms didn't dispose of carcasses of dead chickens properly and 22 out of 36 didn't store removed litter to cover shade. However, carcasses of dead chicken and used litter must be disposed of properly because they are high sources of infectious agents [4, 5]. Disposal of litter by spreading on nearby arable farm lands constitutes a risk for dissemination of disease-causing organisms [28]. Thus, those farms are at risk of spread of infectious agents.

In this study, many farms were located far from a standing water and this finding varies from that of Kouam *et al*., [8], who reported that 73.5% of farms were located less than 500 m from a stream which is the risk for pathogen transmission among poultries such as water

spots such as ponds, lakes, and rivers are attractive to migratory birds [29]. Regarding structural biosecurity, nearly all farms in this study had a footbath at the gate and this was higher than the finding of [30, 31], who reported 80% of the farms in Mekelle had footbaths at the farm gate and only a small number of respondents set up at footbath at the farm entrance (37% from broiler farms and 18% at the layer farm). This difference may be due to the prestigious awareness of farm owners about disease transmission by boat to visitors and farm workers. However, only a few poultry farms prohibit vehicle entry and apply tire spray/bath, which poses a great risk as these trucks can spread a pathogenic microorganism on to the farm. Vehicle movement between farms is associated with farm infection [32].

The current study revealed that almost all farms purchase replacement chicken. This finding is higher than that of [33], who disclosed that 63.6% (7/11) of farmers sourced their birds from distributors without knowing the hatchery. Besides, the possibility of infection at the hatchery, day-old chicks may also be carriers of vertically transmitted (from hen to chick) pathogens such as *Mycoplasma* spp [29]. This posed a substantial risk for poultry farms even though the farm can implement biosecurity measures on introduction of day-old chickens from other, the probability of pathogens entering the farm is high. Because each poultry farm has its own risk profile for the introduction of pathogens, disease development, and spread of pathogens to other poultry farms [34]. Several studies have already pointed out that buying animals from different farms entails a greater risk of introduction of disease-causing agents [35].

Several poultry farms in Dire Dawa were prohibiting visitor's entry. This finding was agreed with the study conducted in Egypt by Mohammed and Helal [36], who found 28.6% of small commercial poultry producers allowed visitors to enter poultry shade. However, this finding contradicted with the finding of Birhanu *et al*., [31], who reported 76% of farms allowed visitors entry. The higher prohibition of visitor entrance observed in this study may be attributed to commercial poultry producers in Dire Dawa town having better awareness of the risk of allowing visitors on to farms than those in Mekelle. Human movement among farms was shown to be an important risk factor for poultry diseases such as avian influenza [28], which is encouraging as visitors could access different farms and there by introducing pathogen on to farms. To limit the risk of human movement, an entrance to a farm should be limited to one [37], visitors sign on the logbook when visiting the farm to enable rapid identification of people and farms during an outbreak [38]. Almost all farms involved in the present study bought feed from different sources which presents the risk for introduction of pathogens on to the farms. Besides lorries that can act as a mechanical vector, the feed can also be a source of infection. The feed can be contaminated with, for example, *Salmonella* spp., *Escherichia coli*, *Clostridium* spp., *Aspergillus* spp., and mycotoxins. The contamination of the feed can occur at different times during production, storage, or transport [29].

From the surveyed farms, only a few farms implemented permanent rodent control and wild birds denied access to poultry houses. Failure to implement this practice constitutes a biosecurity risk as wild birds and rodents are a carrier of pathogenic microorganisms that substantially affect commercial poultry producers, especially migratory wild birds are the cause for transboundary disease transmission. This finding was not in line with the study conducted in Khartoum which revealed 33 (73.3%) of the farms controlled access of wild birds, rodents, or insects into poultry sheds or had strict measures to keep other poultry and domestic animals away from their flocks [39]. Reservoir wild birds presence influences the risk of introduction of poultry diseases like avian influenza [37-41]. To attain biosecurity, rodent entry must be minimum [5]. In operational BM perspective, the present survey revealed that in more than half of the farms regular cleaning and disinfection were undertaken and this finding was lower from the study performed at Mekelle in which 88% of the farms assessed carried out regular cleaning and disinfection of equipment's. Lower levels of biosecurity are associated with a higher prevalence and outbreak of avian disease [4-42].

5. CONCLUSION

The findings from this study suggest that the practice of biosecurity implementation strategies in commercial chicken farms in Dire Dawa was poor or lower with a few farm owners that had been improved through trained, workshop, and field day seminars by appropriate agents on the benefit of adhering strictly to biosecurity measures on their farms. The majority of the biosecurity risks for chicken farms originate from inappropriate site selection, purchase of replacement day-old chicken and feed sources as well as lack of training to farm employees. Therefore, a specific biosecurity program should be developed for individual poultry farms according to their particular needs and situations with the cooperation of the decision-makers and farm veterinarian to ensure the success of the program about the importance of proper biosecurity adoption, development of a biosecurity plan, and a need to find appropriate ways to educate the farm owners as well as farm employees and to convince them to heed the plan.

Ethics Approval and Consent to Participate: Not applicable.

Human and Animal Rights: Not applicable.

Consent for Publication

Verbal consent for participation was taken only from 36 farms while others refused to participate and reasons for refusal were not sought.

Data Availability: The data are included in the tables within the manuscript.

Conflict of Interest: The authors declare that they have no conflicts of interest.

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