Comparative Analysis of Production Performance and Economic Efficiency between Open and Closed House Broiler Systems under a Partnership Model in Malang Regency, Indonesia

Nanang Febrianto[1], Nabila Nur Hidayati[1] Muhammad Helmi[1], Puji Akhiroh[1], Priyo Sugeng Winarto[1], Budi Hartono[1*]

[1]Department of Socio-Economic, Faculty of Animal Science, Universitas Brawijaya, Malang 65145 Indonesia

Abstract. This study aims to compare the production performance and production costs of broiler farms using open house and closed house systems under a partnership model in Malang Regency, East Java. Data were collected through a case study approach using farm records, financial reports, direct interviews with farm managers, and field observations. Key performance indicators evaluated included Feed Conversion Ratio (FCR), Body Weight (BW), depletion rate, and Production Index (IP). Economic analysis was conducted based on total fixed and variable costs. The results showed that the closed house system demonstrated superior production performance compared to the open house system. The closed house achieved a lower FCR of 1.51 compared to 1.62 in the open house, and a higher final BW of 2.10 kg versus 2.06 kg. The depletion rate was lower in the closed house (3.1%) than in the open house (3.6%), while the Production Index reached 421.13, exceeding the open house IP of 350.24. Cost analysis indicated that variable costs dominated total costs (>97%) in both systems, with feed representing 73.5–74.3% and DOC 18.6–19.9% of total cost. In nominal terms, total production costs increased with enterprise scale and were higher in closed-house than open-house systems: small (IDR 638.9 million vs. 206.9 million), medium (IDR 1.596 billion vs. 397.4 million), and large (IDR 2.243 billion vs. 1.014 billion). In conclusion, closed-house technology provides clear technical and economic advantages for partnership-based broiler production in tropical settings
Keywords: broiler, partnership, production cost, production performance.

1 Introduction

Broiler production plays a crucial role in supplying affordable animal protein and supporting rural livelihoods in many tropical countries, including Indonesia. However, broiler farming in tropical environments is inherently vulnerable to climatic stress, particularly high ambient

* Corresponding author: budihartono_ub@ub.ac.id

temperature and humidity, which can negatively affect feed efficiency, growth performance, and survival rates [1] [2]. These environmental challenges place significant pressure on production systems to maintain biological performance while controlling production costs, especially under commercial-scale operations.

Housing system is one of the most decisive factors influencing broiler performance and production efficiency. Conventional open-house systems remain widely used due to their relatively low investment cost and operational simplicity. Nevertheless, limited control over temperature, humidity, and air circulation in open housing systems often results in fluctuating microclimate conditions, which may compromise feed utilization, increase mortality, and reduce overall production consistency. These limitations become more pronounced as farm scale and population density increase, making it difficult for open-house systems to sustain high performance under intensive production conditions.

In response to these constraints, closed-house systems have been increasingly adopted in commercial broiler production. Closed housing enables controlled ventilation, regulated temperature, and improved air quality, creating a more stable microclimate throughout the production cycle. Such environmental control is particularly important in tropical regions, where heat stress is a major factor affecting broiler productivity. By reducing environmental fluctuations, closed-house systems allow broilers to allocate more energy toward growth rather than physiological adaptation, thereby improving feed conversion, body weight, and overall production index [3].

Economic considerations are equally critical in evaluating broiler production systems. Feed and day-old chick costs dominate the production cost structure, meaning that even small improvements in feed conversion ratio or reductions in mortality can substantially affect total production costs and farm profitability [4][5]. Although closed-house systems require higher initial capital investment and incur greater depreciation costs, these expenditures may be offset by improved technical efficiency, reduced production losses, and better utilization of production scale. In contrast, open-house systems often face higher effective costs per unit of output due to lower biological efficiency and limited economies of scale [6].

Within partnership-based broiler production models, technical performance indicators directly influence economic outcomes through incentive mechanisms and cost-sharing arrangements. Despite the growing adoption of closed-house technology, empirical evidence comparing production performance, population scale, and cost structure between open-house and closed-house systems under similar partnership conditions remains limited, particularly in tropical developing countries [7][8]. Therefore, a systematic comparison of these two housing systems is essential to clarify their relative technical and economic advantages. This study addresses this need by evaluating broiler farms operating under partnership schemes in Malang Regency, Indonesia, with the aim of providing practical insights for improving efficiency and sustainability in tropical broiler production systems..

2 Materials and methods

2.1 Study area and research design

The study was conducted in closed-house broiler farms operating under a partnership scheme in Malang Regency, Indonesia. A quantitative descriptive design with a case-study approach was employed to examine the relationship between technical performance indicators and financial outcomes within one production cycle for each observed unit. This approach is consistent with prevailing practices and the methodological references cited in the manuscript.

2.2 Sampling procedure and eligibility criteria

Observational units were selected using purposive sampling to represent variability in business scale and operational patterns across the study area. The inclusion criteria were: (i) at least one broiler house actively operating during the observation period; (ii) availability of complete technical and financial records for a single production cycle; and (iii) a minimum of one active house per unit.

2.3 Technical performance measurement

Technical performance was evaluated using four key indicators: depletion/mortality rate (%), Feed Conversion Ratio (FCR), average market weight (kg/bird), and Performance Index (PI). All indicators were calculated using standardized procedures to ensure consistency and comparability across units.

2.3.1 Depletion Rate

The depletion rate represents the reduction in broiler population during a single production cycle, encompassing both mortality and culling events. This indicator reflects the level of biological loss occurring throughout the rearing period and is commonly expressed as a percentage of the initial population. The depletion rate was calculated using the following formula:

$$\text{Depletion (\%)} = \frac{\text{Number of dead birds} + \text{Number of culled birds}}{\text{Initial population}} \times 100$$

2.3.2 Feed Conversion Ratio (FCR)

Feed Conversion Ratio (FCR) is a key efficiency indicator that measures the relationship between the total feed intake and the live body weight produced by broilers during the production cycle. A lower FCR indicates more efficient feed utilization. FCR was calculated as follows:

$$\text{FCR} = \frac{\text{Total feed consumed (kg)}}{\text{Total live body weight produced (kg)}}$$

2.3.3 Performance Index (PI)

The Performance Index (PI) is a composite indicator used to evaluate the overall success of broiler production within a single rearing period by integrating survivability, growth performance, feed efficiency, and production duration. A higher PI value reflects superior technical performance. The PI was calculated using the following equation:

$$\text{PI} = \frac{(100 - \text{depletion (\%)}) \times \text{ABW (kg)}}{\text{FCR} \times \text{Average slaughter age (days)}}$$

2.4 Cost and revenue analysis

Production costs and revenues were estimated using standard cost-accounting equations. Total production cost (TC) was calculated as the sum of total variable costs (TVC) and total fixed costs (TFC):

$$\text{TC} = \text{TVC} + \text{TFC}$$

Production costs and revenues were estimated using the following equations:
TC = Total Cost (IDR)
TVC = Total Variable Cost (IDR)
TFC = Total Fixed Cost (IDR)

2.5 Data sources and collection procedure

Primary data were obtained through structured interviews with house managers and direct field observations, including feeding and watering management, ventilation and microclimate conditions, and liveweight measurements. These data were complemented by secondary farm records, such as daily feed and mortality logs, harvest summaries, contract pricing information, cost vouchers, and partnership documents used to derive the cost structure and incentive mechanisms.

The data collection process involved mapping and verifying eligible units based on the predefined inclusion criteria, compiling technical and financial indicators for the same production period, and cross-checking farm records against vouchers and harvest recaps to ensure consistency in units, dates, and recorded volumes.

2.6 Data processing and analytical approach

Data processing began with summarizing the technical performance of each unit for the single observation cycle, including FCR, depletion/mortality, market weight, and PI. The central role of FCR as a core efficiency indicator in broiler production is supported by evidence showing that improved biosecurity can reduce infection pressure, enhance feed intake and body weight gain, and ultimately improve overall performance indices (5).

3 Result and Discussion

3.1 Population scale and housing capacity

Table 1. Population of broilers in open and closed house systems

Housing System	Enterprise Scale	Population (birds)
Closed House	Small	17.792
	Medium	44.429
	Large	65.000
Open House	Small	5.907
	Medium	11.500
	Large	28.000

Source: data research, 2025

Table 1 highlights pronounced differences in broiler population capacity between closed-house and open-house systems across all enterprise scales. Closed-house farms accommodated substantially larger flocks, ranging from 17,792 birds at the small scale to

44,429 birds at the medium scale and reaching 65,000 birds at the large scale. In contrast, open-house systems operated at markedly lower capacities, with populations of 5,907, 11,500, and 28,000 birds at the small, medium, and large scales, respectively. These findings indicate that closed-house adoption structurally enables greater scale expansion, primarily through improved space utilization, environmental control, and flock management efficiency.

The observed differences in population scale are directly associated with production performance outcomes. Despite operating at higher stocking levels, closed-house systems consistently exhibited lower Feed Conversion Ratios (FCR), more controlled depletion rates, and higher Performance Index (PI) values than open-house systems. This suggests that increased population density in closed-house operations does not compromise biological performance but is instead associated with enhanced production efficiency. This pattern aligns who demonstrated that closed-house systems under partnership schemes maintain microclimate stability, allowing higher stocking capacities to be supported by effective feed and health management [7].

Conversely, population constraints in open-house systems limit the realization of economies of scale. Smaller flock sizes result in fixed and labor costs being distributed over lower output volumes, leading to higher production costs per kilogram of live weight, particularly when combined with higher FCR values and lower PI scores. Production systems with minimal environmental control experience greater performance variability and scale limitations, thereby reducing technical efficiency [8]. Sustainable increases in flock size, therefore, are more feasible under closed-house systems capable of maintaining stable temperature, humidity, and air quality.

Operationally, closed-house systems allow more precise regulation of ventilation and temperature, reducing heat stress variability and stabilizing production outputs across cycles. Empirical evidence from studies on ventilation-control strategies in broiler houses indicates that improved microclimate management lowers heat stress risk, which is commonly associated with deteriorating FCR and increased mortality. More broadly, the literature emphasizes that high-density broiler production can be maintained without performance penalties when environmental conditions are adequately controlled, whereas insufficient microclimate control in open-house systems increases susceptibility to stress-related efficiency losses.

3.2 Production performance indicators

Table 2. Performance indicators of broilers in open and closed house systems

	Performance Indicators			
	Depletion (%)	**FCR**	**Body weight (kg)**	**IP**
Open house	3.6	1.62	2.06	350.2
Closed house	3.1	1.51	2.10	421.1

Source: data research, 2025

Table 2 presents a comparative overview of production performance between open-house and closed-house systems operating under a partnership scheme. Clear differences were observed across all key technical indicators, namely depletion rate, Feed Conversion Ratio

(FCR), body weight, and Performance Index (PI). These indicators are widely recognized as core parameters for evaluating technical efficiency and incentive determination in nucleus–plasma broiler partnerships [7]. In the present study, closed-house systems recorded a lower depletion rate (3.1%) than open-house systems (3.6%), indicating improved survivability under controlled housing conditions. This reduction in depletion suggests that enhanced environmental regulation in closed houses effectively mitigates heat stress and associated mortality risks, consistent with findings reported [9].

Differences in feed efficiency were more pronounced. Closed-house operations achieved a lower FCR (1.51) compared with open-house systems (1.62), reflecting more efficient conversion of feed into live weight. This result aligns who reported superior feed efficiency in closed-house broiler systems under partnership arrangements and identified FCR as a primary determinant of technical and economic performance [7]. The lower FCR observed in closed-house systems reflects greater stability in feed intake and nutrient utilization resulting from controlled temperature, humidity, and air quality. In contrast, open-house systems are more susceptible to environmental fluctuations, which increase maintenance energy requirements and reduce feed conversion efficiency.

From a growth perspective, broilers reared in closed-house systems achieved a slightly higher final body weight (2.10 kg) than those in open-house systems (2.06 kg). Although the absolute difference was modest, it remains economically relevant within partnership-based production systems, where incremental increases in harvest weight directly translate into higher output volumes and farmer income. The combined effects of improved feed efficiency and marginally higher body weight were reflected in the substantially higher Performance Index (PI) observed in closed-house systems (421.1), compared with open-house systems (350.2). The PI value recorded for closed-house operations exceeds the commonly accepted benchmark of PI ≥ 300 for well-managed broiler production and is comparable to, or slightly above, performance levels reported in modern broiler systems with effective environmental control [3]. Conversely, the performance indicators of open-house systems approach the lower bound of international benchmarks, underscoring structural limitations in maintaining biological efficiency under tropical conditions. Overall, the results demonstrate that closed-house systems provide clear technical advantages over open-house systems within partnership schemes, primarily through reduced depletion, enhanced feed efficiency, and superior overall performance.

3.3 Production cost structure and economic implications

Given that feed efficiency, survivability, and overall performance directly influence production costs, differences in technical performance between housing systems are expected to translate into distinct cost structures and economic outcomes. Therefore, an examination of production cost components across enterprise scales is essential to clarify how technical advantages observed in closed-house systems are reflected in their economic efficiency.

Table 3. Production cost in closed-house and open house broiler farm

Cost Component	Housing System											
	Closed House						*Open House*					
	Small		Medium		Large		Small		Medium		Large	
	IDR	%	IDR	%	IDR	%	IDR	%	IDR	%	IDR	%
Fixed Costs												
Land tax / land rent	162,857	0.002	-	-	-	-	162,235	0.01	-	-	-	-
House and warehouse depreciation	11,952,960	1.93	30,341,699	1.89	30,275,000	1.35	3,794,654	1.82	4,071,429	1.03	22,857,143	2.25
Equipment depreciation	5,831,896	0.92	13,376,335	0.83	14,799,138	0.66	1,167,992	0.56	2,713,143	0.68	3,845,429	0.38
Total Fixed Costs	17,798,427	2.85	43,718,034	2.72	45,074,138	2.01	4,992,690	2.39	6,784,572	1.71	26,702,572	2.63
Variable Costs												
Day-old chicks (DOC)	121,872,917	19.05	304,335,714	19.07	445,250,000	19.85	38,689,815	18.59	78,775,000	19.83	191,800,000	18.91
Feed	472,075,367	73.81	1,180,923,129	74.01	1,664,758,000	74.21	153,351,930	74.30	294,963,750	74.20	745,593,800	73.53
Veterinary drugs and vaccines (OVK)	3,103,752	0.49	7,750,564	0.49	11,339,250	0.51	975,628	0.47	2,006,175	0.50	4,884,600	0.48
Operational costs	24,087,956	3.80	59,247,714	3.71	76,767,286	3.42	8,869,333	4.25	14,885,000	3.76	45,079,556	4.45
Total Variable Costs	621,139,992	97.15	1,552,257,121	97.28	2,198,114,536	97.99	201,886,706	97.61	390,629,925	98.29	987,357,956	97.37
Total Production Costs	638,938,419	100	1,595,975,155	100	2,243,188,674	100	206,879,396	100	397,414,497	100	1,014,060,528	100

Source: Research data, 2025

Table 3 presents clear differences in the production cost structure between closed-house and open-house systems across all enterprise scales. In both systems, variable costs dominated total production costs, accounting for more than 97%, while fixed costs contributed less than 3%. This cost pattern is characteristic of modern broiler production systems, in which feed and day-old chicks (DOC) represent the primary cost components, as consistently reported in international Scopus Q1 literature [3][10].

In closed-house systems, total production costs increased with enterprise scale, rising from IDR 638.9 million at the small scale to IDR 2.24 billion at the large scale. Although nominal costs were higher than those observed in open-house systems, the cost structure indicates superior economic efficiency. Feed costs accounted for a relatively stable share of total costs (73.8–74.2%) across scales, suggesting that population expansion in closed-house systems does not lead to increased feed inefficiency. This finding is consistent with the technical performance results presented earlier, where closed-house systems achieved lower FCR values and higher performance indices. Evidence from Q1 studies further confirms that effective microclimate control in closed housing reduces variability in feed intake and improves feed conversion efficiency, thereby lowering feed costs per kilogram of live weight [3].

By contrast, open-house systems exhibited lower total production costs in absolute terms, but the proportion of feed costs remained high (73.5–74.3%) and was accompanied by a higher share of operational costs, reaching up to 4.45% at the large scale. This reflects additional resource requirements to mitigate environmental fluctuations, including increased energy use and management inputs associated with unstable temperature and humidity. Open-house systems in hot climates are more susceptible to elevated operational costs and performance risks due to heat stress, ultimately increasing effective production costs per unit of output [6].

From a fixed-cost perspective, closed-house systems incurred higher depreciation costs for housing and equipment, particularly at medium and large scales. However, the relative contribution of fixed costs declined as enterprise scale increased (from 2.85% to 2.01%), indicating the presence of economies of scale. This pattern aligns with economic analyses of broiler production in the United States and Europe, which suggest that higher initial investments in closed-house facilities can be offset by lower unit costs through increased production capacity and improved technical efficiency [10].

When linked to production performance, the observed cost structure reinforces the conclusion that closed-house systems offer superior economic efficiency, despite higher nominal costs. Lower FCR values and better-controlled depletion rates reduce feed expenditure and mortality-related losses, resulting in more efficient production costs per kilogram of live weight. Previous studies have demonstrated that an FCR reduction of 0.05–0.10 points can generate substantial feed cost savings at commercial scale, often exceeding the additional costs associated with energy use and housing depreciation [3].

4 Conclusion

This study demonstrates that closed-house broiler systems operating under a partnership model in Malang Regency achieve superior production performance and economic efficiency compared with open-house systems. Closed-house operations recorded lower depletion rates, improved feed conversion ratios, slightly higher final body weights, and substantially higher Performance Index values, indicating more efficient and stable biological performance under controlled environmental conditions. Although closed-house systems incurred higher nominal production costs, their cost structure revealed greater economic efficiency, characterized by stable feed cost proportions, reduced mortality-related losses, and declining fixed-cost shares with increasing scale, reflecting economies of scale. These findings imply that the adoption of closed-house technology provides clear technical and economic advantages for broiler production in tropical environments, particularly within partnership arrangements. From a practical perspective, these results support the promotion of closed-house systems as a strategic option for improving farm productivity and profitability, while highlighting the importance of scale optimization and environmental management. Future research is recommended to evaluate multi-cycle performance, incorporate risk and sensitivity analyses, and assess long-term economic sustainability under varying market and climatic conditions.

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