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Research Article

Adoption of Biosecurity Practices among Poultry Farmers in Punjab, Pakistan

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ABSTRACT

Strengthening biosecurity on poultry farms is crucial to mitigate the risk of infectious diseases like avian influenza, which can have far-reaching economic and public health implications. The poultry industry's resilience depends on robust biosecurity practices as a vital component of the country's agricultural sector and food supply. This study was conducted in District Rawalpindi of Punjab province, where 1715 poultry farms were identified. The study was mainly focused on 315 poultry farms selected out of 1715 using the proportionate sampling technique. Managers of these selected 315 farms were interviewed using a structured interview schedule. Collected data were analyzed using Statistical Package for Social Sciences (SPSS). The results revealed a varying level of awareness among different type of poultry keepers. Farmers demonstrated high awareness of vaccination protocols (98.41% and 98.42%), their knowledge of other essential measures, such as fumigation, disinfection, and nutritional supplements, was significantly lower (53.33% to 69.84%). However, awareness and adoption of biosecurity measures were higher among environmentally controlled poultry farms. This study recommends an awareness campaign for poultry farmers using a collaborative approach among veterinary services providers, academia, and research organizations.

Keywords: Adoption, Biosecurity Practices, Farmers' Awareness, Poultry Biosecurity, Poultry Farming.

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INTRODUCTION

The poultry industry is vital to Pakistan's economy, contributing significantly to GDP growth (Khan et al., 2021). It provides employment opportunities for millions of people, particularly in rural areas (Hussain et al., 2015). The industry also plays a crucial role in meeting the country's protein requirements, with poultry meat accounting for 30% of total meat consumption (Sohaib and Jamil, 2017). Moreover, the poultry sector has immense potential for export growth and generating foreign exchange earnings for the country (Naeem et al., 2022). The poultry sector is a dynamic part of the livestock industry, offering employment to over 1.5 million people in Pakistan. With a significant investment exceeding Rs 1,056 billion, this industry has seen impressive progress, achieving an average annual growth rate of 7.3% over the past decade. This growth has positioned Pakistan as the eleventh largest poultry producer globally, with immense potential for further expansion. The poultry sector accounts for approximately 40.7% of the country's total meat production (Government of Pakistan, 2024). The poultry sector in Pakistan has shown admirable growth, but factors like avian influenza and economic challenges have hindered it (Muhammad et al., 2017).

Structural deficiencies in the poultry sector in Pakistan include poor farm management, a lack of regulations, and product price fixing (Aslam et al., 2020). The demand and supply gap for electricity in Pakistan has plagued poultry production, leading to increased total cost of production and reliance on diesel generators. The demand and supply gap for electricity in Pakistan has plagued poultry production, leading to increased total cost of production and reliance on diesel generators (Khokhar et al., 2015).

Adopting biosecurity practices can reduce the use of antimicrobials on commercial chicken farms, as the prophylactic application of antimicrobials often mediates poor biosecurity practices (Imam et al., 2021). Implementing strict biosecurity measures, such as restricting access to poultry farms and ensuring proper disposal of manure and dead birds, can significantly reduce the risk of disease outbreaks. Regular cleaning and disinfection of poultry houses, equipment, and vehicles are also crucial in preventing the spread of diseases (Msimang et al., 2022). Furthermore, vaccination programs and health monitoring can help detect and control diseases early, reducing the need for antibiotics and promoting a healthier flock (Ravikumar et al., 2022).

Proper handling, storage, and administration of vaccines are essential for their effectiveness (Zoetis., 2020). Regular monitoring of vaccine efficacy and flock immunity is necessary to ensurethe success of vaccination programs (Tseng et al., 2024). Fumigation is a critical biosecurity measure in poultry farms, effectively reducing bacterial loads and preventing disease outbreaks (Marmion et al., 2021). Formaldehyde fumigation, in particular, is highly effective against Salmonella and Escherichia coli in poultry houses (Gosling et al., 2021). However, proper ventilation and safety measures are essential during fumigation to minimize risks to human health and the environment (Gerber et al., 2020). Disinfection is critical in poultry farm biosecurity, aiming to reduce microbial loads and prevent disease outbreaks (Martelli et al., 2017). Effective disinfectants for poultry farms include quaternary ammonium compounds, sodium hypochlorite, and hydrogen peroxide, demonstrating broad-spectrum antimicrobial activity(Bezek et al., 2023).

Flushing is a common practice in poultry farms, involving the removal of litter and manure from poultry houses to reduce disease risk and improve bird health (Martelli et al., 2017). Regular flushing can help decrease ammonia levels, moisture, and pathogen loads in poultry houses. However, improper flushing techniques can lead to environmental contamination and water pollution (Bist et al., 2023). Optimizing flushing frequency and methods is crucial to balance bird health, ecological sustainability, and economic viability (Tenzin et al., 2017). Flushing can also help reduce energy consumption by improving ventilation system efficiency and reducing the need for additional heating and cooling (Baxevanou et al., 2017).

Poultry farmers' awareness of essential biosecurity preventive knowledge is positively associated with their preventive behaviors against highly pathogenic avian influenza (Cui and Liu, 2016). Awareness of biosecurity measures, such as regular clearing of the poultry environment and washing of feeding and drinking troughs, positively influences poultry farms' biosecurity control score (Ajewole and Akinwumi, 2014). Educating poultry keepers to improve housing and management systems can help prevent future disease outbreaks in backyard holdings (Tenzin et al., 2017). Therefore, in this study, an attempt is made to explore poultry farmers' awareness and adoption of the different biosecurity measures. The key objectives of the study included:

- To explore the socio-economic attributes of the study participants
- To assess the awareness among study participants about different biosecurity practices
- To examine the adoption among study participants about different biosecurity practices
- To present key recommendations for the future course of action

MATERIALS AND METHODS

Study area

Punjab is the second largest province of Pakistan, spread over 205,344 sq km, 25.8% of the country's total land area. The cities of the Punjab are the most urbanized, with 40% of the population residing in urban areas. Punjab is the most heavily irrigated area due to the most extensive canal system in the world. It is home to several mountainous regions (Suleiman Mountains, Margalla Hills and Salt Range) and deserts (Thar, Thall, and Cholistan). Moreover, Punjab province's livestock population is higher than that of any other province in Pakistan.

Based on resources, this study was limited to one district, Rawalpindi, which was chosen conveniently. Rawalpindi is situated on the Pothohar Plateau and is characterized by its humid sub-tropical climate. The area was selected purposively due to the high concentration of poultry farms in the adjacent rural areas. Rawalpindi was purposively selected for the present study because it was easily accessible to the researcher. Rawalpindi has 1687 poultry farms,

including 1274 broiler and 413 layers. Poultry Research Institute is located in Rawalpindi and serves the whole country regarding poultry-related business and issues.

Population, sampling, and sample size

The sampling method used in the present study was convenient sampling at the first level and then random sampling on the second level. A total of 315 farms were selected in the present research, including 236 broilers and 78 layer farms. Thus, the 315 poultry farm managers were this study's respondents. The sample size was calculated using a sample size calculator on the web (http://www.raosoft.com/samplesize.html) and was 315. Considering that the population is not homogeneous but is categorized into broiler and breeder farms, the sample of 315 farms was taken proportionally, making 78 farms from layers and 237 from broilers.

Data collection and analysis

The data were collected using the survey method. Surveys are one of the finest data collection methods in which the researcher selects a specific number of respondents and administers a pre-developed, standardized interview schedule to every respondent individually. The interview schedule's reliability was checked by calculating Cronbach's alpha value. The initial pre-testing data for 35 farms was set up in SPSS, and Cronbach's alpha was calculated to be 0.874, which means the interview schedule is reliable. Data were collected using face-to-face interview techniques, and collected data were analysed using Statistical Package for Social Sciences (SPSS).

RESULTS

Demographic attributes of respondents

In this section, the demographic attributes of the respondents were explored. The essential qualities included the respondents' age, educational level, farm ownership status, the type of farm, and the purpose of establishing a poultry farm. The information on these stated aspects is presented below.

Table 1. Demographic attributes of respondents (n=315).

Demographics	Frequency	Percentage
Age		
Young (21-35)	174	55
Medium Age(36-50)	95	30
Old (51-65)	46	15
Education Level		
Illiterate	67	21
Primary	32	10
Middle	26	08
Matric	137	44
Intermediate	13	04
Graduate	32	10
Masters and above	8	03
Farm ownership		
Owned	202	64.1
On Rent	113	35.9
Farm Type		
Open Sided	216	68.57
Semi-Environment Controlled	24	7.62
Environment Controlled	75	23.81
Purpose		
Broiler	234	74.28
Layer	78	24.76
Breeder	03	0.95

Table 1 shows that 55% of respondents were within the 21-35 age bracket, whereas a mere 15%exceeded 51 years, yielding a mean age of 36.98. Regarding education, one-fifth (21%) of respondents had no formal education.

Moreover, 44%were at the matriculation level, and one in ten respondents (10%) had obtained a primary level of education. Likewise, one in ten respondents (10%) had graduated, and only 3% reported completing post-graduation. Regarding farm ownership and infrastructure, a significant majority (64.1%) of respondents were owners of their respective poultry farms, while 35.9% operated rented facilities. The farms themselves were categorized into three distinct typologies: open-sided (68.57%), environment-controlled (23.81%), and semi-environment-controlled (7.62%). The purpose of farms was mainly focused on broiler production, as reported by 74.28%, whereas 24.76% were primarily focused on layer production.

Biosecurity practices for poultry farms

Biosecurity practices for poultry farmers are critical to preventing the introduction and spread of diseases that can severely impact poultry health and production. These practices encompass a range of strategies to minimize risks associated with pathogens. This section explores awareness among poultry farmers about different biosecurity practices, as illustrated in Table 2.

Table 2. Awareness of biosecurity practices for poultry farms.

Different biosecurity measures	Awareness	
	Frequency	Percentage
Do you know the recommended vaccines?	310	98.41
Are you aware of the recommended vaccination schedule?	311	98.42
Do you have awareness regarding fumigation at poultry houses?	219	69.52
Are you aware of the process of disinfection at poultry sheds?	220	69.84
Do you know the method of flushing at poultry farms?	236	74.92
Are you aware of the recommended medicines for poultry birds?	222	70.47
Do you have awareness regarding use of minerals and vitamins in poultry feed?	168	53.33
Do you know the spray schedule and requirements for poultry houses?	168	53.33

Table 2 shows the highest awareness levels are found in the knowledge of recommended vaccines (98.41%) and vaccination schedules (98.42%). Lower awareness levels are seen in aspects like fumigation (69.52%), disinfection (69.84%), and use of minerals and vitamins in feed (53.33%). The spray schedule and poultry house requirements also have a relatively lower awareness level (53.33%).

Adoption of biosecurity practices

In this section, various biosecurity practices were tabulated, and adoption among farmers was explored. The adoption of biosecurity measures was estimated for the different types of farms, such as (i) open-sided farms, (ii) semi-environment-controlled farms, and (iii) environment-controlled farms. Questions were binary, and respondents were asked to respond yes or no. The information in this regard is presented in Table 3.

Table 3. Biosecurity practices for open-sided farms.

	Availability/Access		Application	
	Frequency	Percentage	Frequency	Percentage
Vaccination	214	99.07	214	99.07
Fumigation	130	60.19	130	60.19
Disinfection	130	60.19	130	60.19
Flushing	142	65.74	142	65.74
Medicine	131	60.64	131	60.64
Vitamins and Minerals	83	38.43	83	38.43
Spray	84	38.88	84	38.88

Table 3 shows that 99.07% of farms regularly followed the vaccination schedule of the birds. Fumigation and disinfection of the farms were practiced on 60.19% each. This percentage increases for flushing, which is 65.74% for open-sided farms. The number of medicine applications to the birds was 60.64% for the poultry birds, and vitamins and minerals were provided to the birds on 38.43% of farms. Spray was performed on 38.88 farms. The highest

percentage is for vaccination (99.07%), and the least is for providing vitamins and minerals (38.43%).

Table 4. Biosecurity practices for semi-environment controlled farms.

	Availability/Access		Application	
	Frequency	Percentage	Frequency	Percentage
Vaccination	21	87.50	21	87.50
Fumigation	14	58.33	14	58.33
Disinfection	15	62.50	15	62.50
Flushing	19	79.16	19	79.16
Medicine	16	66.67	16	66.67
Vitamins and Minerals	10	41.67	10	41.67
Spray	09	37.50	09	37.50

Table 4 illustrates mixed data regarding bio-security practices for semi-environment-controlled farms. It was also noted that 87.5% of farms had vaccination access to vaccination facilities, and the rest did not even vaccinate the birds for possible diseases. As with fumigation, 58.33% of farms have access to fumigation and apply it on the farms, but the rest of the farmers did not even fumigate. 62.5% of farms were regularly disinfected. The respondents told the researcher that they disinfect the farms only if there is some deadly disease in the area. Flushing was also practiced on 79.16% of farms. Medicine provision and vitamin availability to the birds were recorded for 66.67 41.67% of farms. Only 37.5% of semi-environment-controlled farms had proper spraying facility at the farms.

Table 5. Biosecurity practices for environment controlled farms.

	Availability/Access		Application	
	Frequency	Percentage	Frequency	Percentage
Vaccination	75	100	75	100
Fumigation	75	100	75	100
Disinfection	75	100	75	100
Flushing	75	100	75	100
Medicine	75	100	75	100
Vitamins and Minerals	75	100	75	100
Spray	75	100	75	100

As evident from Table 5, all the environment-controlled farms had the availability, access, and application facilities for biosecurity practices. These practices include vaccination, fumigation, disinfection, flushing, medicine provision, vitamins and minerals, and sprays. Also, such farms had sufficient staff to perform all these tasks.

DISCUSSION

Key findings of the study showed that most farmers were using open-sided poultry farms, whereas 23.81% were using environmentally controlled farms. At the same time, the primary purpose of poultry farms was broiler production. One of the primary benefits of environmentally controlled poultry farms is the management of air quality. Research has shown that the use of automated systems, such as UV light treatment and air filters, can effectively control harmful gases like ammonia and carbon dioxide, which are detrimental to poultry health. A study evaluated a prototype system designed to monitor and regulate these gases, demonstrating its potential to maintain optimal air quality, thereby promoting better health and productivity among poultry (Dagatan et al., 2023). Moreover, a study on the risk factors associated with Newcastle disease outbreaks in environmentally controlled farms highlighted the importance of biosecurity measures. Farms that implemented strict biosecurity protocols experienced lower incidences of disease, underscoring the role of controlled environments in mitigating disease risks (Maqsood et al., 2021). The economic implications of environmentally controlled poultry farms are significant. By optimizing conditions for poultry growth and health, these farms can enhance productivity and reduce costs associated with disease management and mortality. A study focusing on antimicrobial use reduction in broiler farms indicated that while reducing antibiotic use may initially increase production costs, the long-term benefits of healthier flocks and reduced disease incidence can outweigh these costs. This is particularly relevant as consumer demand shifts towards antibiotic-free poultry product (Azabo et al., 2022).

Results also indicated that the poultry farms managers using environmentally controlled poultry farms had

overwhelmed awareness and adoption of biosecurity measures. This indicates that they were having experience and being in connection with effective information sources. Low biosecurity measures and high risk of infectious diseases, such as Newcastle disease, exist in backyard poultry production in developing countries (Conan et al., 2012). The adoption of biosecurity measures within the framework of One Health offers a comprehensive strategy for enhancing the health, welfare, and productivity of commercial poultry (Jaramillo, 2023). A study conducted in Imo State, Nigeria, revealed that the majority of poultry farmers in the study area had a high level of biosecurity practice. Farmers who were members of farmers' groups were more likely to adopt biosecurity practices. Similarly, farmers who had received training in livestock management were more likely to implement biosecurity measures (Tasie et al., 2020). Another study in Bangladesh found that a history of immune-suppressive diseases, such as Newcastle disease, egg drop syndrome, or infectious bursal disease, was a significant risk factor for the occurrence of Clostridium perfringens in layer flocks. This highlights the importance of implementing effective biosecurity measures to prevent the introduction and spread of diseases in poultry farms (Arif et al., 2022).

Our study also indicated inadequate awareness about the biosecurity measures, especially among poultry farms based on open air and semi-controlled environments. We believe that awareness is the most significant aspect of keeping the flocks safe. To address these challenges, it is crucial to raise awareness among poultry farm owners and relevant authorities about the importance of biosecurity. Developing tailored communication materials on basic bird health, management, and biosecurity practices can help educate farmers and encourage the adoption of these measures (Laurent et al., 2012). Furthermore, regular extension visits by veterinary officers and other experts can provide valuable support and guidance to poultry farmers in implementing and maintaining effective biosecurity practices (Tasie et al., 2021). Strengthening the collaboration between farmers' associations and veterinary services can also contribute to the widespread adoption of biosecurity measures (Laurent et al., 2012).

CONCLUSION

This study concludes that awareness and adoption of biosecurity practices for poultry farms was high among those managing environmentally controlled poultry farms compared to those managing open-air and semi-environmentally controlled poultry farms. Awareness about the biosecurity measures and adoption of these measures is important in managing poultry diseases. This study finds an awareness and adoption gap among open-air poultry farm managers because more than half of the poultry farms in the study area were open-aired. Therefore, this study recommends an extensive awareness campaign for the awareness of poultry farmers. Seminars, workshops and capacity-building programs mutually organised by the veterinary extension services, academia and research organisations can be very effective. Veterinary extension services providers should also integrate Information Communication technologies in their advisory services to disseminate the latest information among the poultry keepers.

AUTHOR CONTRIBUTIONS

All authors contributed equally to this research.

COMPETING OF INTEREST

The authors declare no competing interests.

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