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Production and economic performance of broiler farms at different altitude: A case study of Paranje partnership in West Java

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ABSTRACT

The altitude of closed house poultry farms affects broiler chicken performance through changes in temperature, humidity, and oxygen levels. Although the closed house system is designed to stabilize the internal microclimate, the external environment influences the physiology of chickens at different altitudes. This study examined the effect of farm altitude on broiler performance and partner farmers' revenue within the Parenje partnership system in the West Java Province. This research was conducted using secondary data from the Paranje Partnership in West Java Province between 2022 and 2024. The data were grouped based on the altitude of the farm as follows: P1 (≤300 m), P2 (301–600 m), and P3 (>600 m). Each group consisted of 210 best performance records over three years, totalling 630 data points. The observed parameters included feed consumption, harvest weight, harvest age, depletion, feed conversion ratio (FCR), performance index (IP), and farmer revenue per chicken. The data were processed descriptively and are presented in the tables. The results showed that farms in P1 achieved the most efficient feed consumption, highest harvest weight, lowest FCR, and the highest IP and revenue. Conversely, farms in P3 recorded the lowest performance and revenue owing to environmental pressure. IP proved to be the main indicator of technical efficiency and was highly correlated with farmers' revenue. The conclusion of this study is that the altitude of poultry houses affects technical performance and profitability of broiler production, with P1 being the best recommendation.

Introduction

Broiler chickens are a primary poultry commodity that play an important role in providing animal protein to the community. Their rapid growth and efficient feed conversion make broilers the top choice at a relatively affordable price (Maharjan *et al*., 2021). However, optimal productivity can only be achieved when the rearing environment supports optimal growth conditions. One innovation that supports this is the closed-house system, which is designed to create a stable microclimate by regulating temperature, humidity, and air circulation (Baoming *et al*., 2020).

The closed-house system can only help regulate the internal conditions of the coop; however, its effectiveness is still influenced by the external environment (Hajiyev *et al*., 2024). Differences in altitude affect temperature, humidity, air pressure, and oxygen levels, which, in turn, affect the metabolism and growth of broiler chickens (Khajali, 2022). Lowlands are defined as areas with an altitude ≤300 m above sea level, midlands at 301-600 meters, and highlands at 600 m (Lungarska and Chakir, 2018). Previous studies have shown that rearing broilers at different altitudes affects production performance (Yilmaz *et al*., 2006), but the revenue value has not yet been studied further, and this research will complete the data.

West Java Province, as a national broiler production center, possesses vast topographical variations and a well-organized partnership farming system. This partnership system is a form of cooperation between plasma farmers, who provide facilities and carry out cultivation activities with integrator companies, which supply production materials, provide technical and managerial advice, and handle the accommodation and marketing of production outcomes (Febrianto *et al*., 2023). Paranje partnership, one of the partner farms in this region, implements a closed house system with uniform SOPs across various locations at different altitudes, making it an ideal object for examining the relationship between coop location altitude and business outcomes.

This study aimed to examine the effect of closed houses at different altitudes on broiler performance and farmers' revenue. The results of this study will give benefit to serve as consideration in determining the optimal location for the construction of the barn, both technically and economically. The research hypothesis was that rearing in lowland areas would results in higher rearing performance and farmer revenue than in midland and highland areas.

Materials and methods

Research Materials

A total of 630 data were used from three altitude groups, with 70 data at each altitude over a period of three years between 2022 to 2024. This study used secondary data obtained from farmers who are part of the Paranje Partnership. All farmers in this partnership used closed house cage systems measuring 6 × 30 m. The collected data included the feed consumption, harvest weight, harvest age, depletion rate, feed conversion ratio (FCR), performance index (IP), and revenue. All data were obtained from partner farmers who were supervised by technical services and followed standardized operational maintenance procedures (SOP).

Location and research design

This research was conducted in West Java Province, Indonesia, which is the largest production center of broilers in the country and main location of the Paranje Partnership. Furthermore, Paranje Partnership implement a affordable contract farming model, make it accessible to the middle-revenue class. The study employed a case study approach with a comparative qualitative method.

Criteria and sampling

The data in this study were obtained from partner farmers of the Paranje Partnership and grouped based on the elevation category of livestock pens as follows:

P1: Lowland (≤300 meters above sea level / masl)

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P2: Midland (301–600 masl)

P3: Highland (>600 masl)

Each group was represented by the 70 best performance data points per year, selected using purposive sampling based on the highest performance index achieved. The total data analyzed in this study amounted to 210 points for each parameter, with a total of 630 data points. The data were then processed and discussed descriptively.

Data collection techniques

Data were collected from internal reports of the Paranje Partnership, which were systematically documented by a technical service. The data collected includes production performance, covering feed intake, harvest weight, harvest age, depletion, feed conversion ratio (FCR), and performance index (PI), as well as financial performance as show by revenue.

Production performance analysis

Feed conversion ratio

The FCR was defined as the amount of feed required to produce one kilogram of body weight. Ideally, one kilogram of feed can yield one kilogram or more of body weight (FCR ≤ 1). However, these ideal conditions have not always been achieved. In broiler chickens, a target FCR of 1 can usually only be reached before the chickens are two weeks old. Subsequently, the FCR tended to increase as the chickens aged. The formula for FCR, according to Karar *et al.* (2023).

FCR= Total Feed Consumtion/Total Body Weight

Performance index

The IP is one of the main parameters used to measure the success of a livestock business. The IP value was calculated based on the ratio of feed consumption during the rearing period, the total body weight of the chickens at harvest, the average age at harvest, and the depletion or mortality percentage. The formula for IP According to Febrianto *et al.* (2023):

IP= (100- Deplesi)× Body Weight/(FCRxAverage Age) ×100

In this context, IP refers to the Performance Index, D indicates the depletion or mortality percentage (%), ABW represents the average body weight of the chickens at harvest (kg), FCR refers to the feed conversion ratio, and average age describes the rearing period of broilers, which is generally measured in days.

The Performance Index (IP) value of broiler farming was divided into five categories. An IP below 300 was categorized as low, an IP between 301 and 325 was considered fair, an IP within the range of 326–350 was classified as good, an IP between 351 and 400 was considered very good, and an IP above 400 was classified as excellent (Santoso and Sudaryani, 2011).

Financial performance analysis

Revenue

In the broiler industry, revenue refers to the total amount of money earned from the sale of live chicken or chicken-derived products per unit of chicken. This revenue reflects the result of the business's main activities, namely the sale of chickens and other related products. The formula for revenue according to Sehabudin *et al.* (2022) is as follows:

Partner Farmers Revenue= Total Cash received from the core business (Rp)/(initial population (birds)

Data analysis

The data were then grouped, analyzed using descriptive-comparative methods, and presented average value in table form to facilitate interpretation and understanding of the relationship between the altitude of the farm location and farmers' production performance and revenue.

Results and Discussion

This study examines the effect of the altitude of closed-house poultry farms on IP and Revenue in the Paranje partnership system in West Java. These results are supported by data on feed consumption, harvest weight, harvest age, depletion, and feed conversion. The results are presented in Table 1.

Feed consumption

Broiler chicken feed consumption increases with the elevation of the coop location, with the highest value observed at P3 (2.80 kg/bird), followed by P2 (2.79 kg/bird), and the lowest at P1 (2.77 kg/bird). This pattern remained consistent over the three years of observation, indicating that altitude affected feed requirements. The lower temperature at P3 reduces the risk of heat stress and helps maintain broiler appetite while

Table 1. Performance Parameters and Farmer Revenue.

Group	Feed Intake (kg)	Harvest weight (kg)	Harvest age (day)	Depletion (%)	FCR	IP	Revenue (Rp/bird)
			2022				
P1	2.78±0.13	1.83±0.07	30.21±0.69	2.55±1.51	1.52±0.05	390.49±23.72	3.118,22±572.36
P2	2.77±0.12	1.82±0.07	30.33±0.84	2.84±1.50	1.52±0.05	383.66±23.07	3.012,72±640.21
P3	2.77±0.12	1.80±0.08	30.83±0.83	3.23±1.35	1.54±0.06	369.07±29.51	2.721,76±692.42
			2023				
P1	2.74±0.12	1.86±0.06	30.76±0.75	2.61±1.35	1.47±0.04	401.42±14.96	3.772,43±503.91
P2	2.74±0.13	1.85±0.07	30.30±0.91	2.78±1.68	1.48±0.05	402.20±19.13	3.549,72±555.61
P3	2.78±0.11	1.85±0.07	29.88±1.02	2.46±1.48	1.50±0.04	401.73±19.52	3.419,23±909.83
			2024				
P1	2.80±0.11	1.92±0.06	30.38±0.83	2.48±1.17	1.46±0.04	422.06±16.58	4.095,08±476.52
P2	2.85±0.13	1.91±0.05	30.63±0.73	2.58±1.36	1.50±0.05	406.11±17.58	3.682,17±550.95
P3	2.86±0.10	1.88±0.07	30.67±0.78	3.27±1.31	1.52±0.04	390.15±19.08	3.274,32±561.74
			2022-2024				
P1	2.77±0.12	1.87±0.07	30.45±0.79	2.55±1.34	1.48±0.05	404.65±22.67	3.661,91±657.95
P2	2.79±0.13	1.86±0.07	30.42±0.84	2.73±1.51	1.50±0.05	397.32±22.21	3.414,87±649.33
P3	2.80±0.12	1.84±0.08	30.46±0.97	2.99±1.43	1.52±0.05	386.98±26.49	3.138,44±791.51

also stimulating increased metabolism to maintain body temperature, thus raising energy needs (Khajali and Wideman, 2016).

Highlands, which have lower air pressure, can cause a condition where there is insufficient oxygen supply to body tissues owing to the lower oxygen content in the air (hypoxia) (Parr *et al*., 2019). Hypoxia leads to physiological stress that can decrease organ function including the digestive system (Ezzulddin, 2023). This disturbance drives chickens to consume more feed to compensate for the increased energy and nutrient needs caused by metabolic stress (Desbruslais and Wealleans, 2022). Overall, the combination of physiological conditions and a stable appetite at lower temperatures makes the highland microclimate a key factor in increased feed consumption.

In addition to these physiological factors, the harvest age of broiler chickens in highland areas also tends to be longer than those in lowland areas, as an adaptation to slower growth due to lower oxygen pressure. This naturally longer average age increases the cumulative feed consumption per bird, thereby contributing to higher total recorded feed consumption.

Harvest weight

The harvest weight of broiler chickens decreased as the altitude of the farming location increased. Over the three years of observation, P1 showed the highest harvest weight (1.87 kg/bird), followed by P2 (1.86 kg/bird), and the lowest in P3 (1.84 kg/bird). Harvest body weight at each location also tended to increase each year. Differences in body weight at each altitude may be caused by the environmental conditions that support growth. Raising broiler chickens in highland areas results in lower growth rates than raising them in lowland areas (Chuskit *et al*. 2024). In general, farming at P1 had a higher oxygen pressure, thus supporting sufficient oxygen availability. With sufficient oxygen, cellular respiration efficiently produces ATP, which is required for muscle tissue synthesis (Alnahhas *et al*., 2023). Conversely, broiler chickens in P3 face physiological limitations that hinder growth even though feed consumption is high. Hypoxic conditions trigger homeostatic functions and a shift in nutrient utilization patterns (Samanta and Semenza, 2017). In contrast, hypoxia inhibited myogenesis (Jung *et al*. 2024). As a result, the feed consumed does not fully contribute to weight gain, causing chickens in P3 to tend to have lower final weights than those in P1 and P2.

Harvest age

The harvest age of broiler chickens at each altitude was almost uniform and did not display any specific pattern. Over the three years of observation, P3 (30.46 days) showed the highest value, and P2 (30.42 days) showed the lowest. This is because the air pressure in highland areas is lower than that in lowland areas, resulting in reduced oxygen levels in the air. This condition leads to a decrease in the body's metabolic rate due to a reduced oxygen supply to tissues (hypoxia) (Laguë, 2017). Mild hypoxia caused by low partial oxygen pressure also disrupts cellular energy production (ATP), inhibits myogenesis, and decreases the efficiency of muscle tissue growth (Chun and Kim, 2021). Although broiler harvest age is determined managerially, these physiological conditions indicate that broilers raised in highland areas may not have reached their optimal growth potential at the time of harvest, resulting in a lower final body weight than broilers raised at lower altitudes.

Depletion

The depletion rate of broiler chickens increased with increasing farming location. Over the three years of observation, the highest value was recorded at P3 (2.99%), followed by P2 (2.73%), and the lowest at P1 (2.55%). Low temperature and air pressure, along with high humidity in highland areas, reduce litter quality (Hasibuan *et al*., 2021), creating an ideal environment for the growth of pathogenic microbes that attack the digestive and respiratory tracts if not properly managed (Utama and Christiyanto, 2021). The higher feed consumption at P3 also resulted in more excreta, which accelerated litter accumulation. Thick and moist litter becomes a breeding ground for microbes and accelerates ammonia production due to nitrogen decomposition by bacteria (Bist *et al*., 2023). Ammonia accumulation in the coop causes respiratory tract irritation, reduces immunity, and increases physiological stress, thereby increasing the risk of infection and mortality in broiler chickens in highlands (Liu *et al*., 2020).

Feed Conversion Ratio (FCR)

The FCR value of broiler chickens increased with elevation of the rearing location. Over three years of observation, the highest efficiency was observed at P1 (1.48), followed by P2 (1.50), and the lowest at P3 (1.52). This pattern indicates that the feed utilization efficiency decreases as the altitude of the chicken house increases. The high feed consumption at P3 was not matched by a similar gain in body weight, reflecting a low efficiency in converting nutrients into body mass. Environmental conditions in highland areas, such as cold temperatures and low air pressure, cause mild hypoxia, which reduces the efficiency of cellular functions and diverts energy utilization to maintain homeostasis rather than growth (She and Qu, 2025). In addition, poor litter quality at P3 further worsened the respiratory tract condition, decreased appetite, and increased stress and mortality rates, which directly affected the final body weight (Soliman *et al*., 2021). The combination of physiological disturbances, environmental stress, and reduced digestive efficiency causes chickens to require more feed to achieve the same weight, resulting in a higher FCR value at P3 compared to P1 and P2.

Performance Index (IP)

Broiler chicken rearing performance declined as the altitude of the rearing location increased. Rearing at P1 had the highest IP (404.65), followed by P2 (397.32) and P3 (386.98). This pattern reflects the integration of all technical parameters, such as final weight, harvest age, depletion, and feed conversion, which collectively determine the production efficiency. The high IP in P1 was closely related to the most efficient FCR (1.48), the highest harvest weight (1.87 kg/bird), and the lowest depletion (2.55%). Lowland environmental conditions, with optimal oxygen pressure and microclimate stability, allow chickens to reach their maximum growth potential (Khajali, 2022). Overall, this improves production efficiency. Conversely, the lowest Performance Index in P3 is due to the highest feed consumption (2.80 kg/bird), the lowest harvest weight (1.84 kg/bird), the poorest FCR (1.52), and the highest depletion (2.99%). Highland conditions, characterized by mild hypoxia and environmental stress, worsen the physiological status and thus decrease overall productivity (Wang *et al*., 2019). The difference in the Performance Index values between locations underscores the importance of adapting management strategies based on geographic and microclimatic conditions to achieve optimal performance.

Farmers' Revenue

The revenue value of partner farmers declined in line with an increase in elevation. Over three years of observation, P1 recorded the highest value (3,661.91), followed by P2 (3,414.87), and the lowest was P3 (3,138.44). This pattern is consistent with the trend of the Performance Index (PI), where P1 had the highest PI (404.41) and P3 the lowest PI (386.77). This alignment indicates that P1 can be used as a reasonably accurate technical projection for estimating the economic outcomes of broiler chicken production (Ramukhithi *et al*., 2023). The high revenue in P1 was inseparable from optimal technical efficiency. The combination of a high final

harvest weight (1.87 kg/bird), the most efficient FCR (1.48), and the lowest depletion rate (2.55%) reduced costs and increased harvest yield. This shows that most of the feed consumed was effectively converted into marketable body weight, while the higher survival rate of chickens until the end of the rearing period contributed to increased revenue (Olorunwa, 2018).

Conversely, revenue in P3 decreased due to various interrelated technical obstacles. Higher feed consumption (2.80 kg/bird), lower harvest weight (1.84 kg/bird), inefficient FCR (1.52), and the highest depletion (2.99%) reflect low production efficiency. This situation has led to increased costs per unit of output and fewer chickens harvested, thereby reducing the total revenue of farmers (Ahiwe *et al*., 2018). In other words, a high P1 value reflects technical performance and has a direct impact on economic achievement. Therefore, the differences in revenue between locations emphasize that strategies to improve maintenance performance must be accompanied by environmental-based management adaptations so that technical efficiency and economic benefits can be achieved sustainably.

Conclusion

The conclusion of this study is that the altitude of poultry houses affects the technical performance and profitability of broiler production. P1 demonstrated the highest performance and revenue, followed by P2, with P3 having the lowest. Based on these findings, lowland areas (P1) are recommended as the most profitable location for broiler farming.

Conflict of interest

The authors have no conflict of interest to declare.

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