Knowledge, Attitude and Practice Regarding Biosecurity of Small-Scaled Broiler Farms in Sitakunda, Chattogram

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By:

Tonmoy Chakroborty

Roll No: 17/50

Reg No: 01882

Intern ID: 86

Session: 2016-17

Faculty of Veterinary Medicine

Chattogram Veterinary and Animal Sciences University
Khulshi, Chattogram – 4225, Bangladesh

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Approved by:

_____

(Mr. Abdul Rahman)

Associate Professor

Department of Agricultural Economics and Social Sciences

Faculty of Veterinary Medicine

Chattogram Veterinary and Animal Sciences University
Khulshi, Chattogram – 4225, Bangladesh

Statement of Author

I, Tonmoy Chakroborty, certify unequivocally that I have performed all the tasks detailed in this report. The data was gathered from books, national and international periodicals, and other sources. All citations have been properly acknowledged. Consequently, I am solely responsible for collecting, manipulating, preserving, and publishing all data compiled in this report.

The Author

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Abstract

Poultry farming is one of the most essential and vibrant sectors in the agricultural economy of Bangladesh. It provides animal protein, income, employment, and social security to millions, especially the rural poor. The purpose of this study was to estimate the Knowledge Attitude, and Practice (KAP) of small-scaled commercial broiler farmers related to biosecurity measures. Data were collected using questionnaires from 25 close system broiler farms according to the Non-Probability Multistage Cluster Sampling Method (localities, farms, and respondents), in Sitakunda, Chattogram for about a period of 1 month. Data was managed by Microsoft Excel 365 and analyzed by STATA corp SE 18. A low level of KAP regarding biosecurity among workers as a preventive system was revealed. Analysis of the number of birds on the farms revealed that 52% of participants had 1000-1500 birds, but 68% of the participants received training. 68% of questions got expected answers from the farmers in the knowledge section, and 39% and 78% respectively in the attitude and practice section. Most of the farmers followed general biosecurity protocol in the farm without knowing the significance as their educational levels were low among them. The outcomes of this research contribute to a holistic understanding of the dynamics surrounding biosecurity, ultimately offering valuable insights for policymakers, researchers, extension workers, and farmers alike. These insights have the potential to catalyze improvements in biosecurity practices, thereby bolstering the productivity and profitability of broiler farming in Bangladesh.

Keywords: knowledge; attitude; practice; biosecurity; small-scale farming; commercial broiler.

1. Introduction

Poultry farming is one of the most essential and vibrant sectors in the agricultural economy of Bangladesh. It provides animal protein, income, employment, and social security to millions, especially the rural poor (Saleque and Ansarey, 2020). The history of poultry rearing in Bangladesh can be traced back to the early 20th century when British colonial rulers introduced exotic chicken breeds for egg production in some parts of the country (Chowdhury and Bhuiyan, 2009). However, the commercial poultry industry in Bangladesh has evolved rapidly over the past few decades.

Since the 1960s, the poultry industry has radically transformed by introducing improved breeds and modern technologies (Rahman et al., 2015). Commercial poultry farming has emerged as a profitable business opportunity for entrepreneurs and small-scale farmers (Raha, 2014). According to the Bangladesh Bureau of Statistics (BBS), the poultry sector contributed about 2.55 percent to the country's gross domestic product (GDP) in the fiscal year 2018-2019 (BBS, 2019). The sector also employs about 3.5 million people (Saleque and Ansarey, 2020).

However, the poultry industry in Bangladesh also faces many challenges and constraints that affect its productivity and profitability. Among them, biosecurity is one of the most critical issues that needs to be addressed urgently. Biosecurity refers to the procedures used to prevent the introduction and spreading of disease-causing organisms in poultry flocks (Palić, 2019). Biosecurity is essential for ensuring the health and welfare of poultry birds, reducing the risk of zoonotic diseases, improving the quality and safety of poultry products, and enhancing the competitiveness and sustainability of the poultry industry (Vaarst et al., 2015). Despite its importance, many poultry farmers in Bangladesh need to address or implement biosecurity. This is mainly due to farmers' need for more awareness, knowledge, skills, resources, and incentives (Ali et al., 2020). As a result, poultry farms are frequently exposed to various infectious diseases such as avian influenza, Newcastle disease, infectious bursal disease, coccidiosis, salmonellosis, etc. These diseases cause significant losses in terms of mortality, morbidity, production performance, and profitability of poultry farms (Faysal et al., 2021; Hennessey et al., 2021). Therefore, there is a need to assess the current status of biosecurity

practices and their impact on poultry production and profitability in Bangladesh. Moreover, there is a need to understand poultry farmers' knowledge, attitude, and practice (KAP) regarding biosecurity and its related aspects, such as antimicrobial use (AMU), vaccination, hygiene, etc. KAP studies can provide valuable insights into poultry farmers' perceptions, beliefs, behaviours, and barriers regarding biosecurity and help design effective interventions to improve their biosecurity level (Ahmed et al., 2021). The present study aims to address these gaps by conducting a KAP survey on biosecurity among small-scale broiler farmers in Sitakunda upazila of Chattogram district. Sitakunda is one of the largest broiler-producing areas in Bangladesh with more than 5000 small-scale broiler farms (BBS, 2019). The study will also measure the biosecurity level of these farms using a standard checklist and evaluate its relationship with their production performance and profitability.

1.1. The goals and objectives of this study:

1. To assess the current biosecurity practices and its related aspects such as antimicrobial use, vaccination, and hygiene among small-scale broiler farmers in Sitakunda, Chattogram.
2. To measure the biosecurity level of small-scale broiler farms using a standard checklist and evaluate its relationship with their production performance and profitability.
3. To identify small-scale broiler farmers' knowledge, attitude, and practice regarding biosecurity and its related aspects.
4. To determine the factors influencing biosecurity practices.
5. To provide useful information to policymakers, researchers, extension workers, and farmers to improve biosecurity practices and enhance the productivity and profitability of broiler farming in Bangladesh.

2. Materials and Method

2.1. Study Area and Planning:

The study was conducted in Sitakunda, Chattogram, a hub of poultry farming and industrial development. The area is known for its high concentration of small-scale and commercial poultry farmers who rely on indigenous chicken breeds and broiler for their livelihoods and source of protein. The study was planned to collect data on the demographic, and to check the knowledge about biosecurity, practices of biosecurity and attitude of farmers towards biosecurity. The study was designed to be conducted over a period of one month, during which time a questionnaire was administered to farmers who owned only commercial broiler farms. Although we found two types of farming, one is contract-based farming where a company supplied chickes, feed and veterinary care in returns of half of the profit and another one was credit based farming where farmers started farming by their own capital or with the help of local dealers. At first by pilot questionnaire survey, the quality and data availably according to questions was ensured. Finally, the questionnaire was adjusted accordingly. For selecting the farmers, a systematic sampling technique was used. The researcher followed a paved road in the rural area and identified households that raised indigenous chickens. The researcher then selected every fifth household that raised indigenous chickens, starting from the first house near to them and skipping the three houses in between. This method ensured that the sample was representative of the population and reduced the potential for bias in the selection process. The sample size was determined using a power analysis, with a confidence level of 95% and a margin of error of 5%.

2.2. Data Management:

Once we received the responses from the questionnaire, we made sure to handle the data with great care. We used a Microsoft Office 365 Excel file to manage and clean the data, taking extra precautions to ensure it was complete and accurate. If we found any missing or inconsistent values, we promptly corrected or removed them. To ensure the soft data was kept safe and confidential, we saved it on a password-protected laptop. Rest assured that we take data security seriously, and we are constantly striving to improve our methods to protect your information better.

2.3. Statistical Analysis:

The information gathered from the questionnaire was carefully examined using descriptive statistics to provide an overview of the demographic, phenotypic, and breeding traits of the native chicken populations. We used STATA 17, a widely used statistical software package for data analysis in social sciences to perform this analysis. The findings were presented using appropriate tables and figures, and the statistical tests were considered significant at $p < 0.05$.

3. Result and Discussion

3.1 Demographic data of farmers and farms:

Results showed that the study encompassed a sample of 25 male participants, constituting the entirety of the cohort, as there were no female participants. In terms of educational distribution, the majority held secondary level education (52%), followed by higher secondary (16%), primary (24%), and graduation (8%). Business ownership was the most prevalent occupation (84%), while shopkeepers and shopkeepers engaged in farming represented 8% each. Analysis of the number of birds on the farms revealed that 52% of participants had 1000-1500 birds, followed by 32% with 500-1000 birds, 12% with 1500-2000 birds, and 4% with over 2000 birds.

Table 1: Demographic data of farmers and farm

Variables	Category	Frequency	Percent %	Cumulative
Gender	Male	25	100	100.00
	Female	0	0	100.00
Educational level	Primary	6	24	24.00
	Secondary	13	52	76.00
	Higher Secondary	4	16	92.00
	Graduation	2	8	100.00
Occupation	Business	21	84	84.00
	Shopkeeper	2	8	92.00
	Shopkeeper and Farmer	2	8	100.00
Number of birds in the farm	500-1000	8	32	32.00
	1000-1500	13	52	84.00
	1500-2000	3	12	96.00
	>2000	1	4	100.00
Farm Location	Urban area	0	0	0.00
	Rural area	25	100	100.00
Received Training	Yes	17	68	68.00
	No	8	32	100.00

Geographically, all participants hailed from rural areas without representation from urban locales. 68% reported receiving training, whereas the remaining 32% had not undergone any training. The data underscore the sample's predominantly male, rural-based, and business-oriented nature, with a notable emphasis on secondary-level education.

Table 2 presents the descriptive statistics for key variables within the study. The average age of the participants was 43.28 years (SD = 6.47), ranging from 33 to 56 years. The annual income demonstrated a mean of 258,000 (SD = 160,520) units, with a range spanning from 50,000 to 500,000 units. As indicated by the number of members, family size had an average of 5.16 (SD = 1.89), varying from 2 to 9 members. Participants' experience in the field exhibited an average of 11.84 years (SD = 6.38), ranging from 5 to 26 years. The size of the sheds housing the birds had a mean of 2632 square feet (SD = 5719.32), with a minimum of 1000 square feet and a maximum of 30000 square feet. These statistics provide an insight into the variables' central tendency and variability, highlighting the participants' diverse characteristics and operations.

Table 2: Socioeconomic data of farmers

Variables	Observations	Mean	Std. dev.	Min	Max
Age	25	43.28	6.471218	33	56
Annual Income	25	258000	160520	50000	500000
Family Member (n)	25	5.16	1.885913	2	9
Experience	25	11.84	6.381484	5	26
Size of shed (ft)	25	2632	5719.318	1000	30000

3.2. Knowledge section (n=25)

Table 3 provides an overview of participants' responses regarding their knowledge of biosecurity practices within poultry farming. For the question, "What is Biosecurity?", 76% of participants answered affarmatively, while 24% responded negatively. Regarding the main goal of implementing biosecurity measures, 32% were knowledgeable, while 68% were not. All participants knew the appropriate method for disposing of dead birds on a farm. In preventing the entry of free-roaming animals onto the farm, 68% were knowledgeable, with

26% needing more knowledge. Concerning the purpose of a foot bath or foot spray at the farm entrance, 20% demonstrated understanding, while 80% did not. Similarly, only 20% of participants knew how often the vaccination schedule for poultry should be reviewed, while 80% still needed to possess this information.

Table 3: Estimating knowledge of farmers about biosecurity (n=25)

Variables	Category	Frequency	Percent %	Cumulative
1. What is Biosecurity?	Yes	19	76	76.00
	No	6	24	100.00
2. What is the main goal of implementing biosecurity measures on a farm?	Yes	8	32	32.00
	No	17	68	100.00
3. What is the correct way to dispose of dead birds on a farm?	Yes	25	100	100.00
	No	0	0	100.00
4. What should be done to prevent free-roaming animals from entering the farm?	Yes	17	68	68.00
	No	8	26	100.00
5. What is the purpose of a foot bath or foot spray at the entrance of a farm?	Yes	5	20	20.00
	No	20	80	100.00
6. How often should the vaccination schedule for poultry be reviewed?	Yes	5	20	20.00
	No	20	80	100.00
7. How should drug packages be disposed of on the farm?	Yes	18	72	72.00
	No	7	28	100.00
8. How should water containers on the farm be cleaned?	Yes	17	68	68.00
	No	8	32	100.00
9. What should be done to prevent wild birds from entering the farm?	Yes	22	88	88.00
	No	3	12	100.00
	Yes	17	68	68.00

10. What is the purpose of a ventilation system in a poultry shed?	No	8	32	100.00

Regarding proper disposal of drug packages on the farm, 72% were knowledgeable, with 28% needing more awareness. For cleaning water containers, 68% were informed, whereas 32% were not. To prevent wild birds from entering the farm, 88% knew preventive measures, while 12% did not. Lastly, 68% comprehended the purpose of a ventilation system in a poultry shed, and 32% did not. These findings highlight varying degrees of familiarity with biosecurity practices, emphasizing areas where education and training could potentially enhance participants' understanding and adoption of these measures.

3.3. Attitude section (n=25)

Table 4 presents participants' beliefs and attitudes toward various aspects of biosecurity in poultry farming. When asked about the importance of biosecurity for bird health and farm profitability, 96% agreed, while 4% disagreed. Similarly, 88% believed in their role to prevent disease spread in the poultry industry, with 12% expressing uncertainty. All participants recognized the capacity of biosecurity to prevent disease spread to neighboring farms. Education's role in fostering awareness was acknowledged by 96%, whereas 4% did not share this belief. The potential for long-term cost savings through biosecurity measures was endorsed by 100%, with no disagreement. Similarly, all participants (100%) supported government assistance for biosecurity investments.

Table 4: Investigating the attitude of farmers regarding attitude toward maintaining biosecurity.

Questions	Category	Frequency	Percent %	Cumulative
Do you believe that biosecurity is important for the health of your birds and the profitability of your farm?	Yes	24	96	96.00
	No	1	4	100.00
	Yes	22	88	88.00

Do you believe that you have a role to play in preventing the spread of disease within the poultry industry?	No	3	12	100.00
Do you believe that following biosecurity practices on your farm can help prevent the spread of disease to other farms in the area?	Yes	25	100	100.00
	No	0	0	100.00
Do you believe that it is important to educate other poultry farmers in your community about the importance of biosecurity?	Yes	24	96	96.00
	No	1	4	100.00
Do you believe that investing in biosecurity measures on your farm can help you save money in the long run?	Yes	25	100	100.00
	No	0	0	100.00
Do you believe that the government should provide financial assistance to farmers who invest in biosecurity measures?	Yes	25	100	100.00
	No	0	0	100.00
Do you believe that following biosecurity practices can help maintain consumer confidence in the safety and quality of your poultry products?	Yes	25	100	100.00
	No	0	0	100.00
Do you believe that biosecurity should be a priority for all farmers, regardless of the size of their operation?	Yes	25	100	100.00
	No	0	0	100.00
Do you believe that it is important for farmers to stay up-to-date on the latest biosecurity recommendations and guidelines?	Yes	25	100	100.00
	No	0	0	100.00

Maintaining consumer trust through biosecurity measures was deemed important by all respondents. Additionally, all participants recognized biosecurity as a universal priority, irrespective of farm size, and emphasized the significance of staying updated on biosecurity recommendations and guidelines. These results underscore a strong belief in the value of biosecurity measures for various aspects of poultry farming, indicating a favorable disposition toward their adoption and integration into farm practices.

3.4. Practice section (n=25)

Table 5 outlines participants' reported practices related to biosecurity in their poultry farming operations. All participants (100%) reported regularly cleaning and disinfecting their farm equipment and poultry house. Likewise, all respondents practiced regular disposal of dead birds and animals on their farms. Concerning management practices, 84% implemented all-in/all-out management, and 16% did not. 72% had designated areas for manure storage and disposal, while 28% did not.

Table 5: Estimating practices of biosecurity in farm by farmers

Questions	Category	Frequency	Percent %	Cumulative
Do you clean and disinfect your farm equipment and tools regularly?	Yes	25	100	100.00
	No	0	0	100.00
Do you clean and disinfect the interior and exterior of your poultry house regularly?	Yes	25	100	100.00
	No	0	0	100.00
Do you have a designated area for manure storage and disposal?	Yes	18	72	72.00
	No	7	28	100.00
Do you regularly dispose of dead birds and other animals on your farm?	Yes	25	100	100.00
	No	0	0	100.00
Do you practice all-in/all-out management for your poultry?	Yes	21	84	84.00
	No	4	16	100.00
Do you have a footbath or foot spray at the entrance of your poultry house?	Yes	9	36	36.00
	No	16	64	100.00

Do you limit visitors and their access to your poultry house?	Yes	25	100	100.00
	No	0	0	100.00
Do you use separate equipment for sick birds and healthy birds?	Yes	24	96	96.00
	No	1	4	100.00
Do you isolate and treat sick birds separately from healthy birds?	Yes	24	96	96.00
	No	1	4	100.00
Do you use personal protective equipment when handling birds or manure?	Yes	25	100	100.00
	No	0	0	100.00
Do you have a rodent control program in place?	Yes	11	44	44.00
	No	14	56	100.00
Do you practice proper biosecurity measures when transporting your birds?	Yes	15	60	60.00
	No	10	40	100.00

The study indicated that an overwhelming majority of the participants, specifically 96%, took proactive measures to isolate and treat ill avian species separately from their healthy counterparts. Furthermore, personal protective equipment was implemented during the handling of both birds and manure, with separate equipment employed for sick and healthy birds. The participants also utilized footbaths or sprays at the entrances of poultry houses, limited visitor access, and adhered to proper biosecurity protocols during bird transportation, with 100% compliance in each area. However, it was observed that only 36% of the participants had footbaths or sprays, while 44% had a rodent control program, and 60% practiced biosecurity during transportation. These findings indicate a commendable commitment to certain biosecurity practices, while also underscoring the need for improvements in areas such as rodent control and specific management practices during bird transportation.

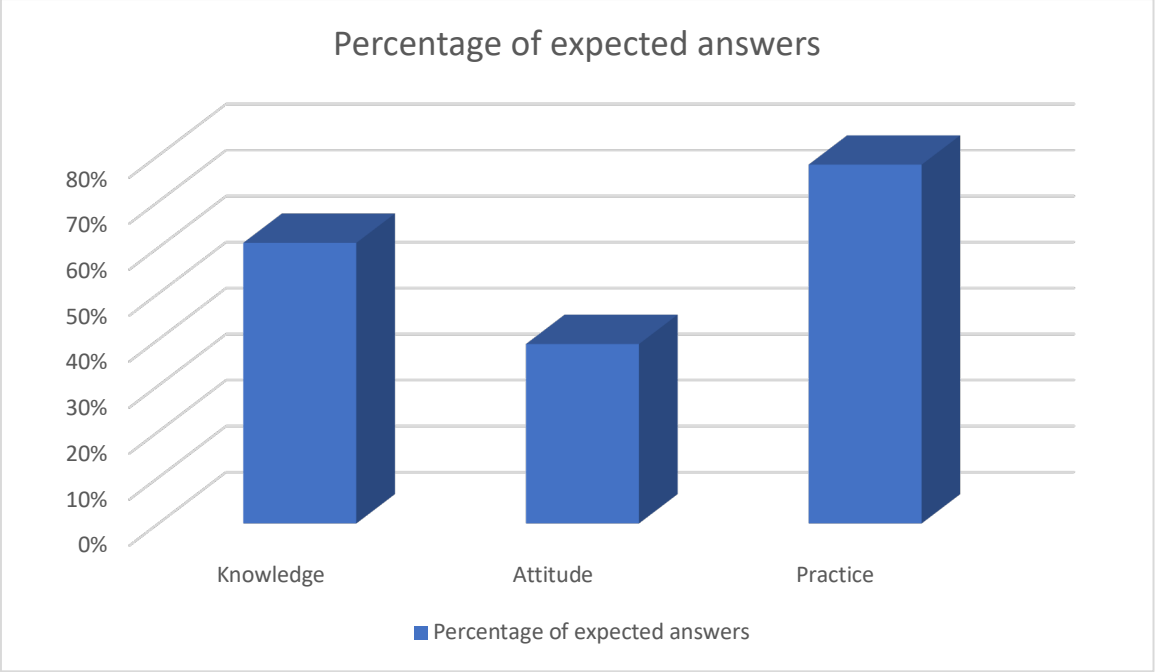

Figure 1: Average scrore of estimated answers in knowledge, attitude and practice section (n=25)

Based on the assessment, it was found that 68% of farmers were able to provide accurate answers to the knowledge section questions. On the other hand, the percentage of farmers who correctly answered the attitude and practice sections were 39% and 78%, respectively. These findings suggest that while farmers may have a good grasp of theoretical concepts, there is still a need to improve their attitudes and practical skills in order to enhance their overall performance and productivity. Upon comparison to other KAP studies (Ahmed et al., 2021, Lambrou et al., 2020) the findings revealed a low score in the knowledge section. This outcome could potentially be attributed to the limited educational level of farmers. Furthermore, it is noteworthy that the attitude section also scored lower than similar studies. However, it was pleasantly surprising to discover that biosecurity practices on farms were higher than initially anticipated. This positive outcome can be credited to the training program organized by LDDP, which evidently had a beneficial impact on daily biosecurity practices. In light of these findings, it is evident that implementing regular training programs is crucial to continuously improve the poultry sector.

4. Conclusion

In conclusion, this study addressed its objectives comprehensively by assessing the prevailing biosecurity practices and their associated facets, including antimicrobial usage, vaccination, and hygiene, within the context of small-scale broiler farms in Sitakunda, Chattogram. The evaluation of biosecurity levels using a standardized checklist facilitated the examination of its correlation with production performance and profitability, shedding light on the interplay between these variables. The investigation into the knowledge, attitude, and practices of small-scale broiler farmers concerning biosecurity provided valuable insights into the existing awareness and implementation gaps. By identifying influential factors, the study delved into the determinants shaping biosecurity practices in this setting. The outcomes of this research contribute to a holistic understanding of the dynamics surrounding biosecurity, ultimately offering valuable insights for policymakers, researchers, extension workers, and farmers alike. These insights have the potential to catalyze improvements in biosecurity practices, thereby bolstering the productivity and profitability of broiler farming in Bangladesh.

Data availability statement

The author collected data through a questionnaire and stored it securely on their computer. Only the author has access to the data.

Limitations and Gaps of the Study

- **Sample Size and Representativeness:** The study's sample was limited to small-scale broiler farmers in a specific geographic region, potentially restricting the generalizability of findings to the broader population of poultry farmers.
- **Gender Imbalance:** The study exclusively featured male participants, which might introduce a gender bias and hinder a comprehensive understanding of biosecurity practices among female farmers.
- **Lack of Inclusion of Financial Data:** The study did not delve into the financial aspects of biosecurity adoption, which could have provided a more comprehensive understanding of the economic implications of these practices.
- **Focus on Small-Scale Farms:** The study exclusively targeted small-scale broiler farms, omitting insights from larger operations, potentially limiting the overall picture of biosecurity practices in the poultry industry.
- **Limited Exploration of Farmer Perceptions:** While the study aimed to gauge knowledge, attitudes, and practices, it could have delved deeper into farmers' perceptions, motivations, and barriers for adopting or not adopting specific biosecurity measures.
- **Potential Response Bias:** The willingness of participants to participate in the study might have led to a bias towards those more concerned or knowledgeable about biosecurity, potentially skewing the results.

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Competing interests

As the study was conducted by the author himself, so there is no competing interest.

5. References

Ahmed, M. A. B., Abdelgadir, A. E., & Ismail, H. M. (2021). Estimation of Knowledge, Attitude, and Practice Related (KAP) to Biosecurity Measures and Hazard Analysis Critical Control Point (HACCP) Prerequisites in Poultry Meat Production in Khartoum State, Sudan. *J Anim Sci Livest Prod*, *5*(5), 1-5.

Ali, M. Z. (2020). Common respiratory diseases of poultry in Bangladesh: A review. *SAARC Journal of Agriculture*, *18*(1), 1-11.

Bangladesh, S. Y. (2019). Bangladesh Bureau of Statistics: Dhaka.

Faysal, M. A. H., Ahmed, M. R., Rahaman, M. M., & Ahmed, F. (2021, July). A Review of groundbreaking changes in the poultry industry in Bangladesh using the internet of things (IoT) and computer vision Technology. In *2021 International Conference on Automation, Control and Mechatronics for Industry 4.0 (ACMI)* (pp. 1-6). IEEE.

Hennessey, M., Fournié, G., Hoque, M. A., Biswas, P. K., Alarcon, P., Ebata, A., ... & Barnett, T. (2021). Intensification of fragility: Poultry production and distribution in Bangladesh and its implications for disease risk. *Preventive Veterinary Medicine*, *191*, 105367.

Lambrou, A. S., Luitel, H., Bhattarai, R. K., Basnet, H. B., & Heaney, C. D. (2020). Informing influenza pandemic preparedness using commercial poultry farmer knowledge, attitudes, and practices (KAP) surrounding biosecurity and self-reported avian influenza outbreaks in Nepal. *One Health*, *11*, 100189.

Miah, M. Y., Chowdhury, S. D., Bhuiyan, A. K. F. H., & Ali, M. S. (2014). Effect of different levels of dietary energy on growth performance of indigenous Desi chicks reared in confinement up to target weight of 950 g. *Livestock Research for Rural Development*, *26*(7), 124-129.

Palić, D., & Scarfe, A. D. (2019). Biosecurity in aquaculture: practical veterinary approaches for aquatic animal disease prevention, control, and potential eradication. In *Biosecurity in animal production and veterinary medicine: from principles to practice* (pp. 497-523). Wallingford UK: CABI.

Saleque, M. A., & Ansarey, F. (2020). Poultry industry: challenges and solutions. *URL: https://www. daily-sun. com/printversion/details/502289/Poultry-Industry:-Challenges-and-Solutions*.

Sarma, P. K., Raha, S. K., & Jorgensen, H. (2014). An economic analysis of beef cattle fattening in selected areas of Pabna and Sirajgonj Districts. *Journal of the Bangladesh Agricultural University*, *12*(452-2016-35625), 127-134.

UNICEF. (2012). Bangladesh Bureau of Statistics, 2019. *Progotir Pathey, Bangladesh Multiple Indicator Cluster Survey 2019, Survey Findings Report*.

UR Rehman, K., Rehman, R. U., Somroo, A. A., Cai, M., Zheng, L., Xiao, X., ... & Zhang, J. (2019). Enhanced bioconversion of dairy and chicken manure by the interaction of exogenous bacteria and black soldier fly larvae. *Journal of environmental management*, *237*, 75-83.

Vaarst, M., Steenfeldt, S., & Horsted, K. (2015). Sustainable development perspectives of poultry production. *World's poultry science journal*, *71*(4), 609-620.

Appendix

Questionnaire

Questions	**Answers**
1. Name of the Farmer:	
2. Age:	
3. Gender:	☐ Male ☐ Female ☐ Other
4. Education Level:	☐ No formal education ☐ Primary ☐ Secondary ☐ Higher secondary ☐ Diploma ☐ Bachelor's ☐ Master's ☐ Ph.D.
5. Occupation:	☐ Farmer ☐ Business ☐ Service ☐ Others
6. Annual Income:	☐ Less than 50,000 BDT ☐ 50,000-100,000 BDT ☐ 100,000-200,000 BDT ☐ 200,000-500,000 BDT ☐ Above 500,000 BDT
7. Number of family members living on the farm:	☐ 1-2 ☐ 3-4 ☐ 5-6 ☐ More than 6
8. How long have you been rearing broiler chickens?	☐ Less than 1 year ☐ 1-3 years ☐ 3-5 years ☐ More than 5 years
9. Number of broiler chickens on your farm:	☐ Less than 500 ☐ 500-1000 ☐ 1000-5000 ☐ More than 5000
10. What is the size of your farm (in square feet)?	☐ Less than 1000 ☐ 1000-5000 ☐ 5000-10000 ☐ More than 10000
11. Is your farm located in a rural or urban area?	☐ Rural ☐ Urban
12. Have you ever received any training on biosecurity measures?	☐ Yes ☐ No

Farmer and Farm Demographic:

- **Questions regarding Knowledge in Biosecurity in Farm:**

Question	A	B	C	D
1. What is Biosecurity?	[ ] Ensuring a safe and secure environment for living organisms including plants and animals	[ ] Measures taken to reduce the risk of infectious agents entering or leaving a farm or area	[ ] Preventing animals from accessing water sources	[ ] None of the above
2. What is the main goal of implementing	[ ] To increase production of crops or animals	[ ] To minimize the risk of introducing	[ ] To increase the cost of production	[ ] None

biosecurity measures on a farm?		infectious agents onto the farm		of the above
3. What is the correct way to dispose of dead birds on a farm?	[ ] Leave them where they died	[ ] Bury them in a shallow pit	[ ] Burn them or bury them deep enough to prevent scavenging animals from digging them up	[ ] None of the above
4. What should be done to prevent free-roaming animals from entering the farm?	[ ] Build a fence around the farm	[ ] Leave the farm open to all animals	[ ] Use chemical repellents to keep animals away	[ ] None of the above
5. What is the purpose of a foot bath or foot spray at the entrance of a farm?	[ ] To clean the shoes of visitors before they enter the farm	[ ] To keep rodents from entering the farm	[ ] To disinfect the shoes of farm workers to prevent the spread of diseases	[ ] None of the above
6. How often should the vaccination schedule for poultry be reviewed?	[ ] Every year	[ ] Every 6 months	[ ] Every 3 months	[ ] None of the above
7. How should drug packages be disposed of on the farm?	[ ] Burn them	[ ] Bury them in the ground	[ ] Recycle them	[ ] None of the above
8. How should water containers on the farm be cleaned?	[ ] Wash with soap and water	[ ] Rinse with water only	[ ] Disinfect with a cleaning solution	[ ] None of the above
9. What should be done to prevent wild birds from entering the farm?	[ ] Install bird-proof netting	[ ] Leave the farm open to all birds	[ ] Use chemical repellents to keep birds away	[ ] None of the above
10. What is the purpose of a ventilation system in a poultry shed?	[ ] To control temperature and humidity	[ ] To prevent the spread of diseases	[ ] To provide fresh air	[ ] None of the above

Note: In the answer column, farmers can tick the appropriate box for the corresponding answer using a checkmark symbol (☑) instead of a cross (☐) if desired. You can also add more questions based on the specific focus of your research and the available literature on biosecurity in small-scale broiler farms.

- **Questions regarding Attitude in Biosecurity in Farm:**

Attitude	**Tick if Yes**
Do you believe that biosecurity is important for the health of your birds and the profitability of your farm?	[ ]

Do you believe that you have a role to play in preventing the spread of disease within the poultry industry?	[ ]
Do you believe that following biosecurity practices on your farm can help prevent the spread of disease to other farms in the area?	[ ]
Do you believe that it is important to educate other poultry farmers in your community about the importance of biosecurity?	[ ]
Do you believe that investing in biosecurity measures on your farm can help you save money in the long run?	[ ]
Do you believe that the government should provide financial assistance to farmers who invest in biosecurity measures?	[ ]
Do you believe that following biosecurity practices can help maintain consumer confidence in the safety and quality of your poultry products?	[ ]
Do you believe that biosecurity should be a priority for all farmers, regardless of the size of their operation?	[ ]
Do you believe that the poultry industry as a whole should do more to promote and enforce biosecurity practices?	[ ]
Do you believe that it is important for farmers to stay up-to-date on the latest biosecurity recommendations and guidelines?	[ ]

Note: Please tick the appropriate box for each question based on your attitudes and beliefs regarding biosecurity.

- **Questions regarding Practice in Biosecurity in Farm:**

Practice	**Tick if Yes**
Do you clean and disinfect your farm equipment and tools regularly?	[ ]
Do you clean and disinfect the interior and exterior of your poultry house regularly?	[ ]
Do you have a designated area for manure storage and disposal?	[ ]
Do you regularly dispose of dead birds and other animals on your farm?	[ ]
Do you practice all-in/all-out management for your poultry?	[ ]
Do you have a footbath or foot spray at the entrance of your poultry house?	[ ]
Do you limit visitors and their access to your poultry house?	[ ]
Do you use separate equipment for sick birds and healthy birds?	[ ]
Do you isolate and treat sick birds separately from healthy birds?	[ ]
Do you use personal protective equipment when handling birds or manure?	[ ]
Do you have a rodent control program in place?	[ ]
Do you practice proper biosecurity measures when transporting your birds?	[ ]

Note: Please tick the appropriate box for each question based on your actual practices on the farm

Biography of Author

Meet Tonmoy Chakroborty, the beloved eldest child of Chandan Chakroborty and Swapna Chakroborty. He is currently pursuing his Doctor of Veterinary Medicine (DVM) at Chattogram Veterinary and Animal Sciences University under the Faculty of Veterinary Medicine. Tonmoy worked incredibly hard to pass his Secondary School Certificate Examination (SSC) in 2013 from Khaja Ajmeri High School, Chattogram with a perfect GPA of 5.00. He continued to excel and passed his Higher Secondary Certificate Examination (HSC) in 2015 from Government Hazi Mohammad Mohsin College, Chattogram with flying colors, earning a GPA of 5.00 out of 5.00. We understand that Tonmoy is currently undergoing a year-long internship, and we couldn't be more proud of his dedication to his studies. Tonmoy's unwavering enthusiasm for his field of study is truly inspiring, and we have no doubt that he will develop the necessary practical skills and knowledge to succeed in the modern era of science.