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Assessment of Biosecurity Measures in Poultry Farms in and around Warangal District of Telangana State

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Abstract

The intensification of poultry farming has heightened the risk of infectious disease outbreaks, making biosecurity a vital aspect of disease prevention. This study evaluates biosecurity practices in poultry farms across Warangal district, Telangana, using a structured scoring system based on key parameters such as hygiene, visitor restrictions, water and feed safety, and cleaning protocols. A survey of 100 farms revealed that 93% maintained good biosecurity standards, scoring between 24 and 32 out of a possible 42 points. Closed farms demonstrated superior biosecurity, with all implementing the "all-in, all-out" system, compared to 76.3% of open farms. Statistical analysis using correlation and regression methods showed a significant link between biosecurity scores and disease incidence, with higher-scoring farms experiencing fewer outbreaks. These findings highlight the critical role of robust biosecurity measures in disease prevention. Enhancing farm management, improving sanitation, and enforcing stricter access control can significantly reduce disease risks, ensuring healthier poultry and improved productivity.

Keywords: Biosecurity, Disease Prevention, Hygiene Practices, Mortality Rate

Introduction:

With the increasing population and shrinking land holdings, farming practices have become more intensive. This intensification raises the risk of disease outbreaks among animals and birds (Randolph et al., 2007). On a farm, infectious diseases can spread through contaminated surroundings, water, and feed. They can also be transmitted by visitors, vectors, stray animals, and birds. India has long struggled with significant losses while managing disease outbreaks in poultry (Panda et al., 2024)

India has faced 28 Avian Influenza outbreaks, leading to the culling of approximately 7.2 million birds and costing the government around US$ 3 million in farmer compensation (DAHD&F, 2015).

Biosecurity refers to a set of management practices and physical measures aimed at minimizing the risk of introducing, establishing and spreading animal diseases, infections, or infestations within, to, and from an animal population. These measures help prevent both direct transmission between animals and indirect transmission between farms. (Ellis-Iversen et al., 2011)

Implementing essential biosecurity practices is the most effective strategy to minimize the risk of infectious disease outbreaks and their subsequent spread these measures not only help in controlling disease transmission but also play a crucial role in maintaining food safety and safeguarding public health. In general, an effective biosecurity system is built upon three fundamental pillars: isolation, traffic control, and sanitation, all of which work together to prevent the introduction and dissemination of pathogens within poultry farms (Indrawan and Daryanto, 2020).

Isolation aims to minimize the introduction and spread of pathogens by using physical barriers such as fences to prevent contact between farmed poultry and external sources of infection. Traffic control involves regulating the movement of people, animals, and equipment to reduce the risk of disease transmission. Sanitation focuses on maintaining strict hygiene through regular cleaning and disinfection practices, ensuring a bio secure environment that minimizes the presence of pathogens. Together, these measures play a crucial role in protecting poultry from infectious diseases and supporting overall farm biosecurity (Tanquilut et al., 2020).

To minimize the risk of disease transmission, it is essential to implement precautionary measures such as quarantine and sourcing animals from verified farms. Additionally, practices like maintaining hygiene through hand washing and wearing boots (Amass et al., 2003), along with efficient transportation logistics and the “all-in-all-out” system, can help control the spread of infections. Research on poultry farms in Belgium found external biosecurity scored 64 out of 100, while internal biosecurity scored 73 out of 100 (Gelaude et al., 2014). Ohlson et al. (2010) identified a strong correlation between higher biosecurity levels and a lower prevalence of infections in farms.

The performance of a farm is closely linked to the implementation of effective biosecurity measures. According to the classification system established by the FAO (2004), poultry farms are divided into four categories. Farms in sectors 3 and 4 have lower biosecurity standards compared to those in sectors 1 and 2. As a result, poultry farms in sectors 3 and 4 are at a greater risk of contracting and spreading diseases, including Highly Pathogenic Avian Influenza (HPAI). Biosecurity measures are specifically designed to reduce the transmission of infectious diseases both within and between farms.

Poultry health management has become an increasingly important concern alongside biosecurity measures. Livestock and birds play a significant role in the transmission chain of zoonotic diseases. To ensure public health safety, food derived from livestock must be free from disease-causing agents (Sharma, 2010)

Considering these findings, the present study was carried out in the Warangal district of Telangana, which is a significant hub for the poultry industry. This region, now known as the Eastern Region of Telangana, is home to around 1,800 poultry farms. On average, approximately 2.24 lakh kilograms of chicken are sold daily, with sales increasing to 3.12 lakh kilograms on Sundays and festive occasions (Ali and Masood, 2016).

Materials and Methods:

Data Collection and Interpretation

A survey was conducted using a questionnaire to evaluate the implementation of biosecurity measures in around 100 poultry farms. The assessment of biosecurity at these farms was carried out using a straightforward biosecurity score checklist that evaluated factors such as wild bird protection, staff hygiene, visitor restrictions, water and feed sources, cleaning protocols and overall planning. This checklist, developed by Dr. Les Sims, (Martindah et al., 2014) was based on information from the FAO regarding biosecurity systems.

Fourteen risk assessment parameters were used, with a maximum possible score of 42. A higher score indicates a better level of biosecurity. Parameters 1 to 13 represent potential pathways for disease entry into farms and poultry sheds, while the 14th parameter provides an overall assessment of biosecurity measures. Each parameter was scored on a scale of 0 to 3, where 0 represents the lowest level of biosecurity, indicating minimal protective measures. The scoring definitions and criteria for each indicator are detailed in Table 1 which also includes example scores for selected farms. Scores of 1 and 2 reflect a moderate level of biosecurity, whereas a score of 3 signifies high biosecurity, meaning the measures were effectively implemented. The farms are categorized into three groups based on their biosecurity scores as shown in Table 2.

Table 1: Indicator and definition of biosecurity scores

S.No	Indicators	Score	Definition	Farm 1	Farm 2	Farm 3
1	Attractiveness to wild birds	3	Farm is located in non-migrated bird area. No trees or water pools within 100 m	3		
		2	Trees surrounding the farm but no pond		2	2
		1	Ponds nearby the farm within 50 m			
		0	Both trees and ponds located within 50 m			
2	Wild-bird protection	3	Chicken in cages, surrounded by nets as a protective enclosure		3	3
		2	The nets to protect the poultry sheds about 70%	2		
		1	The nets can protect 50% of the poultry sheds			
		0	The poultry shed is open and there is no net			
3	Measures related to staff in the farm	3	Farm worker lives in the farm at least for one production cycle			
		2	Farm worker lives outside the farms and use disinfectant, equipments (change of shoes, clothes etc) when entering the poultry sheds			
		1	There is some action upon entering the poultry shed, but very little impact on biosecurity. (eg just changing shoes)	1	1	1
		0	Farm workers work without any control when entering and out of the farm and does not			

			implement biosecurity standards			
4	Measures for incoming poultry	3	The farm keeps the same cycle and all the poultry comes from the same (all in, all out) company	3	3	3
		2	Measures are taken for the control of the incoming poultry			
		1	New entering poultry is separated only by using a partition			
		0	No measure is taken for new entering poultry			
5	Measures for visitors	3	Visitor cannot enter the farms or there is a fully developed disinfection system (taking a shower; changing clothes).			
		2	Taking some measures for the visitors, fencing around the farm. Footwear and disinfection are required at the entrance	2	2	2
		1	Measures taken but not so effective or under poor arrangement			
		0	Visitor can enter the poultry sheds directly			
6	Measures for traders	3	Traders are not allowed to enter the farm			
		2	Traders enter the farm without entering the poultry sheds		2	2
		1	Traders are allowed to enter the poultry sheds after getting disinfection	1		
		0	No measures for the traders at all			
7	Measures for equipments and vehicles	3	No vehicle entering the farm (transport for feed, day old chicks etc.)			
		2	Disinfect the vehicles upon entry into the farm	2	2	2
		1	Measures are taken but not so effective or under poor arrangement			
		0	No control to the vehicles/ vehicles are free entering the farms			
8	Source of water	3	Clean water from dug wells (underground)/artesian well	3	3	3
		2	Clean water from rain water and uncontaminated			
		1	Sources: surface water (river, pond) to be treated, e.g., chlorine			
		0	Sources: surface water without treatment			
9	Source of feed	3	Feed provided by the company (commercial feed)			3
		2	Formulation of feed mixed at the farm using machinery (mini feed mill)	2	2	
		1	Mixed feed formulation by the farmers			
		0	Mixed feed without special formulation			
10	Local environment: distance	3	The farm is far from a public road and other farms more than 300 m from road to the farm	3	3	
		2	Either other farm or public road are located within 100-<300 m			
		1	Either other farm or public road located within 50-100 m			1
		0	Both other farm and public road located within 50 m			
11	Different types of poultry in farm	3	Only one type of poultry in the farm	3	3	3
		2	A few types of poultry in the farm, kept in			

			separated housings			
		1	A few types of poultry in the farm, free range			
		0	Various types of poultry around the poultry sheds			
12	Capacity to clean and disinfect	3	Cleans and disinfects the whole area regularly (more than once a week) the farm	3	3	3
		2	Cleans and disinfects only several parts of the farm regularly			
		1	Cleans and disinfects, usually during outbreaks			
		0	No disinfection or cleaning at all			
13	Measures taken at the entrance	3	Fully developed system of disinfection (usually under the guidance of a poultry sheds company). e.g. taking a shower and changing clothes			
		2	Some measures of disinfection, including-pass a disinfectant tank before entering the shed, change boots or other footwear special for the sheds	2	2	2
		1	Measures taken but not so effective, for example only change the shoes			
		0	No disinfection or cleaning at all			
14	Biosecurity plans	3	Design a coherently suitable plan under sustainable biosecurity development			
		2	Farmers have separate plans e.g. updating equipments for a better biosecurity level, learn about biosecurity		2	2
		1	Just obey any guidance or regulation of the local area. No individual plan	1		
		0	No plan or guidance to follow			

Table 2: Categorization of farms

S. No	Category	Score
1	Very good	29-42
2	Good	15-28
3	Poor	1-14

Statistical Analysis

To strengthen the findings, statistical methods were employed:

- **Correlation Analysis:** Examined relationships between biosecurity scores and disease occurrence.

Regression Analysis: Identified key biosecurity factors affecting farm disease prevalence.

Results and Discussion:

Following Dr. Les Sims' 2011 (Martindah et al., 2014) biosecurity score chart, most farms (93) scored between 24 and 32, placing them in categories I and II as shown in Figure 1. Closed farms typically scored higher, with 100% using the "all-in, all-out" system. Closed farms are poultry farms that operate with strict biosecurity protocols. These farms follow the “all-in, all-out” system, which means all birds are brought in and removed as a single group. After each cycle, the entire farm is cleaned and disinfected before a new batch of birds is introduced. This approach reduces the risk of disease transmission. In contrast, open farms have less control over biosecurity. Only 76.3% of open farms followed the “all-in, all-out” method. These farms often allow continuous or staggered entry of birds, which increases the chances of disease spread. Biosecurity measures such as visitor restrictions and environmental controls are also less strictly enforced, making open farms more vulnerable to infections.

Correlation Findings

To explore the relationship between specific biosecurity measures and farm outcomes such as disease incidence, mortality rate and productivity, a correlation analysis was conducted. This statistical approach identifies the strength and direction of associations between variables. The results, presented in Table 3, highlight the degree to which different biosecurity practices — including hygiene, sanitation, and visitor control are linked to critical farm performance indicators.

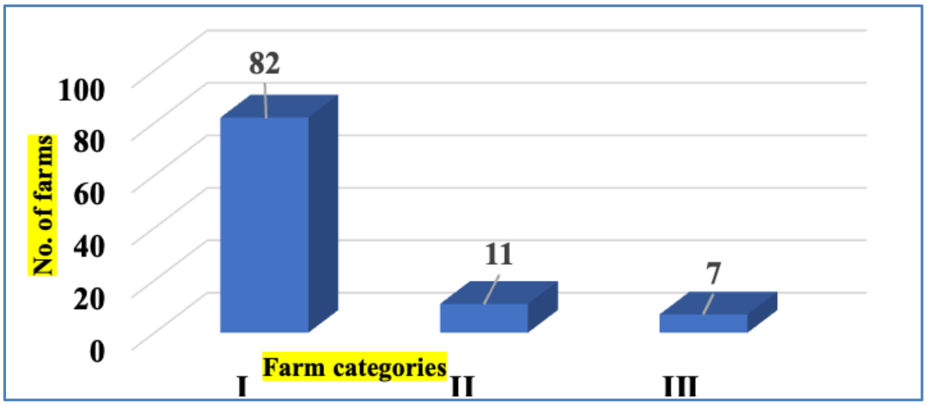

Figure 1: Results for Biosecurity measures

Table 3: Correlation between Biosecurity Parameters and Farm Outcomes

Parameter	Disease Incidence	Mortality Rate	Farm Productivity	Visitor Access Control	Sanitation Measures
Biosecurity Score	-0.78 (p < 0.01)	-0.65 (p < 0.01)	0.72 (p < 0.01)	-0.63 (p < 0.01)	0.52 (p < 0.05)
Hygiene Practices	-0.72 (p < 0.01)	-0.60 (p < 0.01)	0.68 (p < 0.01)	-0.50 (p < 0.05)	0.59 (p < 0.05)
Visitor Restrictions	-0.63 (p < 0.01)	-0.55 (p < 0.05)	0.62 (p < 0.01)	1.00	0.48 (p < 0.05)
Sanitation Practices	-0.70 (p < 0.01)	-0.58 (p < 0.05)	0.66 (p < 0.01)	0.48 (p < 0.05)	1.00

- A strong negative correlation (-0.78, $p < 0.01$) between biosecurity score and disease incidence suggests that farms with higher biosecurity measures report fewer disease outbreaks.
- Mortality rate is negatively correlated with hygiene practices (-0.72, $p < 0.01$), indicating that better hygiene leads to lower bird mortality.
- Farm productivity has a strong positive correlation with overall biosecurity score (0.72, $p < 0.01$), emphasizing that strict biosecurity enhances farm efficiency.
- Visitor restrictions negatively correlate with disease incidence (-0.63, $p < 0.01$), reinforcing the importance of limiting external farm access.
- Sanitation measures show a moderate positive correlation with biosecurity score (0.52, $p < 0.05$), highlighting their role in disease control.

Economic Impact of Biosecurity Measures

- Farms with high biosecurity scores reported 25–30% lower mortality rates and increased profit margins due to reduced disease-related losses.
- Investment in proper sanitation, vaccination, and access control resulted in long-term cost savings.

Regression Findings:

Table 4 summarizes the regression coefficients and their statistical significance, providing insights into which practices most strongly influence disease reduction on poultry farms.

- Negative coefficients indicate that higher biosecurity measures correlate with lower disease incidence.
- Statistically significant p-values (< 0.01 and < 0.05) confirm strong associations.
- Higher biosecurity and hygiene scores lead to reduced mortality rates and improved productivity.

***Regression Analysis Results*:**

- Dependent Variable: Disease Incidence
- Independent Variable: Total Biosecurity Score
- R-squared: 0.525 (52.5% of the variation in disease incidence is explained by biosecurity scores)
- Regression Coefficient (β): -0.8797 (A higher biosecurity score is associated with lower disease incidence)
- P-value: 0.002 (Statistically significant, meaning biosecurity measures significantly impact disease incidence)
- Intercept: 25.89 (Baseline disease incidence when biosecurity measures are minimal)

Table 4: Regression Analysis of Biosecurity Parameters and Their Impact on Disease Incidence

Biosecurity Score	-0.78	< 0.01	Significant
Hygiene Practices	-0.72	< 0.01	Significant
Visitor Restrictions	-0.63	< 0.01	Significant
Sanitation Measures	-0.70	< 0.01	Significant
Economic Impact	+0.52	< 0.05	Moderate

The findings of the present study underscore the significant role of biosecurity in reducing disease incidence and improving productivity in poultry farms, particularly through practices such as the "all-in, all-out" system, sanitation and visitor control.

According to the FAO (2004) classification, farms in sectors 3 and 4 characterized by poor infrastructure and low compliance with biosecurity are more vulnerable to disease outbreaks. This directly reflects the situation observed in the open farms in our study, which had lower biosecurity scores and higher disease incidence compared to closed farms.

Amass et al. (2003) highlighted the effectiveness of strict hygiene protocols like hand washing and boot usage in preventing disease transmission. Similarly, our correlation analysis found that hygiene practices had a strong negative relationship with mortality rates, reaffirming the critical role of sanitation in poultry health.

Randolph et al. (2007) emphasized that intensification of livestock production increases disease risk. Our study, conducted on poultry farms, supports this conclusion that the farms with inadequate biosecurity in densely populated poultry zones reported higher disease prevalence.

Sharma (2010) stressed that poor biosecurity compromises food safety and public health. The current study strengthens this perspective by demonstrating that disease control through biosecurity not only protects birds but also reduces zoonotic risks. Ohlson et al. (2010) identified strong correlations between biosecurity and infection rates in livestock. In parallel, our regression analysis revealed a significant negative correlation (β = -0.8797, $p < 0.01$) between total biosecurity score and disease incidence.

Ellis-Iversen et al. (2011) and Conan et al. *(*2012) discussed how logistical and financial limitations hinder biosecurity implementation in developing countries. Our findings echo these constraints, particularly among smaller farms lacking the infrastructure or training to enforce consistent measures.

Ali and Masood (2016) investigated operational challenges in Warangal's poultry industry and noted infrastructural inefficiencies. Our study builds on this by quantitatively evaluating how those challenges impact biosecurity outcomes, particularly in open farms. Indrawan and Daryanto (2020) emphasized that biosecurity contributes to both farm-level and consumer-level safety. The present study confirms this by showing that enhanced farm hygiene and access control led to decreased mortality and increased profitability benefiting both producers and consumers.

Tanquilut et al. (2020) described the three pillars of biosecurity: isolation, traffic control, and sanitation. Our study not only adopts this framework but also statistically validates it by showing each pillar's measurable effect on disease outcomes. Islam et al. (2023) assessed farms in Bangladesh and found gaps in visitor control and training. Likewise, our findings show that opens farms in Warangal without visitor restrictions had significantly higher disease rates.

Jimenez et al. (2023) conducted a One Health review showing that combining WASH practices with biosecurity dramatically reduces infection burden and antimicrobial resistance. Our study supports this by highlighting a strong negative correlation between sanitation scores and disease incidence. Kumar (2023) reported that poor water quality and irregular sanitation were key risk factors in Indian farms. These same factors were prominent among lower-scoring farms in our sample, underscoring the generalizability of these findings across Indian contexts.

Panda et al. (2024) revealed that farms managed by trained personnel implemented biosecurity measures more effectively. This observation parallels our finding that closed farms, typically better managed, consistently outperformed open farms in biosecurity compliance and disease control. Shukla et al. (2024) and Mahadevan et al. (2024) found that PPE use and formal training are lacking in small and medium poultry farms. Similarly, many open farms in our study lacked structured protocols, staff training and consistent implementation factors directly linked to higher disease prevalence.

Conclusions:

The study underscores the critical role of biosecurity in preventing the spread of infectious diseases in poultry farms. While many farms adhere to basic biosecurity measures, there remains significant room for improvement, particularly in open farms. Implementing stricter hygiene protocols, ensuring proper farm access control, and enhancing farm management practices can substantially reduce disease risks. The adoption of standardized biosecurity frameworks, along with awareness programs for farmers, will be instrumental in improving disease prevention strategies. Strengthening these measures will not only safeguard poultry health but also contribute to the overall sustainability of the poultry industry.

Conflict of Interest:

The authors declare that there is no conflict of interest relevant to this study.

Data Availability:

The questionnaire used in the study is attached as supplementary file.

Ethical Statement:

This study did not involve any experimental procedures on animals or humans. Therefore, ethical approval was not required.

Author's Contribution:

Navya Sri Bairi: Conceptualization, Data collection, Analysis, Writing the original draft. Srinu Beesam: Supervision, Methodology, Review and editing.

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