A study on relationship between strength of biosecurity and disease occurrence in commercial layer farms in Rangpur

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List of Abbreviations and symbol

Abbreviations	Elaboration
%	Percentage
<	Less than
≥	Greater than equal
Etc.	Et cetera
et al.	And his association
GDP	Gross domestic product
NCD	Newcastle disease
DLS	Department of Livestock Services
FAO	Food and Agriculture Organization
USAID	United States Agency For International Development
UVH	Upazila Veterinary Hospital
CVASU	Chattogram Veterinary And Animal Sciences University

Abstract

Biosecurity measures play a crucial role in maintaining the health and productivity of poultry farms especially for layer farming to prevent disease outbreaks and ensure ongoing profitability. Implementing stringent biosecurity practices helps minimize the risk of disease transmission not only among the birds but also to humans and other animals. This study which covered the layer farms of Rangpur Sadar area delves into the intricate association between biosecurity measures with overall disease occurrence and mortality rates in commercial layer farms. In addition, we specifically looked for the association of biosecurity measures with the occurrence of coccidiosis. In this study analysis of different biosecurity parameters such as floor type, footbath usage, disinfectant application, deworming practices, personnel hygiene etc, results that this biosecurity parameter were closely associated with the disease occurrence and mortality rate of chicken in layer farm. Notably from this study, farms which implementing uses of footbath ($P<0.02$) experienced a 0% disease occurrence rate. Conversely, farms that did not adhere to biosecurity measures saw a significant increase in disease incidence (80-100%) and elevated mortality rates (50-60%). This study also highlights that farms practices regular deworming practices ($P<0.001$) experienced 0% occurrence of coccidiosis. Ultimately, this study underscores that rigorous biosecurity combined with hygienic measure is essential for maintaining a disease-free environment and achieving optimal outcomes in commercial layer farms.

Keywords: Biosecurity, Layer, Disease, Mortality, Coccidiosis, Hygiene

Chapter 1

Introduction

Biosecurity entails a set of health strategies or actions intended to safeguard populations—whether they encompass plants, animals, or humans—from the transmission of contagious infectious agents or pathogens (Toma *et al.,* 1999). In simpler terms, biosecurity involves a collection of actions designed to prevent the entry of harmful pathogens and limit the spread of microorganisms. Embracing the One Health concept, biosecurity becomes especially crucial as it encompasses measures to halt the transmission not only between humans and animals but also extends to plants and the overall environment. (Dec 28,2021) The consistent implementation of biosecurity measures is essential for ensuring the success of all forms of animal production (Shane *et al.,* 1993).

Poultry farming stands out as a thriving and lucrative segment of animal-based enterprises, known for its rapid meat production globally and layer farming is notifiable for its egg production. This industry's importance extends to the country's agricultural sector (Attia *et al.,* 2022). Poultry's significance is notable, contributing approximately 37% of the total meat production and 80.65% of total egg production from layer farming and they plays a pivotal role in providing a significant portion, around 22-27%, of the animal protein supply. This substantial contribution solidifies poultry's role as a key player in the broader livestock sector, further bolstering the country's economy by contributing a considerable 1.4% to its GDP (DLS, 2020)

In a remarkably short span of less than a day, a single microorganism possesses the remarkable ability to undergo reproduction and multiplication on a scale that surpasses the total number of individuals populating the entire world. This exponential growth potential underscores the urgency of safeguarding layer farms from the relentless expansion of these highly prolific microorganisms. The linchpin to achieving this vital protection lies in the judicious implementation of a comprehensive health strategy known as biosecurity. Biosecurity emerges as the ultimate line of defense, constituting a meticulously devised plan to fortify the health and integrity of layer farms. It functions as a robust shield against the infiltration and proliferation of detrimental microbes, aiming to thwart their disruptive impact on the poultry business. By adhering to the principles of biosecurity, the potential risks posed by infectious

agents are effectively minimized, fostering an environment conducive to the sustained success of layer production endeavors (Diaz Carrrasco *et al.*, 2020).

Furthermore, the prosperity of poultry production specially in layer farms is inextricably tied to two core pillars: astute farm management and unwavering hygiene practices. These factors are intricately interwoven, forming the foundation upon which the entire enterprise thrives. The prudent orchestration of farm operations, encompassing aspects such as nutrition, housing, and disease prevention, is paramount. This synergy of effective management practices ensures that the flock is provided with optimal conditions for growth, productivity, and well-being. Working alongside meticulous farm management is a firm commitment to maintaining top-notch cleanliness. The strict upkeep of hygiene within the poultry environment acts as a strong barrier against harmful germs and potential disease outbreaks. This not only keeps the layer healthy but also boosts the overall effectiveness and long-term success of the production process. The speedy growth of microorganisms reminds us how important it is to protect poultry farms from their multiplication. The smart way to do this is by using biosecurity measures. The success of the layer business depends on two important things: good farm management and keeping things clean. These work together to make sure poultry farming keeps doing well over time (Diaz Carrasco *et al.,* 2020).

Maintaining high levels of biosecurity and hygiene on farms is extremely important in the layer farming. These aspects should be integral to any layer production system. To prevent diseases from entering farms and to reduce the spread of existing infections, it's essential to take proper preventive steps. Developing robust biosecurity practices is the most effective approach to lowering the chances of diseases being introduced (Boklund *et al.,* 2004; Niemi *et al.,* 2009).

Implementing appropriate biosecurity measures can have several positive impacts. It can improve the general health of the flock, lower expenses on treatments and medicines, decrease losses, boost farm profitability, shield the farm from disease impacts, and aid in handling a disease if it does enter the premises (Goualie *et al.*, 2020). The Food and Agriculture Organization (FAO) highly advocates the rigorous implementation of biosecurity measures as the most powerful approach for preventing and managing the transmission of contagious diseases (FAO, 2020).

The layer farm has faced considerable setbacks due to outbreaks of various infectious diseases. Presently, newly emerging avian influenza, Newcastle disease, salmonellosis,

Gumboro disease, colibacillosis, and fowl cholera stand as the primary infectious culprits affecting the commercial poultry sector. These includes decreased egg production, heightened treatment expenses, and elevated flock mortality. These combined factors lead to lowered productivity and greater financial burdens for both individual farmers and the industry on the whole. These diseases have been brought to attention through research conducted by (Islam *et al.,* 1998; Talha *et al.,* 2001; Giasuddin *et al.,* 2002; Rashid *et al.,* 2013). In response to the challenge posed by these infectious diseases, effective strategies for prevention and control have been identified. Promoting stringent biosecurity and hygiene practices is crucial, requiring not only the implementation of vaccination and deworming but also a shift in management systems. These combined measures have been underscored as potent tools for managing certain poultry diseases, as articulated by (Abdu *et al.,* 2007) (FAO, 2013). To this end, a comprehensive approach is warranted, encompassing three pivotal components: sanitation, isolation, and traffic control. These elements collectively form a multifaceted defense mechanism, aimed at mitigating the impact of infectious diseases and safeguarding the poultry industry's growth and stability (USAID, 2009).

There are some research had been conducted about biosecurity measures in different farm (layer chicken, broiler chicken, dairy farm, pig farm) in different region of Bangladesh and found many research had been conducted on the basis of biosecurity measures and assessment in farm level from different country like New Zealand, Belgium etc. However, there is a scarcity of studies investigating the connection between the effectiveness of biosecurity measures and the occurrence of disease outbreaks specifically in commercial layer farms.

As a response to this research gap, the current study was undertaken with the primary objective of evaluating and understanding the association between the effectiveness of biosecurity measures and the incidence of disease outbreaks within a commercial layer farm situated in the Rangpur Sadar, Rangpur, Bangladesh.

This study covered the following objectives:

1. Relationship between strength of biosecurity and disease outbreak in layer farm
2. Find association between different biosecurity parameter and disease occurrence
3. Find association of some biosecurity measures with coccidiosis.
4. Find association of biosecurity parameters with mortality rate of layer chicken

Chapter 2

Materials and Methods

2.1 Study area

This study was conducted in Katabari, Palichara, Haragach, Baniyapara and Mominpur at Rangpur Sadar area. This area had been chosen because most of the people of this area were involved in layer farming and I found many of layer farm here for collecting data

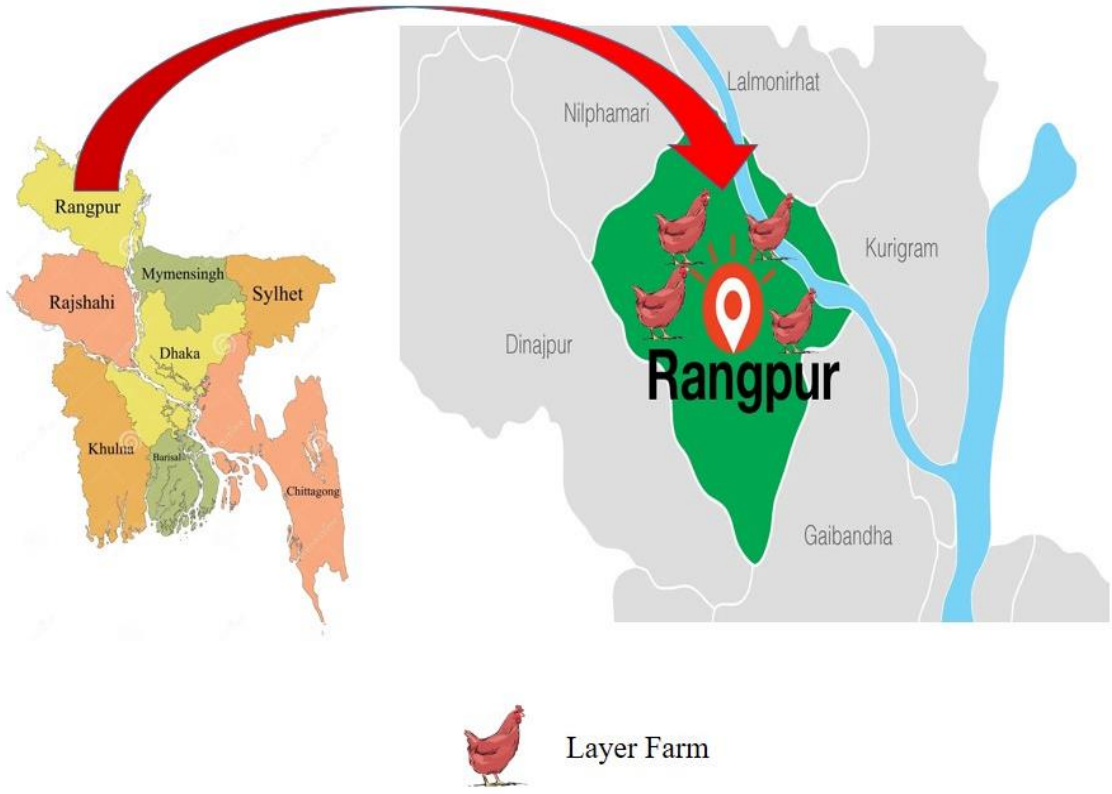

Figure 1: Picture shows the study area

2.2 Study Period

The period of my collecting data for this study was from 16 th April to 30th June when my internship placement was at my Upazila Veterinary Hospital (UVH), Rangpur.

2.3 Data Collection

For this study data was collected by using pre-designed questionnaire which was made through adding the information which is related to the study such as the feed source, water source of layer farm, vaccination, deworming history, foot bath, use of disinfectant in the farm, disease outbreak in recent times etc. in the questionnaire I attached both close and open ended question. The questionnaire underwent an initial pre-testing phase, during which data was collected from a select number of farms. Subsequently, any required adjustments or corrections were incorporated based on the findings from this preliminary data collection. Then after completing the final questionnaire the data was collected by door to door survey at owner house in different villages of Rangpur sadar area Farmers filled up the form independently, but the survey conductor explained and translated every question into the native language. About 25 questionnaires were filled by the layer farmers. Data collection was conducted in a randomized manner, encompassing the available poultry farms within the designated area. No specific prerequisites or criteria were imposed when selecting farms for inclusion in the data collection process.

Figure 2: Data collection from layer farmer

2.4 Statistical analysis

The data was initially recorded within Microsoft Excel 2016. Subsequently, the data was compiled and organized in a manner conducive to statistical analysis. This involved arranging the data based on variables for the purpose of objectives of this study. For the analysis, a statistical program (STATA-15) was utilized, and the findings were presented in tabular format.

Chapter 3

Results

3.1 General farm information

Table 1: General farm information (N=25)

Variable	Categories	Number	Percentage (%)
Farm size	Small (<500)	10	40
	Medium (500-1500)	13	52
	Large (>2000)	2	8
Floor type	Concrete	13	52
	Soil	12	48
Feed type	Ready feed	14	56
	Hand mixers	11	44
Water source	Motor	10	40
	Tube well	9	36
	Pond	6	24
Transportation area	Yes	7	28
	No	18	72
Types of rearing	Cage	25	100
Quarantine shed	Yes	0	0
	No	25	100
Vaccination	Yes	23	92
	No	2	8
Feed storage condition	Access of wild birds	3	12
	Access of rodents	5	20
	Both	11	44
	No access of them	6	24
Proper waste management	Yes	10	40
	No	15	60

Table 1 shows the general information about the layer farms from which the data collection was done. The layer farms were divided into 3 categories out of which 40% were small scale with <500 chickens, 52% were medium scale with chickens between 500-1500 and remaining 8% were large scale with >2000 chickens.

In the Table 1 Farmers were found to use 2 types of floors out of which 52% (13) were concrete and 48% (12) were muddy in their farm. Here 14 farms (56%) used ready feed and rest of 11 farms (44%) used hand mixers feed made with raw ingredients. Motor (40%), Tube well (36%) and in some cases pond (24%) were used as water source of those farms.

As the village farmers had very poor knowledge about hygiene and biosecurity of the farms so that only 28% layer farms had their separate transportation area for unloading the goods or chicken from vehicles while 72% farms had no transportation area. As these were layer farms so cage rearing system was used in all 25 farms (100%) but isolation shed were not available in any of the farms (0%). Table 1 also shows that, out of 25 layer farms regular vaccination was done in 92% farms but no vaccination history found on remaining 8% farms.

The food storage condition of these layer farms were very miserable because the farmers were not informed or concerned about this matter. Regarding the food storage condition of the farms, only 24% layer farms were found to have no access to outdoor animals like wild birds or rodents, 12% farms had a history of access to wild birds, 20% farms has access to rodents and the other 44% farms had a history of access to both. Among all the layer farms 60% did not have any wastage management system and 40% farms had proper wastage management system.

3.2 Association between biosecurity parameter and disease occurrence

According to the Table 2, two types of floors used here. After analyzing the data, we found if concrete floor used then the percentage of disease occurrence is 38.46% on the other hand in muddy floor its 75%. Here the *P value* is *0.06*. As the farms were layer farm and all chickens were reared in cage rearing system so the floor type is not significant for disease occurrence. Footbath is one of the major components of biosecurity. If footbath is used at the entrance of the farms and sheds infectious agents or pathogens cannot enter the farm through entry route. Here Table 2 shows that which farms that did not use foot bath their disease occurrence rate is 73.68% on the other hand disease occurrence history is 0% in those farms

which uses footbath. Here *P value* is *0.02* which is significant. So the uses of footbath is associated with the disease occurrence in layer farms.

Table 2: Analysis of association between biosecurity parameter and disease occurrence (N=25)

Parameter	**Categories**	**Disease Number (%)**		***P value***
		No	**Yes**	
Floor type	Concrete	8 (61.54%)	5 (38.46%)	*0.06*
	Muddy	3 (25.00%)	9 (75.00%)	
Footbath	No	5 (26.32%)	14(73.68)	*0.02*
	Yes	6 (100.00%)	0 (0%)	
Disinfectant	Yes	9 (81.82%)	2(18.18%)	*0.001*
	No	2 14.29%)	12 (85.71%)	
Deworming	No	1 (33.33%)	2 (66.67%)	*0.002*
	Yes	10 (76.92%)	3 (23.08%)	
	Irregular	0 (0%)	9 (100.00%)	
Proper wastage management	No	2 (18.18%)	9 (81.82%)	*0.021*
	Yes	9 (64.29%)	5 (35.71%)	
Personnel hygiene	Maintained (change dresses and shoes and wash hands)	7 (77.78%)	2 (22.22%)	*0.011*
	Not maintained	4 (25.00%)	12 (75.00%)	
Breakage of the floor	Absent	8 (80.00%)	2 (20.00%)	*0.03*
	Present	3 (20.00%)	12 (80.00%)	

According to Table 2, the disease occurrence rate is 85.71% in the farms where disinfectants were not used, but the disease occurrence rate was relatively low in the farms where disinfectants were used which was only 18%. Also the Table 2 shows that, the chickens on farms that were regularly dewormed had a disease rate 23.08% but those that were irregularly dewormed had a much higher disease occurrence rate which is 100%. After analysis we got the *P value 0.002* which carried the significant result. Regular use of disinfectants to keep the farm disease free is very important to maintain the biosecurity hygiene of the layer farm. From the Table 2, 64.29% farms had no disease occurrence because they maintain proper wastage management in their farms, on the other hand the disease occurrence rate is very high 81.82% in those farms where no proper wastage management system maintained. This analysis

carried the *P value 0.021* which proved that wastage management had significant relation with disease occurrence.

For a successful commercial layer farm business it is very important to keep the farm disease free and we know that, for keeping the farm disease free maintaining personnel hygiene , keep the shed clean, prevent the access of rodents by keeping the floor breakage free is very important. Sometimes when breakage is present in the floor then access of rodents can cause many diseases which are very dangerous. From Table 2 we can see that, the farm which were maintained proper personnel hygiene had only 22.22% of disease occurrence but which not maintained had the disease occurrence 75%.Here the *P value* is *0.011* which is significant result. And also Table 2 shows, the disease occurrence rate is 80% in those farms where breakage is present on the floor, on the other hand where there was no breakage on the floor the disease occurrence rate is only 20%. As here the *P value* is *0.03* and its carried the significant value for disease occurrence. So disease occurrence rate can differ with the hygienic management of the farm.

3.3 Association between biosecurity measures and occurrence of coccidiosis

Table 3: Analysis of the association between biosecurity measures and occurrence of coccidiosis of chicken in the farm (N=25)

Parameter	**Categories**	**Coccidiosis (%)**		***P value***
		No	**Yes**	
Deworming	No	0 (0%)	3 (100.00%)	*0.001*
	Yes	13 (100.00%)	0 (0%)	
	Irregular	4 (44.44%)	5 (55.56%)	
Water source	Motor	10 (83.33%)	2 (16.67%)	*0.005*
	Tube well	1 (11.11%)	8 (88.89%)	
	Pond	2 (50.00%)	2 (50.00%)	
Footbath	No	7 (36.84%)	12 (63.16%)	*0.07*
	Yes	6 (100.00%)	0 (0%)	

According to Table 3, the farmers who regular dewormed their chicken had no coccidiosis occurrence(0%) , 55.56% farms found coccidiosis which were irregularly dewormed and the matter of sorrow was the farms which were not totally dewormed found 100% coccidiosis

occurrence. The regular and irregular deworming had a close association with occurrence of coccidiosis that found here the significant value. Here *P value* is *0.001* and its carried the significant results.

According to the Table 3, the farms which used motor had coccidiosis 16.67%, in case of pond its 50%. Here *P value* is *0.05* that means the result is not significant if the more farm information we added the water source would be more significant parameter for coccidiosis occurrence. From Table 3, the P value is 0.07 which is also not significant result. May be for some lacking at the time of data collection and for some information lacking footbath is not significant for the coccidiosis occurrence in that farm.

3.4 Association between biosecurity parameter and mortality rate of chicken

Table 4: Analysis the association between biosecurity parameter and mortality rate of layer chicken (N=25)

Parameter	**Categories**	**Mortality rate**		***P value***
		High	Low	
Isolation shed	No	10 (50.00%)	10 (50.00%)	*0.041*
	Yes	0 (0%)	5 (100.00%)	
Footbath	No	10 (52.63%)	9 (47.37%)	*0.022*
	Yes	0 (0%)	6 (100.00%)	
Deworming	No	2 (66.67%)	1 (33.33%)	*0.003*
	Yes	1 (7.69%)	12 (92.31%)	
	Irregular	7 (77.78%)	2 (22.22%)	

Isolation shed are where chickens with disease od with symptoms of disease are kept separately, so that the pathogen of the disease do not spread from them to healthy chickens. In this case isolation shed plays a major role in reducing chicken mortality. Isolation of sick chickens reduces the mortality rate as the pathogen does not have chance to infect healthy chickens. Since there are many chickens in the same shed in layer farm compared to cattle and goat farm, the disease spreads from one to another in very little time. According to Table 4, the farms which used isolation shed their 100% chicken had low mortality in their farm, besides 50% of having high mortality in which farms that had no isolation shed of them. Here *P value*

is *0.041* which carried a significant result for chicken mortality. Moreover we can say that, isolation shed have close association with the mortality rate in layer farm.

Table 4 shows the layer farms where footbath used had low mortality which is 100% and the farms that maintain regular deworming having low mortality rate which is 92.31% but where there was no footbath had high mortality rate 52.63% in their chicken and also found high mortality rate about 77.78% in that farm which had irregular deworming history. *P value* for footbath is *0.022* and *P value* for deworming is *0.003*. Both results carried a significant parameter for causing high mortality rate in layer farm.

Discussion

In layer farming, it's really important to have strong biosecurity plans to keep the farms healthy and disease free. One big part of this is making sure that sick birds are away from the healthy ones. The utilization of diverse disinfectants plays a pivotal role in curbing the mortality rate within the layer farm. Regular incineration of poultry waste acts as a deterrent to the proliferation of pathogens on the premises. The day-to-day cleansing of both the layer house and equipment contributes significantly to purging the environment of contaminants. Adopting the practice of burning deceased birds as a disposal measure effectively reduces the layer's vulnerability to infectious ailments. Establishing a dedicated quarantine and isolation area within the layer farm serves as a barrier against the dissemination of diseases from afflicted birds to their healthier counterparts. Employing disinfectants for laundering farm attire and footwear further ensures the resistance of the layer farm to the infiltration of pathogens and diseases. Oluwasusi reported that a substantial reduction of up to 90% in disease occurrence could be achieved by diligently applying biosecurity measures such as employing footbaths and disinfectants, along with effective waste disposal practices (Oluwasusi *et al.,* 2018).

This study's outcomes underscore the significant impact that various variables exert on the prevalence of diseases within farm environments. Farms that integrate foot baths registered a remarkable absence of disease history, standing in stark contrast to the substantial 73.68% occurrence rate evident among those farms that did not adopt this practice. Likewise, the utilization of disinfectants translated to a notably reduced disease rate of 18%, a notable difference from the striking 85.71% rate witnessed in farms that disregarded disinfection protocols. The regimen of regular deworming emerged as another pivotal determinant. Farms adhering diligently to scheduled deworming exhibited a relatively modest disease rate of 23.08%. Conversely, farms that inconsistently pursued deworming practices experienced an alarming 100% occurrence rate of diseases, reinforcing the imperative of a consistent approach.

Furthermore, the study underscores the role of efficient wastage management in the context of disease control. Farms that executed adept waste management strategies enjoyed a commendably low disease occurrence rate of 64.29%. In contrast, farms struggling with suboptimal waste management faced a significantly higher disease occurrence rate of 81.82%, serving as a poignant reminder of the intrinsic link between meticulous waste control and disease prevention.

Coccidiosis stands out as the predominant disease in commercial layer farms, a finding from Singla and Gupta *et al.,* (2012) reported that coccidiosis was the frequently occurring disease in the study area which is closely associated with different biosecurity parameter. Proportional mortality rates due to coccidiosis were 14.5 and 13.3% in small scale and large-scale poultry farms due to low biosecurity measures, lack of regular deworming and mismanagement of them (Safari *et al.,* 2004).

This research findings highlight a notable trend that farmers who consistently administered deworming treatments to their chickens witnessed a complete absence (0%) of coccidiosis cases. In contrast, farms that employed an irregular deworming schedule reported a significantly higher occurrence rate of 55.56% for coccidiosis. Furthermore, the study revealed a stark difference for farms that neglected deworming entirely, as they encountered a 100% occurrence of coccidiosis. These outcomes underscore a substantial correlation between the frequency of deworming practices and the prevalence of coccidiosis among chickens. And regular deworming is one of the major component of biosecurity. The statistical analysis of the data lends support to the observation that maintaining a strict biosecurity associated with a significant reduction in the incidence of coccidiosis cases within chicken populations.

A study was conducted that indicating that maintaining proper biosecurity and vaccination, chick mortality below 3% in day-old chicks. Factors such as disease, predation, high temperatures, and insufficient biosecurity can contribute to elevated mortality rates (Geidam *et al.,* 2006) On an annual basis, the average flock mortality rate ranges from 20% to 25% (FAO, 2003) due to disease and disease occurs due to lack of biosecurity. In a separate investigation (Muhammad *et al.*, 2010) reported that chick mortality comprised 11.4% of the flock size due to bad chick quality, diseases, lack of deworming, absence of footbaths, stress and suboptimal management practices(not maintained personnel hygiene) specifically within layer farms. Notably, mortality is closely associated with disease outbreaks, inadequate management practices (such as deficient biosecurity measures and deworming), ineffective waste management, not vaccinated, absence of footbath and improper brooding temperatures (Chou *et al.,* 2004).

The research revealed that employing isolation sheds led to a complete elimination of chicken mortality, contrasting with farms lacking isolation sheds where mortality was 50%. Among layer farms, using footbaths corresponded to a full mortality reduction, and consistent deworming was associated with a substantial 92.31% decrease in mortality. Conversely, farms

without footbaths experienced 52.63% higher mortality, while irregular deworming correlated with a significant 77.78% increase in mortality. These outcomes underscore the pivotal role played by isolation sheds, footbaths, and consistent deworming in managing and mitigating chicken mortality across various farm setups

In summation, the study's findings collectively highlight the paramount importance of these practices- foot baths, disinfection, regular deworming, and waste management—as integral components of fostering the overall health and vitality of farms. By adhering to these practices, farms can effectively mitigate disease occurrence rates, thereby fortifying the well-being of their livestock and the overall farm ecosystem.

Chapter 4

Conclusion

In the context of Bangladesh's development, disease prevention is vital for successful layer farming. A clear formula emerges: lower disease rates translate to reduced costs and increased profits. Through this study we found out that for maintaining a disease-free environment is only achievable through stringent adherence to robust biosecurity and hygiene protocols. In summary, disease prevention in the poultry industry requires a combination of proactive measures, consistent monitoring, and well-informed management practices. By prioritizing the health and well-being of the flock, layer farmers can reduce the risk of disease outbreaks and achieve better performance potential. This study brings into focus a significant and tangible correlation between the implementation of comprehensive biosecurity practices and the notable reduction in both disease incidence and mortality rates within layer farms. By establishing a robust system of biosecurity, layer farms can effectively curtail the risk of disease outbreaks and mitigate potential losses linked to elevated mortality rates.

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