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Effects of housing system on commercial Broiler chicken performance reared under a semi-arid, small-scale production system

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Abstract: Broiler chickens (*Gallus gallus domesticus*) are a vital source of animal protein in Zimbabwe, with small-scale producers playing a key role in meeting the rising demand for poultry meat. As production intensifies, concerns have arisen regarding the impact of housing systems on broiler performance under small-scale conditions. This study evaluated the effects of cage and deep litter housing systems on growth and carcass parameters of broiler chickens. A completely randomized design was used with two treatments (cage and deep litter), each replicated three times. One hundred and twenty Cobb 500-day-old chicks (DOCs) were brooded together and then allocated to the treatments on day 21. The birds were reared for six weeks, and the following performance parameters were measured: weight gain, feed intake, feed conversion ratio (FCR), carcass weight, and dressing percentage. Results showed no statistically significant differences between housing systems: weight gain (0.92 kg vs. 0.94 kg; $p = 0.298$), feed intake (1.49 kg vs. 1.54 kg; $p = 0.244$), FCR (1.61 vs. 1.61; $p = 0.506$), carcass weight (1.68 kg vs. 1.69 kg; $p = 0.579$), and dressing percentage (73.37% vs. 73.40%; $p = 0.929$). Weekly growth patterns were also similar between systems, with final body weights of 2.34 kg (cage) and 2.36 kg (deep litter) at six weeks. These findings suggest that, under controlled conditions, cage and deep litter systems have comparable effects on broiler performance, and either system can be effectively used in small-scale production.

Keywords: broiler performance; cage; carcass weight; deep litter; dressing out percentage; feed conversion ratio

INTRODUCTION

Poultry is the most traded livestock species globally, both in terms of animal numbers and meat tonnage (Sans et al., 2021). As of 2023, global poultry meat production reached approximately 137 million metric tonnes, accounting for nearly 39% of all meat produced worldwide, surpassing both beef and pork in market share (FAO, 2023). The global broiler (*Gallus gallus domesticus*) meat trade alone exceeds 14 million tonnes annually, driven largely by consumer preference for affordable, lean protein sources. In semi-arid developing regions such as Zimbabwe, poultry production, predominantly of broiler chick-

ens, accounts for more than 70% of the country's meat protein supply, with over 100 million broiler birds slaughtered annually, yielding an estimated 140,000 to 150,000 metric tonnes of meat (Zimbabwe Poultry Association [ZPA], 2022).

Small-scale broiler chicken producers are considered pivotal to the inclusive growth of developing countries' poultry sector, having significantly contributed to local meat markets and rural livelihoods (Gororo and Kashangura, 2016). These producers supply approximately 70% of the national broiler output, bridging the gap between household food security and national protein needs. Broiler chickens have undergone intensive

genetic selection for rapid growth (Hartcher and Lum, 2020; Torrey et al., 2021) and are commonly reared by commercial, small-scale, and backyard farmers (Gororo and Kashangura, 2016; Phiri et al., 2023). Their popularity stems from their ability to quickly meet consumer demand, supporting food self-sufficiency in both urban and rural communities (Gororo and Kashangura, 2016; Mesa et al., 2017; Andri et al., 2022; Sans et al., 2021).

One of the key advantages of broiler chickens is their ability to reach market weight within 35 to 42 days, allowing producers to respond rapidly to fluctuations in meat supply. Broilers can be raised in a range of housing systems (Soliman and Hassan, 2020; Andri et al., 2022). In high-density urban areas of Zimbabwe, most backyard producers rely on cages due to space limitations, whereas commercial farmers prefer deep litter systems (Zhao et al., 2015; Phiri et al., 2023). Broilers also have an efficient feed conversion ratio, averaging 1.4 to 1.7 kg of feed per 1 kg of meat (Moreki et al., 2020; Liu et al., 2020; Irwani et al., 2021), which makes them more cost-effective than cattle or goats, which require 6–10 kg or more of feed per kg of meat.

The fast production cycle, typically under six weeks, provides quick returns on investment and enables flexibility in responding to market dynamics (Zhao et al., 2015; Mukaila et al., 2023; Rabbani and Ahmad, 2021). With minimal capital investment required compared to other livestock (Rabbani and Ahmad, 2021), broiler production is beneficial for smallholder farmers (Hartcher and Lum, 2020; Torrey et al., 2021; Phiri et al., 2023). National demand remains strong, with Zimbabweans consuming more than 15 kg of poultry meat per capita annually, a significant figure for a developing country (ZPA, 2022). This sustained preference for white meat, valued for its tenderness, faster cooking time, and perceived health benefits (Phiri et al., 2023), has positioned broiler meat as the dominant animal protein served at social events such as weddings and community gatherings.

In terms of spatial efficiency, broiler chickens require less room than larger livestock. With ten

to twelve birds accommodated per square meter (Moreki et al., 2020), even producers with limited backyard space can feasibly engage in poultry farming. However, the choice of housing system plays a critical role in determining bird health, productivity, and welfare.

Despite widespread adoption, there is no standardized housing model for broilers in most developing countries (Sans et al., 2021). Housing conditions influence the birds' locomotion, muscle development, and environmental interactions (Sun et al., 2023). An effective housing system should offer adequate ventilation (Sahoo, 2017; Lima et al., 2020; Van Limbergen et al., 2020), access to natural light (Rioja-Lang et al., 2020; Bailie et al., 2018; EU, 2017), warmth during cold periods (Bhadauria, 2017), and protection from predators or disease vectors like wild birds, which can transmit avian influenza or Newcastle disease (Classen, 2014). Additionally, good housing should facilitate environmental control, ease of cleaning, and flock monitoring (Bhadauria, 2017; Profeeds, 2020). In Zimbabwe, the most commonly used systems are deep litter and cage housing.

Deep litter housing involves raising birds over absorbent organic materials such as sawdust or chopped grass, which serve as bedding (Soliman and Hassan, 2020; Anupoju, 2021). For chicks, litter depth begins at eight centimeters and increases as the birds grow, requiring routine maintenance to prevent disease (Anupoju, 2021). This system is generally low-cost and allows effective temperature regulation using heaters or infrared lamps (Profeeds, 2020). However, it is labor-intensive, requires more space, and is associated with a higher risk of diseases such as coccidiosis due to continuous contact with the litter (Momand et al., 2020; Anupoju, 2021; Sans et al., 2021; Lamidi and Osunade, 2023). Feed wastage is also more prevalent in this system.

In contrast, cage systems restrict birds within metal or mesh enclosures, from basic single tiers to complex battery cages (Kodu, 2014; EU, 2017). Caged broilers benefit from reduced labor needs, better feed efficiency, and a lower incidence of floor-related diseases (Zhao et al., 2021; Kodu,

2014). Nonetheless, the initial setup cost is significantly higher, and birds often exhibit poor leg health, weak bones, and reduced meat quality due to restricted movement (Sonkamble et al., 2020; Çavuşoğlu et al., 2018).

Factors such as land availability, funding, production scale, market size, and national regulations influence farmers' decisions about which system to adopt (Zhao et al., 2015; Dawkins, 2017; EU, 2017). While both systems are widely used, comparative data on their effects under small-scale semi-arid conditions remain limited. It is against this background that the current study was undertaken to evaluate whether housing systems influence broiler performance in small-scale production environments. The study specifically examined differences in growth rate, feed conversion ratio, and carcass characteristics of broilers reared under deep litter and cage systems, to identify the more efficient and sustainable model for resource-constrained farmers.

MATERIALS AND METHODS

The study was conducted in Chikomba District, Mashonaland East Province, Zimbabwe. The coordinates for the study site are 19°01'10.61"S, 30°53'50.16"E. Chivhu is located in Natural Farming Region II, with temperature ranges of 18°C to 32°C and rainfall of 650–750mm. The study was run in a completely randomized design with two treatments (cage and deep litter) replicated three times.

Animal management

Before the arrival of the chicks, the brooder was fumigated two days before chick placement. Temperature was regulated using infrared lamps. One hundred and twenty Cobb 500 DOCs from a reputable supplier were used for this study. On arrival, a stocking density of forty chicks per square meter was used, and was reduced to thirty chicks per square meter in the second week. The chicks were brooded together for 21 days and were given straight feed *ad libitum*. A three-phase feeding regime was used, where chicks were fed broiler

starter crumbles (22% CP content) for the first two weeks, broiler grower pellets (20% CP content) from the third week to the fourth week, and broiler finisher pellets (18% CP content) from the fifth week until slaughter. At day 22, the chickens were allocated to the experimental units. The birds were weighed individually and randomly assigned to two groups based on their weight. Birds in each group were randomly allocated to three groups while balancing the groups for both sex and weight. The six groups, each consisting of twenty birds, were randomly assigned to treatments and replicates. A stocking density of twenty chicks per square meter was used, which was reduced as the birds grew to ten birds per square meter, as recommended (Profeeds, 2023; Moreki et al., 2020; Rabbani and Ahmad, 2021). At day twenty-eight, stocking density was reduced to fifteen birds per square meter, and then further reduced to ten birds per square meter at day thirty-five, a level that was maintained up to slaughter. A light regime of 23 hours of light for the first week, which was gradually changed to 8 hours of darkness by week six (Profeeds, 2023; Olanrewaju et al., 2015). Hours of light were 23 for week one, 18 for week two, 12 for weeks three and four, and finally eight from week five to slaughter. The initial weight of the birds was measured and recorded on day 22, when the birds were allocated to their respective treatments. Weekly weights were measured thereafter to compute weekly and total weight gain.

Soft chopped straw was used as litter material for the brooder and deep litter, while raised rodent-proof mesh wire cages were used for a single-tier cage system. The litter material had a thickness of 8 cm and was changed whenever it became wet. Droppings from cages were removed daily. Ventilation and air circulation were controlled by pulling side curtains of the fowl run since both the cage and deep litter systems were in the fowl runs. Feeding was done manually between 0600 and 0700 hours, and periodic checks were carried out every three to four hours. Also, daily feed consumption was measured and recorded before calculating total feed consumption for each treatment. At week six, the birds were

slaughtered, shrunk, and measured for dressing-out percentage.

Measurements

Measurements were done and recorded to gather data on the performance of broiler chickens from the two housing systems. The following broiler performance parameters were measured, calculated, and recorded using different formulae:

1. Growth

$$\text{a) Average weekly weight gain} = \frac{\text{Weight for the week} - \text{Previous week weight}}{\text{Number of weeks}} \quad (1)$$

$$\text{b) Total weight gain} = \text{Weight of birds at week three} - \text{Weight of birds at week six} \quad (2)$$

$$\text{2. Feed conversion ratio} = \frac{\text{Total feed consumed}}{\text{Average weight gained by broiler chickens}} \quad (3)$$

$$\text{3. Dressing percentage} = \frac{\text{carcass weight}}{\text{shrunk live weight}} \times 100 \quad (4)$$

Data analysis

The collected data on broiler chicken performance parameters, including feed intake, weight gain, feed conversion ratio (FCR), carcass weight, and dressing percentage, were statistically analyzed using GenStat software (18th Edition). A two-sample t-test was employed to evaluate whether there were statistically significant differences between the two treatment groups: cage and deep litter housing systems. The choice of the two-sample t-test was appropriate given the study's experimental design, which involved comparing the means of two independent groups under similar management conditions. Before analysis, the data were checked for normality and homogeneity of variances to ensure the assumptions of the t-test were met. Differences between treatment means were considered statistically significant at $p < 0.05$. The results were interpreted to determine the influence of the housing system on the growth performance and carcass characteristics of broiler chickens under small-scale production conditions.

RESULTS AND DISCUSSION

The study examined the impact of cage and deep litter housing systems on the performance of commercial broiler chickens. Different performance measures were collected, and other aspects of productivity were calculated as they are essential in determining the profitability of a broiler production venture. These include growth rate, weight gain, FCR, and dressing percentage.

Growth of broiler chickens from four weeks up to slaughter

The results show that the growth pattern of the commercial broiler chickens was not significantly different ($p < 0.05$) from week four through week six in both housing systems, as shown in Figure 1 below.

At week four, the average weight for the cage was 1.39 kg, while for the deep litter, it was 1.42 kg. In week five, the cage had an average weight of 1.91 kg, and the deep litter had 1.91 kg. By week six, the final average weight was 2.34 kg, compared to 2.36 kg for the deep litter. These weekly weights were within the stipulated weight ranges as suggested by Profeeds (2023). The similarity of these results was highly attributed to similar management practices for the treatments, except for the differences in housing systems.

Weight gain and carcass parameters for broiler chickens raised under deep litter and cage housing systems

The total weight gain for the broiler chickens in the finisher phase, regardless of whether they were housed in deep litter or cage housing systems, did not show any significant difference ($p < 0.05$). The mean for the cage was 0.92 kg, while the deep litter mean weight gain was 0.94 kg (Table 1).

The feed intake for both cage and deep litter housing systems was not significantly different ($P > 0.05$). The average feed intake for cage housing was 1.49 kg, while for deep litter housing it was 1.54 kg. These findings are in line with those of Yilmaz Dikmen and Gündüz (2025), who found that feed intake for commercial broilers raised in

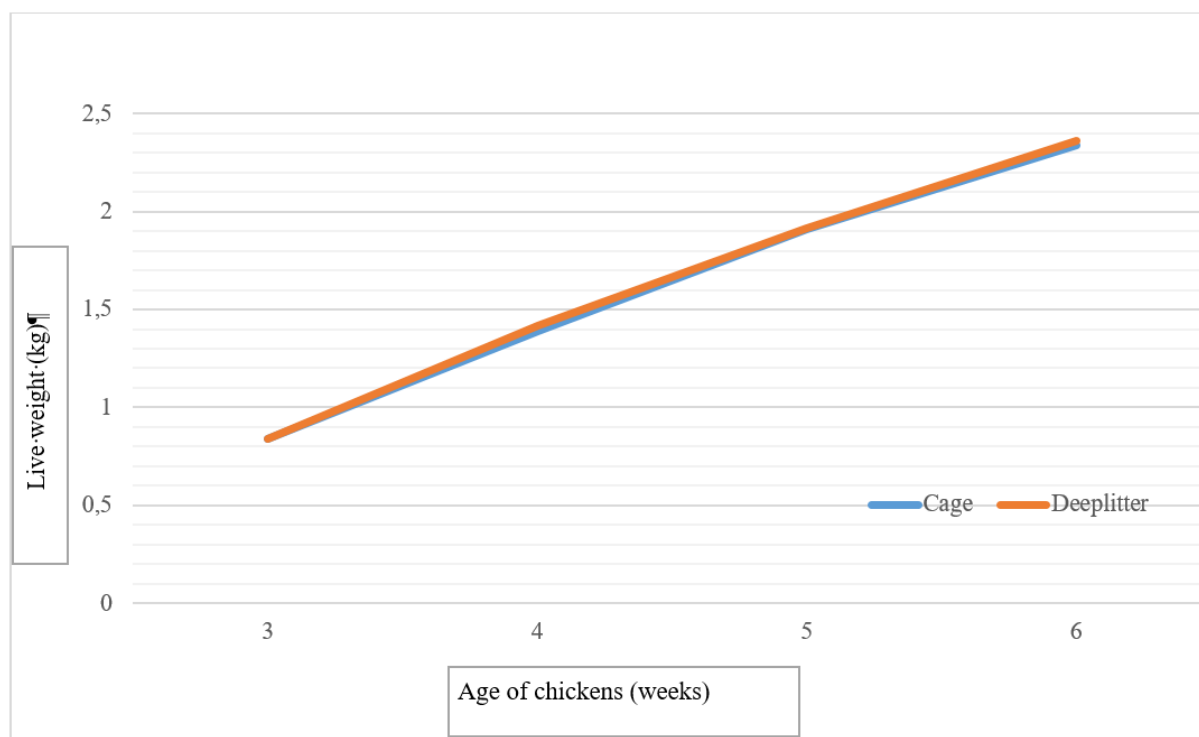


Figure 1. Commercial broiler growth pattern under smallholder rearing systems

Table 1. Average production performance for commercial broiler chickens under smallholder rearing systems

Parameter	Cage	Deep Litter	Grand Mean	P-value	Significance
Total feed intake in finisher stage (kg)	1.49±0.08	1.54±0.09	1.51	0.244	NS
FCR	1.61±0.05	1.61±0.03	1.61	0.506	NS
Weight gain (kg)	0.92±0.03	0.94±0.02	0.93	0.298	NS
Carcass weight (kg)	1.68±0.02	1.69±0.01	1.69	0.579	NS
Dressing %	73.37±0.47	73.40±0.40	73.39	0.929	NS

Notes: Values=mean±standard deviation, NS=Not significant

different housing systems was not significantly different. However, Adegbenro et al. (2020) posit that commercial broiler chickens raised in cages consumed relatively lower amounts of feed compared to those under deep litter conditions, which contrasts with the findings of Abdel-Azeem et al. (2020), who reported that commercial broilers housed in cages consumed more feed than those housed on deep litter. The primary cause of this discrepancy is the stocking density used, where more birds were housed in cages (26 birds/m²) compared to the deep litter housing system (17

birds/m²) (Abdel-Azeem et al., 2020). Therefore, more birds tend to consume more feed.

The average FCR for both cage and deep litter housing systems was similar (1.61). This was supported by Younes (2017), who states that FCR for birds reared in cage and deep litter housing systems is the same. Similarly, no difference in feed intake of broilers reared in cage or floor systems was reported by several studies (Swain et al., 2002; Fortomaris et al., 2007; Ebrahim et al., 2013; Wang et al., 2015; Abdel-Azeem et al., 2020; Yan et al., 2021; Yilmaz Dikmen and Gündüz, 2025).

On the contrary, Menal et al. (2018) and Mesa et al. (2017) found that deep litter had a better feed conversion ratio than cage systems (Sogunle et al., 2008; Santos et al., 2012), while other studies observed that caged broiler chickens had significantly better FCR compared to birds housed on the floor (Abdel-Azeem et al., 2020; Abo Ghanima et al., 2020; Idrus et al., 2021). The inconsistencies in these results might stem from the different strains of commercial broilers used, variations in brooding periods, environmental conditions, stocking densities, and the scale of production in each study. Most of these studies used different commercial broiler strains. Brooding periods and the age at allocation to treatments also varied, ranging from day-old chicks (Abdel-Azeem et al., 2020) to four weeks old (Adegbenro et al., 2020). Stocking densities ranged from ten to twenty-six birds per square meter (Adegbenro et al., 2020).

The results obtained from this study indicate that the housing system does not significantly impact the growth, weight gain, or final body weight of commercial broiler chickens. Similar to the survey by Younes (2017), the final body weight of birds reared in cages and deep litter housing systems did not differ significantly. These results are in line with other findings, which show that weight gain in commercial broiler chickens raised in cage and deep litter housing systems was similar (Swain et al., 2002; Sogunle et al., 2008; Wang et al., 2015; Swain et al., 2002; Adegbenro et al., 2020). Fortomaris et al. (2007) also reported no differences in the body weight of Cobb 500 strain broilers at 28 and 35 days of age between cage and deep litter housing systems. However, some studies noted better performance in deep litter systems, with chickens raised under deep litter performing better than those from cages (Li et al., 2016; Khaleel, 2018; Yan et al., 2021; Yilmaz Dikmen and Gündüz, 2025). These differences may be attributed to enhanced breast muscle development in chickens reared in floor pens (Zhao et al., 2021; Idrus et al., 2021), resulting in greater weight gain. Using litter floor housing could therefore improve broiler growth performance without adversely affecting carcass traits compared to cage rearing (El-Maaty et al., 2023).

On the contrary, some studies have revealed that cage housing resulted in higher body weight and weight gain compared to deep litter for broiler chickens (Adler et al., 2020; Abo Ghanima et al., 2020; Honig et al., 2024). The difference in growth performance is most likely attributed to the fact that birds in cages have restricted movement, which allows them to utilize feed more efficiently and convert it into meat (Olawumi, 2015). This finding aligns with Çavuşoğlu et al. (2018), who observed that the average body weight of broilers was significantly higher in slatted-floor systems compared to birds reared on conventional deep-litter flooring. Additionally, Thanga et al. (2001) reported that broiler chickens reared in cages performed better than those housed in floor systems. The inconsistencies found across studies may be influenced by multiple factors, including genotype, slaughter age, cage system type, housing design, litter materials, stocking density, and the environmental conditions within the housing.

The carcass weight of birds from the two systems was not significantly different ($p < 0.05$). The mean carcass weight for cage housing was 1.68 kg, while that for deep litter housing was 1.69 kg. Dressing percentage for cage and deep litter housing systems was also not significantly different ($p < 0.05$), with a mean of 73.4% for both systems. Carcass traits (carcass weight and dressing percentage) of broiler chickens raised in cage and deep litter housing showed no significant differences in this study. This finding is supported by Diktaş et al. (2015), who also recorded similar carcass weights for broiler chickens raised under different housing systems, despite differences in brooding period, stocking density, and nutritional diets. Conversely, other studies have found that birds reared in cages exhibited significantly higher dressing percentages (Abdel-Azeem et al., 2020; Abo Ghanima et al., 2020; Adegbenro et al., 2020).

CONCLUSION

This study has shown that cage and deep litter housing systems do not significantly differ in

their effects on the performance of broiler chickens, in terms of feed intake, feed conversion ratios, growth, final live weights, carcass weights, and dressing percentages. Therefore, either of the two housing systems can be effectively used to raise broiler chickens under small-scale broiler production systems.

Conflict of Interest

The authors declare that they have no conflict of interest.

Data Availability

Data is available upon reasonable request from the first author.

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