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Implementation of Biosecurity Practices in Small Scale Layer Farms: Evidence from East Kalimantan, Indonesia

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Abstract. *Biosecurity is a key concept in maintaining livestock health, directly influencing productivity by minimizing the risks of infectious and non-infectious diseases. This study aimed to assess the implementation level of the three biosecurity components conceptual, structural, and operational on layer chicken farms and their surrounding environment in Sangatta, East Kutai Regency. The research was conducted from December 2022 to February 2023 using purposive sampling, with criteria including a minimum population of 1,000 chickens, at least two years of operation, a basic understanding of biosecurity, and being in the productive phase. Data were collected through interviews and questionnaires based on a Likert scale to evaluate farmers' responses. A total of 10 farmers participated in this study. The results showed that the overall implementation of biosecurity reached 49.6%, categorized as moderate. Meanwhile, 27.6% of respondents demonstrated a low level of understanding of biosecurity, which was higher than those with good understanding (22.6%). These findings indicate that biosecurity practices among layer chicken farmers in Sangatta are moderately applied, but awareness and comprehension still need to be improved.*

Keywords: *Biosecurity, Laying hens, Sangatta*

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INTRODUCTION

Chickens are one of the most familiar and widely consumed types of poultry because their meat and eggs are easily available and affordable. Among them, layer chickens are the primary commodity that supplies eggs for public consumption. The growing demand for eggs reflects the increasing consumption needs of society. According to data from Statistics Indonesia (BPS), the population of layer chickens in East Kalimantan increased from 1,803,740 in 2020 to 1,949,733 in 2021, representing an 8.09% increase [1]. This trend indicates the rising demand for eggs and the growing importance of the poultry sector in supporting the local economy.

Layer chickens exhibit relatively fast growth and begin producing eggs at 4.5 to 5 months of age, making them an essential livestock commodity that contributes significantly to economic turnover. Generally, the highest egg quality is achieved during the initial laying phase, while productivity and egg quality tend to decline as hens age [2]. One of the most critical aspects of layer chicken management is disease control, as diseases can severely affect productivity. Poultry diseases may result from various factors, including viral and bacterial infections, nutritional deficiencies, toxins, or mechanical injuries [3]. Therefore, effective management and strict implementation of biosecurity measures are essential to maintain flock health and farm productivity.

Biosecurity refers to a set of preventive measures designed to protect livestock health by minimizing the risks of infectious and non-infectious diseases. However, biosecurity implementation in Indonesia remains suboptimal. Studies have shown that the level of biosecurity application in Sumberjambe District, Jember Regency, is below 60% [4], while only 50% of poultry farms in South Sulawesi have adopted biosecurity practices [5]. Although several studies have examined biosecurity practices in various regions of Indonesia, limited information is available on the level of biosecurity implementation among layer chicken farmers in East Kalimantan, particularly in East Kutai Regency. Understanding how farmers apply conceptual, structural, and operational biosecurity measures in this region is crucial for identifying weaknesses in disease prevention and improving poultry health management. Therefore, this study aims to evaluate the level of biosecurity implementation in layer chicken farms in Sangatta, East Kutai Regency, East Kalimantan.

Therefore, this study aims to evaluate the level of implementation of the three main aspects of biosecurity conceptual, structural, and operational on layer chicken farms in Sangatta, East Kutai Regency, East Kalimantan. The findings of this study are expected to provide an overview of the current condition of biosecurity implementation at the farmer level and serve as a foundation for developing strategies to enhance awareness and improve the effectiveness of biosecurity practices in supporting poultry health and farm productivity in the region.

LITERATURE REVIEW

Biosecurity in Poultry Production

Biosecurity is defined as a systematic set of preventive measures aimed at limiting the introduction, establishment, and spread of infectious agents within livestock populations. In poultry production, biosecurity is a cornerstone of flock health management due to the sector's high vulnerability to viral, bacterial, fungal, and parasitic diseases. The literature consistently emphasizes that disease outbreaks in poultry—such as Newcastle disease, avian influenza, infectious bronchitis, and coccidiosis—lead to significant economic losses through reduced productivity, increased mortality, higher medication costs, and decreased feed efficiency (Delpont et al. 2023). Effective biosecurity is thus not only a health intervention but also an economic strategy, ensuring the stability of production outputs and reducing financial risks associated with disease events. In layer farms, the importance of biosecurity is intensified because hens remain in production for extended periods, exposing them to cumulative health threats. Studies show that farms implementing strong biosecurity protocols maintain more stable egg production curves, experience fewer disruptions between production cycles, and achieve better flock uniformity.

Biosecurity Components: Conceptual, Structural, and Operational

The biosecurity framework is commonly divided into conceptual, structural, and operational components, each addressing different dimensions of disease prevention. Conceptual biosecurity focuses on decisions made during the early planning stage, including farm location, separation from other poultry units, orientation relative to prevailing winds, and the use of natural barriers to reduce the flow of pathogens (Huber et al. 2022). Structural biosecurity refers to the physical infrastructure that supports sanitary management, such as durable housing systems, controlled entry points, washable surfaces, drainage systems, insect-proof netting, and barrier fencing. Operational biosecurity encompasses the routine practices carried out by workers and visitors, including cleaning and disinfection protocols, traffic control, personal hygiene, equipment sanitation, manure handling, and pest management. Literature emphasizes that these three elements must operate synergistically, as a weakness in one dimension undermines the effectiveness of the others. However, studies in low- and middle-income countries indicate that farmers often prioritize structural aspects while neglecting conceptual and operational ones, resulting in inconsistent disease prevention. This imbalance reflects practical constraints, limited knowledge, and the absence of long-term planning in small-scale poultry systems.

Biosecurity Implementation in Indonesia

In Indonesia, the adoption of biosecurity shows considerable variation across regions and production scales. While large commercial farms generally follow standardized biosecurity protocols aligned with international guidelines, small- and medium-scale producers demonstrate lower compliance due to limited financial capacities and insufficient technical support (Kambey et al. 2020). Studies from East Java, Central Java, South Sulawesi, and Bali indicate that overall biosecurity compliance frequently falls below 60%, with significant gaps in visitor control, sanitation routines, and quarantine practices for newly acquired birds. Additional research highlights persistent challenges, including inadequate record-keeping, unrestricted movement between poultry units, and poor waste management. Even though government regulations—such as the Indonesian Veterinary Health System (Siskeswanak)—promote biosecurity as a national disease-prevention priority, implementation often depends on the availability of trained extension officers and veterinarians. The uneven distribution of extension services, limited farmer training programs, and insufficient monitoring contribute to weak enforcement. Consequently, disease prevention remains highly reliant on farmers' personal initiative, experience, and financial ability, creating substantial variability in farm-level biosecurity outcomes.

Challenges of Biosecurity in Small-Scale Layer Farms

Small-scale layer farms face unique constraints that hinder the implementation of consistent biosecurity measures. These farms typically operate with limited budgets, traditional management systems, and simple housing structures that lack adequate ventilation control, drainage, or physical barriers. Open-access farm layouts allow uncontrolled entry of humans, rodents, stray animals, and wild birds—recognized reservoirs or mechanical vectors of pathogens. Furthermore, the high cost of disinfectants, protective equipment, and infrastructure upgrades discourages farmers from adopting stricter protocols (Kiambi et al. 2021). Economic pressures, such as fluctuating feed prices and tight profit margins, often lead farmers to prioritize short-term production needs over long-term investment in disease prevention. Studies also indicate that a lack of formal education and a limited understanding of disease transmission pathways reduce farmers' ability to evaluate risks and implement effective responses. As a result, small-scale farms often experience higher disease incidence, recurrent outbreaks, and inconsistent production performance, making them particularly vulnerable to emerging infectious diseases.

Biosecurity in Layer Chicken Production Systems

Layer production systems require rigorous biosecurity because hens experience prolonged exposure to pathogens throughout their laying period, which typically spans more than one year. The prolonged production cycle underscores the importance of preventive strategies to mitigate cumulative health impacts. Conceptual measures—such as locating farms away from wetlands, water bodies, or dense clusters of poultry operations—significantly reduce the likelihood of airborne or waterborne disease transmission (Scott et al. 2018). Structural measures, including closed housing systems, rodent-proof storage areas, sanitation-friendly building materials, and clearly separated clean and dirty zones, are essential for maintaining flock health. Operational practices remain the most critical element in daily disease control, particularly in tasks such as disinfecting egg trays, supporting clean water lines, controlling insects, and isolating sick birds. In tropical regions like East Kalimantan, warm temperatures and high humidity accelerate pathogen growth, increasing the prevalence of vectors such as flies, mosquitoes, and beetles. Therefore, literature identifies environmental management—such as waste control, drying areas, and vector reduction—as a central aspect of biosecurity in tropical layer systems.

Factors Influencing Farmer Compliance with Biosecurity

Multiple psychological, socio-economic, and institutional factors shape farmer compliance with biosecurity practices. Knowledge and awareness play fundamental roles; farmers who understand disease risks and prevention mechanisms tend to adopt more consistent practices. Education level is often associated with better record-keeping, greater openness to innovation, and stronger adherence to veterinary recommendations (Mankad, 2016). Age and experience also influence compliance—older farmers may rely on traditional practices, while younger farmers are more inclined to adopt new technologies such as automated drinkers or chemical disinfectants. Economic conditions, particularly cash flow and access to credit, determine a farmer's ability to invest in infrastructure or routine sanitation materials. Institutional support from extension officers, local government livestock agencies, and farmer cooperatives enhances compliance by providing training, monitoring, and social encouragement for good practices. Studies further highlight that farmers with strong social networks or membership in farmer groups achieve higher compliance due to shared learning, peer support, and collective problem-solving. Without external guidance, biosecurity compliance tends to decline over time, underscoring the importance of continuous extension and policy support.

RESEARCH METHODS

Time and Place of Research

The study was conducted in Sangatta, East Kutai Regency, East Kalimantan Province, from November 2022 to February 2023.

Materials and tools

The research used a quantitative descriptive approach through structured questionnaires distributed to selected respondents. Supporting tools included writing instruments and a camera for documentation.

Method

The selection of respondents was conducted using a purposive sampling technique, which involves selecting participants based on specific predetermined criteria [6]. The criteria applied in this study were as follows:

1. Farm size: Layer chicken farmers with a minimum flock size of 1,000 birds, as determined from an initial field survey indicating that most farms in Sangatta operate with populations ranging from 1,000 to 6,000 birds.

2. Duration of operation: Farmers who have been engaged in layer chicken production for at least two years, ensuring that the farms possess adequate facilities and infrastructure to support biosecurity implementation.
3. Knowledge requirement: Farmers who have a basic understanding of biosecurity practices in poultry farming.
4. Production phase: Farms managing layer chickens in their productive period, as biosecurity measures are most relevant and consistently applied during this stage.

The number of samples (respondents) was determined using the Slovin formula [7], expressed as:

$$n = \frac{N}{1+N(e^2)}$$

where:

- n = sample size
- N = total population
- e = margin of error (10%)
- 1 = constant

Data Collection and Analysis

Data were collected through face-to-face interviews and questionnaires using a Likert scale (Good = 3, Fair =2, Poor = 1). Descriptive quantitative analysis was applied to calculate the mean percentage index (MPI) using the formula:

$$MPI(\%) = \frac{\sum(Score \times Frequency)}{n \times MaxScore} \times 100$$

Interpretation was categorized as:

- Good (≥ 66%)
- Fair (33–65%)
- Poor (≤ 32%)

RESULTS AND DISCUSSION

Respondent Characteristics

Respondents were selected based on criteria including age, gender, education, ownership status, flock size, and farming experience (Table 1). All farms had been operating for at least two years with a minimum of 1,000 chickens. 70% of farms are privately owned, while the rest are affiliated with cooperatives or farmer groups.

Respondents' ages ranged from 28 to 75 years, with an average of 2 years of farming experience. Educational levels included elementary (10%), high school (60%), and college graduates (30%). Most farms manage fewer than 6,000 birds, and 80% operate as small-scale independent businesses under the Sangatta Laying Hen Farmers Association.

Table 1. Respondent Characteristics.

No	Respondent	Age	Gender	Education	No. of livestock	Long time farming (year)	Ownership status
1	Breeder A	28	M	Bachelor	6000	2	Private
2	Breeder B	42	M	High School	5.500	7	Cooperative
3	Breeder C	39	M	High School	1000	4	Group
4	Breeder D	48	M	Elementary	1000	2	Private
5	Breeder E	75	M	High School	1.200	2	Private
6	Breeder F	62	M	High School	1000	2.1	Group
7	Breeder G	52	M	High School	4000	2	Private
8	Breeder H	57	M	High School	1500	2.5	Private
9	Breeder I	38	F	Master's	1000	3	Private
10	Breeder J	59	M	Diploma	2000	2	Private

Source: Primary data 2023

Implementation of Conceptual Biosecurity

Conceptual biosecurity is the foundational level of biosecurity, covering key preventive measures such as farm site selection, age-based separation of poultry, control of stocking density, minimizing contact with wild birds, and designated areas for feed storage or mixing. Study results for conceptual biosecurity are summarized in Table 2.

Table 2. Conceptual Application of Biosecurity

No	Parameter	Good	Fair	Poor
		%	%	%
1	Farm distance 500 m to 1 km	70	10	20
2	Appropriate site selection (climate, soil, water)	20	80	0
3	Accessibility to facilities (feed factory, hatchery)	10	60	30
4	Distance from lakes or migratory bird routes	10	70	20
5	isolation system	10	40	50
	Average	24	52	24

Source primary data: 2023
Note:1. N = Number of respondents answering

Based on data collected from respondents, the implementation of conceptual biosecurity was classified as Fair, with an average of 52%, while the proportions for the Good and Poor categories were both 24%. This indicates that laying hen farmers have a moderate level of awareness regarding the importance of applying conceptual biosecurity in their farms. The relatively high implementation of conceptual biosecurity provides a solid foundation for other disease prevention programs aimed at minimizing the entry of pathogens into the farm [9].

Implementation of Structural Biosecurity

Structural biosecurity represents the second level of biosecurity and encompasses aspects such as farm layout, proper fencing, drainage systems, decontamination procedures, feed storage facilities, changing rooms, and cage equipment. The results of the study on structural biosecurity parameters are presented in Table 3.

Table 3. Implementation of Structural Biosecurity

No	Parameter	Good	Fair	Poor
		%	%	%
1	Farm area fencing	20	10	70
2	Controlled cage access	0	20	80
3	Adequate facilities (warehouse, changing room)	10	70	20
4	Safe water supply and treatment	30	70	0
5	Reliable electricity and access for vehicles	20	70	10
6	Disposal area for carcasses	50	40	10
7	Separation of feed and litter storage	10	70	20
	Average	20	50	30

Source: primary data, 2023
Note:1. N = Number of respondents answering

Based on the data collected, the implementation of structural biosecurity was moderately high, with 50% of respondents falling into the “Fair” category, 20% in the “Good” category, and 30% in the “Poor” category. These results indicate that farmers possess a reasonable understanding of structural biosecurity. Effective implementation of structural biosecurity can help minimize the risk of livestock contamination by disease carriers [9].

Implementation of Operational Biosecurity

Operational biosecurity represents the third level of biosecurity and involves management practices aimed at preventing the occurrence and spread of infections within a farm. It primarily encompasses three aspects: (a) traffic control, (b) in-farm management procedures, and (c) disinfection [10]. The results of the study on operational biosecurity parameters are presented in Table 4.

Table 4. Implementation of Operational Biosecurity

No	Parameter	Good	Fair	Poor
		%	%	%
1	Zone isolation and traffic control	0	40	60
2	Screening of goods/personnel	10	80	10
3	Cleaning after culling	100	0	0
4	Regular cleaning of feeders/drinkers	50	50	0
5	Disinfecting egg trays	20	70	10
6	Proper litter and carcass handling	10	90	0
7	Vehicle disinfection	0	10	90
8	Insect control	20	50	30
9	Rodent control	10	60	30
10	Water quality testing	20	20	60
	Average	24	47	29

Source: primary data, 2023
Note:1. N = Number of respondents answering

Based on the data collected, the implementation of operational biosecurity among respondents was categorized as Fair (47%), with 24% in the Good category and 29% in the Poor category. These results indicate that while respondents are aware of operational biosecurity measures in laying hen farms, overall implementation remains limited. Low compliance is attributed to a lack of knowledge or awareness regarding key practices such as isolation, sanitation, and traffic control. Additionally, some respondents recognize the importance of operational biosecurity but face financial constraints, particularly regarding feed costs, which are often unstable and a primary concern for farmers.

Recapitulation of Biosecurity Implementation

Biosecurity is implemented to prevent the introduction and spread of pathogens within livestock farms. It encompasses three main components: conceptual biosecurity, structural biosecurity, and operational biosecurity. A summary of the biosecurity implementation is presented in Table 5.

Table 5. Summary of Biosecurity Implementation

Biosecurity Component	Good (%)	Fair (%)	Poor (%)	Mean Index (%)	Category
Conceptual	24	52	24	52.0	Fair
Structural	20	50	30	50.0	Fair
Operational	24	47	29	47.0	Fair
Overall Average	22.6	49.6	27.6	49.6	Fair

Source: primary data, 2023
Note:1. N = Number of respondents answering

Based on the recapitulation of biosecurity implementation, the average percentage among laying hen farmers in Sangatta, East Kutai Regency, was 49.6% in the Fair category, 27.6% in the Poor category, and 22.6% in the Good category. These results indicate that overall implementation of health biosecurity and disease control is relatively low. Low compliance is primarily due to some respondents lacking knowledge about biosecurity practices on their farms, particularly regarding the three biosecurity zones and routine testing of drinking water quality.

In contrast, most farmers are aware of the importance of conceptual and structural biosecurity, especially the basic principles. While some farmers have not fully applied biosecurity measures, others in Sangatta have successfully implemented them and may serve as models for peers.

Furthermore, educational level contributes to human capital by enhancing skills and knowledge, while age influences wisdom, conservatism, and the adoption of new technologies and general farm management practices, such as feed management, breeding, and disease prevention [11]. These factors collectively affect the development and management of laying hen operations, shaping farmers' behaviors, decisions, and responsiveness to innovations.

CONCLUSION

The study found that the implementation level of the three biosecurity components conceptual, structural, and operational on layer chicken farms in Sangatta District, East Kutai Regency, was categorized as moderate, with an average score of 49.6%. About 27.6% of farmers had a low understanding of biosecurity, compared to 22.6% with good understanding. These findings indicate that overall awareness and consistency in biosecurity implementation remain limited. To enhance biosecurity implementation, farmers should strengthen their understanding of the three biosecurity zones and regularly monitor water quality. Continuous training through collaboration between Field Extension Officers, the agricultural agency, and the Sangatta Layer Chicken Farmers Association is essential. A targeted and practical extension strategy can serve as an effective policy approach to improve disease prevention and poultry health management in the region.

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