ISSN No:-2456-2165

Biosecurity Assessment of Layer Farms in Sierra Leone using Biocheck. UGent Scoring Tool

Abdul Rahman Sesay
Department of Animal Science, Njala Campus, Njala University, Sierra Leone

Abstract:- Evaluation of the biosecurity of layer farms is essential for successfully controlling and preventing poultry diseases. The objective of this study is to evaluate the biosecurity of layer farms in Sierra Leone using the Biocheck. UGent scoring system. This online biosecurity evaluation tool assesses the farm's biosecurity compliance. The data was collected from 38 layer farms in four provinces and one area in the country. The data were encoded online to provide ratings for each farm's biosecurity. The online algorithm decoded and provided individual farm biosecurity scores across all categories and subcategories. The study found that the overall average biosecurity of the layer farms was (67%). The average external and internal biosecurity scores for layer farms are (64%) and (70%), respectively. The North West province has the highest score of total average biosecurity at (73%), followed by the Southern province at (71%). The subcategories with the highest external biosecurity scores were farm location (92%), material supply (91%), purchase of laying hens (84%), infrastructure and biological vector (69%), and purchase of day-old chicks (66%), while the category with the lowest external biosecurity score were visitors and farmworkers, removal of manure and carcasses, feed and water, and depopulation and transportation of hens. The internal biosecurity subcategories washing and disinfection (87%) and egg management (63%) obtained the highest average score, while disease management and material and measure between compartments received a lower score. To manage and prevent poultry diseases on layer farms, the biosecurity subcategories that received the lowest scores should be improved. The nation's relevant institutions should monitor and enforce biosecurity compliance in layer farms.

Keywords:- *Biocheck. Ugent, Biosecurity Scoring Tool, External Biosecurity, Internal Biosecurity, Layer Farm.*

I. INTRODUCTION

The term "biosecurity" refers to a comprehensive set of actions to reduce the risk of introducing and spreading pathogens [1]. It is an efficient and affordable method of controlling poultry diseases [2,3]. Biosecurity is divided into two major components such as external and internal biosecurity. Internal biosecurity tries to stop the spread of viruses within the herd, while external biosecurity aims to keep pathogens out of the flock [4,5]. Previous research has proven that a high level of animal biosecurity improves animal health and technical and economic performance and reduces antibiotic use [6]. The most practical and cost-effective method of disease prevention in layer farms continues to be any intervention to increase adherence to biosecurity measures [6]. In addition, only a few studies adequately relate production performance to biosecurity using quantitative data [7]. The Ghent University in Belgium developed Biocheck. UGent score tool, a risk-based and independent system to evaluate the quality of on-farm biosecurity. Biocheck. UGent scoring tool has been used in various European countries to assess biosecurity in livestock farms [8].

Finding out the actual state of biosecurity in layer farms may be the first step in implementing the necessary adjustments to make farms more resistant to the threat of disease invasion [9]. Increasing adherence to biosecurity measures is widely acknowledged as the most effective method for reducing the risk of disease [10,9]. Biosecurity has been of utmost significance to the expansion of the poultry business since its procedures considerably minimize or restrict the introduction of diseases into poultry farms [7]. Nevertheless, compliance with biosecurity measures among poultry farms is often low, especially in developing nations, despite these sound effects of biosecurity measures [11]. Low biosecurity levels expose chickens' flocks to various infectious illnesses, which are then linked to significant economic losses [12]. Therefore, providing farmers with accessible and valuable biosecurity knowledge is vital to implementing and keeping their farms free from disease threats [13,7]. No study has been devoted to assessing the biosecurity status of layer farms in Sierra Leone. The study aims to evaluate biosecurity status in layer farms using the Biocheck. UGent scoring system.

II. METHODOLOGY

A. Study area

Sierra Leone is located on Africa's west coast, covers 72 000 km^2, and has a population of 7.65 million as of 2018 [14]. The country is bordered on the east and north by the Republic of Guinea and on the south by the Republic of Liberia. Eastern Province, Northern Province, Southern province, and Western area are the three provinces and one area that make up the nation. The provinces are further divided into districts and chiefdoms, each of which has several villages. The elevation of the terrain varies from less than 50 meters above sea level in coastal parts to more than 500 meters in the highlands. Sierra Leone has a tropical monsoon climate with two distinct seasons: rainy season (May to October) and dry season (November to April). Annual rainfall is around 3000 mm on average, ranging from 2000 mm in the north to 4000 mm in the south. The rainfall distribution is unimodal, with August being the wettest month. Rainfall onset varies greatly, which has substantial implications for the prevailing practice of rain-fed agricultural production. Agriculture is the country's main

ISSN No:-2456-2165

economic engine, with crops, livestock, forestry production, and fisheries employing around two-thirds of the working force and accounting for more than 60% of GDP in 2020 [15]. Rice is an essential food crop, followed by cassava and potato. Mining also contributes significantly to Sierra Leone's economy; it comes second after agriculture [16].

B. Data collection

The biosecurity of layer farms was measured using the Biocheck. UGent score system. It is a reliable, repeatable, and valid risk-based scoring method for measuring on-farm biosecurity [3,17]. Their website (https://biocheckgent.com/en/surveys) provides free access to various biosecurity questionnaires. The biosecurity questionnaire for layer farms was acquired from their website and reproduced for the research. Layer farms in different provinces of the nation were selected. A total of 38 layer farms in four provinces and one area of the country, including the Northern province (n=9), North West province (n=4), Southern province (n=7), Eastern province (n=6), and Western area (n=12), volunteered to take part in the study. A contact person, often the farm manager or owner, was interviewed during site visits to each farm. Most interviews took place in the farms' offices, and some had to be conducted outside the gates due to the risk of disease introduction. The face-to-face interviews were conducted from January to August 2021.

C. Quantification of biosecurity

The online tool Biocheck. UGent offers a risk-based assessment that considers the relative significance of the various biosecurity measures [6]. The resulting scores for each farm enable evaluation of the biosecurity compliance's strong and weak aspects, which can serve as the foundation for recommendations to strengthen biosecurity. It consists of 120 dichotomous or trichotomous questions broken down into several internal and external biosecurity subcategories. There are 2 to 16 questions in each subcategory. The score for each question is multiplied by a weight factor based on the significance of each biosecurity measure [18,3]. A broad panel of poultry experts calculated the relative relevance of each subcategory for disease transmission and assigned it a unique weight factor [18]. For internal and external biosecurity, the final score can vary from zero, which denotes a complete lack of the indicated biosecurity measures, to 100, which denotes a full implementation of the described methods. The total biosecurity score is calculated as the average internal and exterior biosecurity values [6].

D. Data analysis

Biochek. UGent, a risk-based scoring instrument created by the University of Ghent, was utilized to evaluate farm biosecurity. The data of the completed surveys were encoded online to generate ratings for each farm's biosecurity. The algorithm decoded and provided individual farm biosecurity scores across all categories and subcategories. The data were further compiled in Microsoft Office Excel 2016 for consolidation and statistical analysis. For farm characteristics, means standard deviation and range were obtained, while the percentage and graphs for the external and internal biosecurity scores. In addition, a t-test was conducted to compare the total biosecurity scores of layer farms in the external and internal biosecurity subcategories to the global averages.

III. RESULT AND DISCUSSION

A. Farm characteristics

Table 1 displays the characteristics of the surveyed layer farms. All the layer farms included in the study use a housing structure consisting of deep litter. The majority are small-scale layer farms, with a mean flock size of 3034.2 birds and a range of 500-6200. The average years of experience of the persons in charge of the farms were 15.8 years, ranging from 5-26 years. The average number of layer farmworkers was 11.2, ranging from 7 to 16. The oldest structure in the layer farms has a mean age of 18.1 years and a range of 7 to 30 years, while the newest building has a mean age of 4.7 years and a range of 2 to 8 years.

Table 1: Characteristics of layer farms

Farm characteristics	Mean ± S.d.	Range
Flock size	3034.2 ±1216.2	500-6200
Years in keeping birds	15.8±5.3	6-26
Number of farmworkers	11.2±2.4	7-16
Years of the oldest building	18.1±5.9	7-30
Years of the newest building	4.7±1.5	2-8

Source: Field survey, 2021

B. Provincial total average biosecurity score of layer farms

Figure 1 shows the overall biosecurity scores for the four provinces and one area of the country. The average biosecurity score for layer farms in the country was (67%) slightly higher than the total world average of (61%). In terms of the overall average biosecurity score of layer farms in the country's provinces, the North West province (73%) earned the highest, followed by the Southern province (71%), Western area (66%), Northern province (65%), and Eastern province (62%). Even though the provincial scores were greater than the global total biosecurity scores, there was no discernible difference between the provinces' total biosecurity scores.

ISSN No:-2456-2165

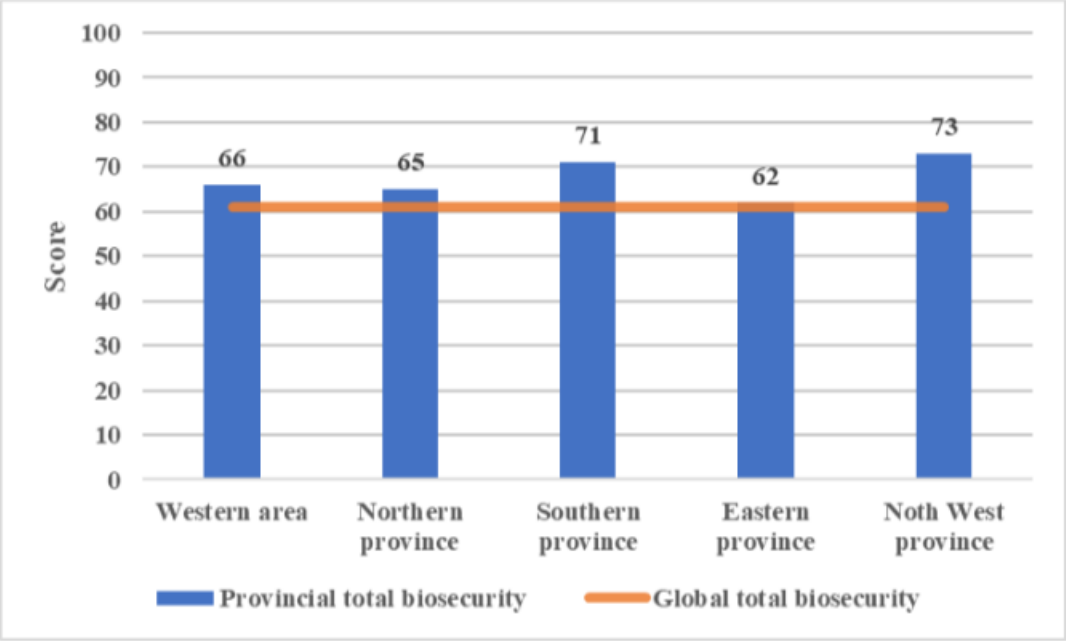

Fig 1: Provincial total average biosecurity score of layer farms

C. Provincial average external biosecurity score of layer farms

Figure 2 displays the external biosecurity scores acquired by layer farms in each of the four provinces and one area of the country. The average biosecurity score for the Southern province is the highest (71%), followed by the North West province (69%), the Western region (65%), and the Northern province (62%). The external biosecurity score of the Eastern province (54%) is considerably lower than the global average.

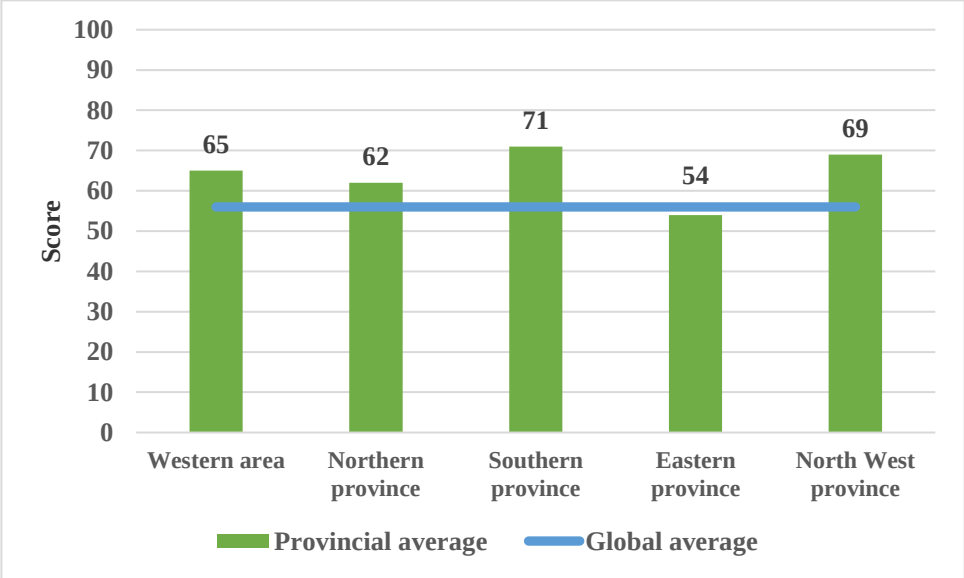

Fig 2: Provincial average external biosecurity score of layer farms

D. provincial average internal biosecurity score of layer farms

For internal biosecurity figure 3, the four provinces perform marginally better than the global average, with the North West province placing best with a score of (76%), followed by the Southern province (70%), the Eastern province (69%), the northern province (68%), and the western area (66%). There is also no substantial difference between any province's internal biosecurity scores. Therefore, it may be concluded that layer farmers adopt a similar management method nationwide.

ISSN No:-2456-2165

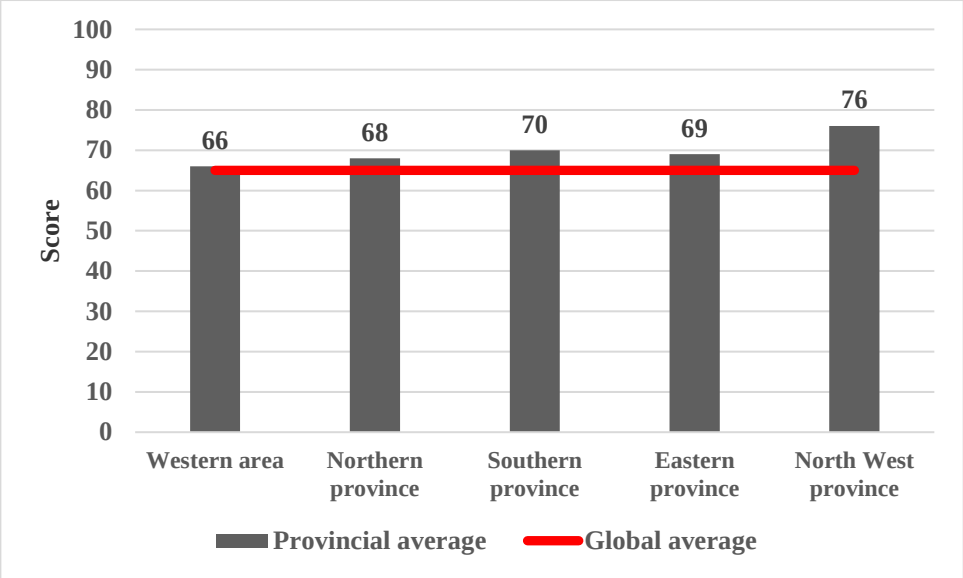

Fig 3: provincial average internal biosecurity score of layer farms

E. External subcategory biosecurity score of layer farms

The overall average biosecurity ratings for the exterior categories of all layer farms were (64%) (figure 4). Compared to the global average biosecurity score, the average performance of all farms in the subcategory of the external biosecurity score demonstrates that the farms perform best in the categories of farm location (92%), material supply (91%), purchase of laying hens (84%), infrastructure and biological vector (69%), purchase of day-old chicks (66%), and transportation of eggs (62%). Visitors and farmworkers (57%), disposal of manure and corpses (43%), feed and water (41%), and depopulation and transportation of chickens (41%) all score worse than the global average (36%). Due to their lower scores than the global average in numerous biosecurity categories, layer farms must improve.

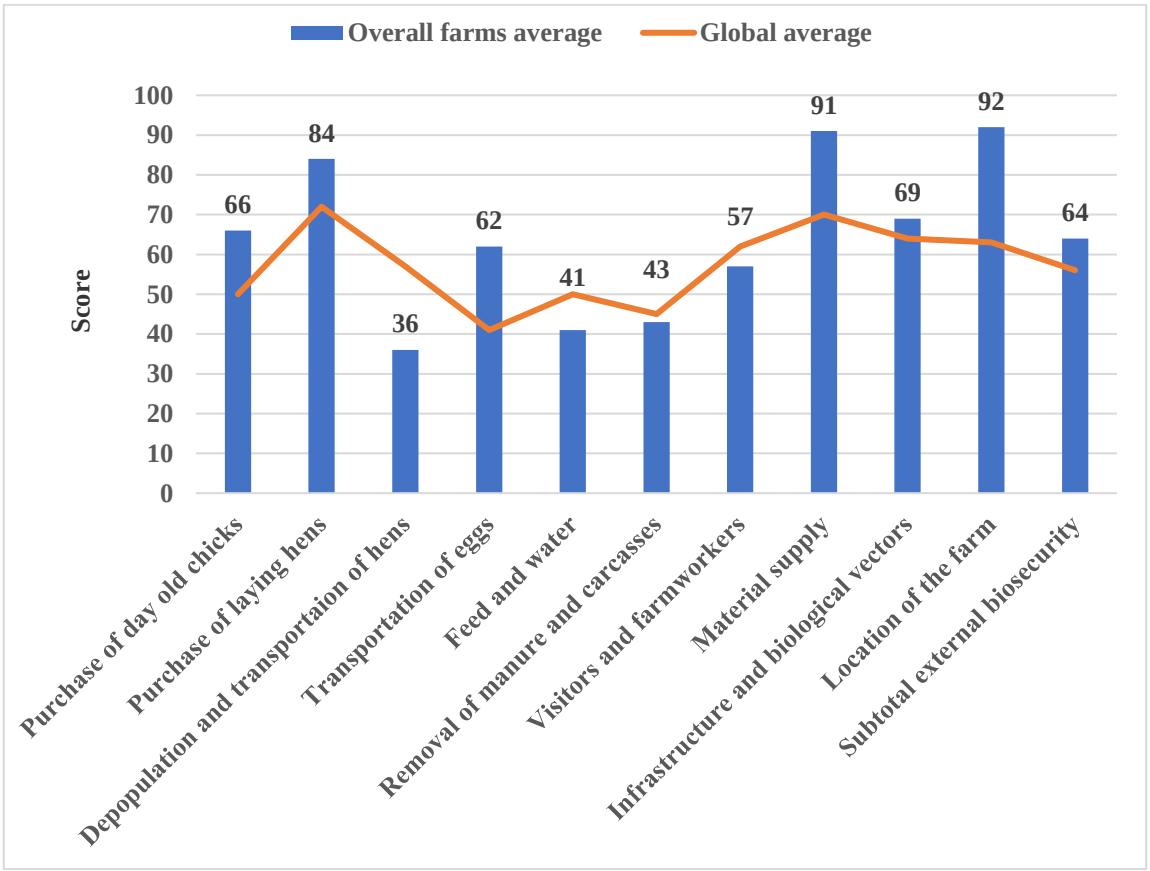

Fig 4: External subcategory biosecurity score of layer farms

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F. Internal subcategory biosecurity score of layer farms

Figure 5 shows that all farms' average performance in internal biosecurity categories was (70%). The performance of all farms in the internal biosecurity subcategory demonstrates that cleaning and disinfection (86%) and egg management (63%) are superior to the worldwide average. Conversely, disease management (69%) and material and measurements between compartments (62%) are lower than the global average. As the performance of layer farmers is below the global average, there is room for improvement in this sector.

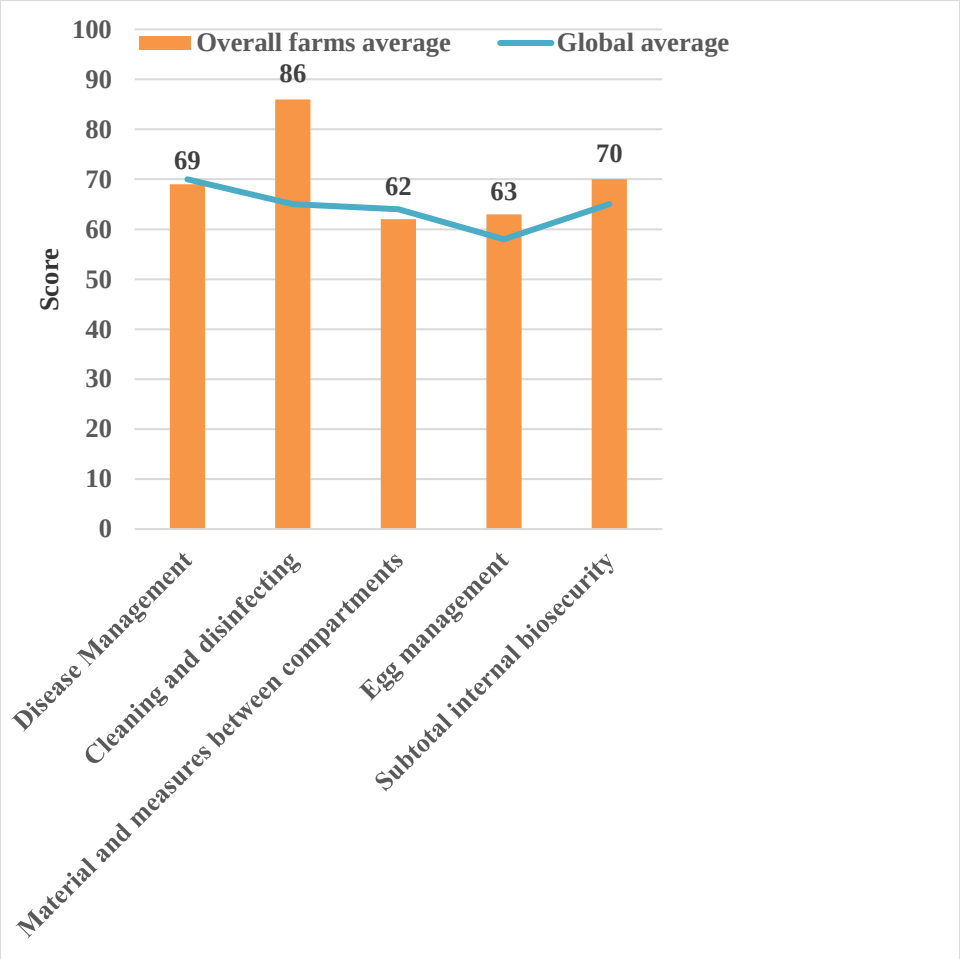

Fig 5: Internal subcategory biosecurity score of layer farms

G. t-test analysis of the overall average scores of layer farms for the different subcategories of biosecurity and global averages

Table 2 displays a t-test comparing the global and overall average scores for the various subcategories of biosecurity. Globally, the average score was (61%), with exterior biosecurity scoring (56%) and internal biosecurity scoring (65%). Similarly, the overall average ratings for the participating layer farms were (67.2%) percent for total average biosecurity, (64.4%) for external biosecurity, and (70%) for internal biosecurity. In the case of layer farms, the total external biosecurity score of the subcategory's procurement of day-old chicks ($p = 0.001$), transport of eggs ($p = 0.001$), material supply ($p = 0.001$), and location of the farm ($p = 0.001$) was statistically significant and higher than the subcategory's global average. In addition, the country's layer farms have space for development in the following subcategories: acquisition of laying hens; depopulation and transportation of chickens; disposal of excrement and corpses; visitors and farm employees; and infrastructure and biological vectors. This is because the average score in these subcategories was significantly lower than the already moderately low global average. The internal biosecurity subcategory cleaning and disinfection scores are substantially higher than the global average ($p=0.001$). However, the scores for egg management are not statistically higher but are nevertheless higher than the global average. To boost biosecurity, layer farmers should strengthen internal biosecurity measures, such as disease management and materials and measures between compartments.

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Table 2: t-test analysis of the overall average scores of layer farms for the different subcategories of biosecurity and global averages.

Subcategory	Global average	Overall farms average	P-value
External biosecurity			
Purchase of 1-day-old chicks	50	65.6	0.001
Purchase of laying hens	72	84.0	0.013
Depopulation and transport of hens	57	36.2	0.040
Transport of eggs	41	62.4	0.001
Feed and water	50	41.4	0.103
Removal of manure and carcasses	45	43.4	0.695
Visitors and farmworkers	62	57.4	0.378
Material supply	70	90.8	0.001
Infrastructure and biological vectors	64	69.0	0.298
Location of the farm	63	92.4	0.001
Subtotal	56	64.4	0.025
Internal biosecurity			
Disease management	70	69.4	0.902
Cleaning and disinfection	65	86.0	0.001
Materials and measures between compartments	64	61.8	0.971
Egg management	58	62.6	0.800
Subtotal	65	70.0	0.022
Total	61	67.2	0.013

Source: Authors computation, 2021

H. Detailed description of layer farms external biosecurity

1). Purchase of day-old chicks

Over the past two years, (93.5%) of layer farms have not changed their supply of chicks. Suppliers of day-old chicks transport chicks directly to the farms for (95%) of the layer farms. Regarding delivery trucks for most farms, (92%) do not include chicks for other farms. Most of these farms' delivery van drivers do not return to the farm with empty containers after making deliveries to other farms. Before entering the layer farms, delivery trucks were cleaned and sanitized in (89%) of the farms. This is a good practice since the frequent movement of trucks from one farm to another might raise the danger of disease spreading [3].

2). Purchase of pullets.

Most farmers (86.3%) have not changed their pullet suppliers in the last two years. Most of the farms had suppliers deliver pullets directly to the farms. Pullets were always sent first to layer farms (97%) before being given to other farms. Delivery van drivers do not return to these farms with empty boxes after making deliveries to other farms. The layer farms (93.6%) sanitize delivery trucks before allowing them to access the farm. When you buy animals, you run the danger of introducing pathogens. Protocols should be in place to guarantee that new animal purchases do not introduce new infections or enable them to circulate freely throughout the farms [6].

3). Transport of live animals.

It's crucial to clean and disinfect transport trucks properly to avoid disease transmission, especially if they're coming from neighboring farms [3,6]. Upon arrival, (89%) of the layer farms cleaned their transport cars. Individuals and dealers were not allowed to enter the stables where direct interaction was possible on (78.4%) of the layer farms. However, while loading the birds onto the vans, only (42%) of the farms provided farm-specific or disposable clothing and shoes to the drivers and capturing crews. When protective clothing is not worn on the farm by farmworkers or visitors, the danger of disease spread increases dramatically [19]. Wearing protective farm clothing should be enforced severely.

4). Transport of eggs

Most layer farms (80%) have dedicated spaces on the farm to store eggs. Eggs are available for sale on the farm, and visitors are welcome to come to make their purchases there. The transport of pathogens by humans is one of the greatest challenges to biosecurity. A significant aspect of a good biosecurity program is the restriction of superfluous human traffic [3]. Layer farms should limit visitor access and ensure that the sale of eggs is restricted or eliminated. Some layer farmers (78.3%) do not clean or disinfect the truck where eggs are transported. In most layer farms, (93%) of the truck drivers are not permitted direct access to the egg storage facility; instead, the farmworkers put the eggs directly onto the truck.

5). Feed and water supply.

Most layer farms (92%) did not have distinct clean and unclean regions. To defend against water, birds, and vermin, (86.2%) of the layer farms had well-sealed feed storage spaces. The chicken buildings were not accessible to feed providers. Around (80%) of the layer farms had their feed storage facilities filled more than 25 times yearly. Feeds are delivered in bags by private feed mills regularly. This poses a significant concern since the more frequently transport trucks move, the

greater the potential of disease pathogens being transported with them. Because feeds can be contaminated along the route to manufacture, transit, or storage, this increases the possibility of transmission [19]. Feed silos provide better protection against rats and other pests than feeds stored in warehouses [20,21]. Over (84.6%) of the farms had several feed suppliers. Many feed sources exacerbate the problem of probable feed contamination and disease transmission. Most layer farms (94.5%) have never conducted a bacteriology examination of their drinkable water. Because most farms are small-scale layer farms, they do not pay much attention to water quality. Some people utilize untreated well water, which is relatively easy. It has been demonstrated that bacteria may quickly contaminate drinking water [19]. Dewulf et al. [6] suggested that drinking water facilities be well-managed, with frequent quality and safety audits.

6). Removal of manure and dead animals.

In most layer farms, (90.5%) manure was removed after each production cycle. Layer farm manure is held in a structure or open space before being sold to other farms as an organic fertilizer for vegetable production. A few farmers continue to dump manure in the surrounding areas. This can increase the chance of spreading infections such as Gumboro, Avian Influenza, and Infectious Bronchitis [19]. This also opens the door to human interaction and the danger of infection transmission, providing a biosecurity concern [22]. Composting and anaerobic storage are required before using manure as organic fertilizer or spreading it on the crops [23]. The birds are inspected twice daily, and any deceased birds are taken, placed in a designated location, and disposed of immediately. There is no suitable carcass storage or disposal mechanism in place. As quickly as possible, carcasses should be removed from animal housing and put in a well-insulated, designated area, as they are a potential cause of the disease [24].

7). Entrance of visitors and personnel.

Visitors visit the farm more than 12 times yearly on (86%) layer farms. Farms should restrict access to facilities since people might operate as mechanical vectors for disease transmission. Most layer farms (82.6%) lack explicit regulations mandating visitors and workers to wash and disinfect their hands before entering the farm. This is a poor practice since humans can transfer disease, mainly if they come into contact with sick birds [19]. Farmworkers and visitors should wash their hands before and after visiting the farm, as their hands may spread pathogens through close contact with sick animals [19,25]. Most layer farms (74.3%) don't require visitors and employees to wear farm-specific clothing and shoes before visiting. People may spread infectious diseases mechanically; thus, visitors and farmworkers should wear specific farm protective clothing and shoes when they enter a farm. To minimize disease transmission by remnants of excreta from other sick animals, visitors and workers should always wear clean, herd-specific clothing and footwear while entering farms [19,26]. Limiting the number of individuals or prohibiting unauthorized persons from entering the animal housing is also advisable [27,20]. Most employees of layer farms (95.7%) do not work for other layer farms. Approximately (5%) of layer farm employees kept chickens in their homes. This dangerous practice should be avoided at all costs because of the risk of disease transmission [21,28]. The number of animal caretakers per chicken house should be kept to a minimum, especially when one animal caretaker is in charge of many poultry houses at once. Pathogens can easily spread between chicken populations within and between farms [29].

8). Supplies and equipment

The majority of layer farms (98%) utilize just their materials and equipment. They didn't lend any of their goods or equipment to another farm. The exclusive use of supplies and equipment prevents spreading of diseases that might otherwise occur if the equipment was shared [24]. However, (75.4%) of layer farms do not make their feed. As a result, most farms will have to rely on feed millers to produce feed regularly. Excessive movement of delivery trucks into and out of layer farms, especially more than twice per month, will undoubtedly introduce disease.

9). Infrastructure and biological vectors

Most layer farms (86.6%) had a robust infrastructure and could keep biological vectors at bay. However, just (13.4%) of the layer farms reported vermin difficulties, and only around (5%) of them had established a vermin management program. Rodents are crucial in several pathogenic pathogens' mechanical and biological transmission. An effective control program is essential to keep vermin under control. Increasing their compliance will undoubtedly lower the number of disease-carrying rodents on their farms [30]. Most layer farms (76.5%) have not had their immediate exteriors paved and cleaned, while only (23.5%) of the farms' exteriors are paved and cleaned. Most layer farms (96.7%) do not have other animals or pets in the neighborhoods.

10). Location of the farm

The nearest poultry farm was more than one kilometer away from (94.5%) of the layer farms. Within a one-kilometer radius of their location, (88.7%) of layer farms do not have any stagnant or flowing water. Most layer farms' (88%) manure does not spread to nearby farmland. The location of the layer farm is vital since certain diseases are conveyed by airborne transmission [31,3]. The proximity of neighboring farms, a river/creek, and slaughterhouses might represent a threat [6]. In addition, the direction of the wind, the presence of rodents or wild birds, and the movement of staff or equipment will aggravate the risk of infection posed by the spread of waste on nearby fields [32]. As a result, the government ought to create laws establishing a predetermined distance between each farm that raises layers of chickens.

I. Detailed description of layer farm's internal biosecurity

1). Disease management and vaccination.

It is critical to have a solid disease management strategy in place to guarantee animal health. This method might involve proper animal handling and treatment, notably through vaccination [6]. Most layer farms (98.3%) vaccinated their flocks and examined the farm's disease status at least twice daily. Every layer farm in the country has a vaccination program for their birds to protect them from common diseases.

This is done to combat the spread of infectious diseases. Vaccines have been shown to lower mortality, boost production, improve animal wellbeing, and help eliminate infectious diseases [33,34]. A well-thought-out health program also makes it easier to implement relevant interventions, particularly when a vaccination needs to be reintroduced [27,35].

2). Cleaning and disinfection.

Cleaning and disinfecting are the most practical and effective means of breaking a disease cycle. After each production cycle, layer farms (97%) cleaned or disinfected their facilities, feeding systems, feed silos, hen houses, and loading and unloading sites. Only (2%) of the layer farms examined the efficacy of cleaning and disinfecting their facilities. After each production cycle, nearly all layer farms had a hygienic transition time of more than eight days. (23.4%) of layer, farms said they strictly followed the usage of disinfection baths, especially for cars entering the farms. Only (2.7%) of layer farms had farm hygiene locks, whereas (67.6%) had a changing area for farm-specific attire. The hygiene lock in a farm or institution divides the clean and unclean parts. Although there is a physical barrier between these two places, the objective is to decrease the risk of human disease transmission by enforcing strict cleanliness and disinfection measures before entering the facility [25]. Furthermore, roughly (32%) of the layer farms featured house-hygiene locks, with virtually all of them having rigorous separation of clean and unclean sections, a footbath or boot washer, and a washing and disinfection room.

3). Materials and measures between compartments.

Most layer farms (98.5%) have cleaning and disinfection procedures after each production cycle. Most farms (96.4%) feature several chicken houses with identical layouts. This simplifies the implementation of several biosecurity measures. Compliance with mandated biosecurity measures may be more challenging to implement and monitor when different housing types are used [22]. Most farms (85%) have a disinfection bath/boot washer at the entrance of each poultry house.

4). Egg management

In most layer farms (97.6%), farmworkers manually gather the eggs in the poultry house. Eggshells that are dirty, fractured, or otherwise damaged are removed as soon as possible and processed separately. The egg trays are composed of cardboard, and despite this, they are not cleaned and sanitized regularly.

IV. CONCLUSION

Protecting chicken flocks against microbial contamination is a crucial aspect of layer farms. Introducing a highly virulent and infectious infection into chicken flocks might have severe economic repercussions for layer producers. Practicing solid biosecurity protocols daily as part of the best management program will help lower the likelihood of catching a disease and limit the spread of an epidemic if one occurs. The overall biosecurity score of the country's layer farms was (67%). The layer farms in the country scored (64%) for external biosecurity and (70%) for internal biosecurity, respectively. The highest level of biosecurity was found in the North West province (73%), followed by the Southern province (71%). When comparing each of the four provinces and one area of the nation for external biosecurity, the Southern province, followed by the Western area, earned the most outstanding scores. The southern province likewise has the most incredible score for internal biosecurity, followed by the northern province, while the eastern province has the lowest score and performs below the worldwide average. The subcategories with the highest external biosecurity scores were farm location (92%), material supply (91%), purchase of laying hens (84%), infrastructure and biological vector (69%), and purchase of day-old chicks (66%), while the category with the lowest external biosecurity score was visitors and farmworkers, removal of manure and carcasses, feed and water, and depopulation and transportation of hens. The internal biosecurity subcategories washing and disinfection (87%) and egg management (63%) obtained the greatest average score, while disease management and material and measure between compartments received a lower score.

Even though layer farms in the country have implemented biosecurity measures, their total biosecurity score of (67%) leaves significant room for improvement. This further demonstrates that the poultry industry should invest more in its biosecurity measures implementation. Nonetheless, it is essential to prioritize the improvement of internal and external biosecurity subcategories with low scores. The nation's relevant institutions should monitor and enforce biosecurity compliance in layer farms.

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