Effects of Rearing System and Age on Egg Weight and Egg Production of Three Pure-Line Local Village Chickens

Julie Marzlinda, M.R.[1]*, Nooraisyah, S.[2], Azrikin Shah, A.[1], Muhammad Syafri Famin, A.A. [1], Muhammad Khairul Azwan, M.[1], Syahirah, M. Y. [1], Norbaizura, H.[3]

[1]Malaysian Agricultural Research and Development Institute (MARDI) Kluang, KM 15 Jalan Kluang-Kota Tinggi, 86000 Kluang, Johor.

[2]Malaysian Agricultural Research and Development Institute (MARDI), Headquarters, Persiaran MARDI -UPM, 43400 Serdang, Selangor.

[3]Malaysian Agricultural Research and Development Institute (MARDI) Muadzam Shah, KM 5 Jalan Rompin, 26700 Muadzam Shah, Pahang.

*Corresponding author: juliem@mardi.gov.my

Received: 22 January 2026
Accepted: 12 May 2026

Abstract

This study evaluated the effects of genotype, rearing system, and age on egg weight (EWT) and hen-day egg production (HDEP) in three pure lines of Malaysian local village chickens (Groups A, B, and D) maintained at MARDI. Two rearing systems were used indicating 20 birds per line were used in individual cages (CG) and 45 per line in the litter floor pens system(LF) the performance was monitored from 18 to 36 weeks of age. Genotype and rearing systems significantly affected both EWT ($p < 0.0001$) and HDEP ($p = 0.0016$) traits. Group B produced the heaviest eggs (45.17 g) and the highest HDEP (51.92%), followed by Groups D and A. Hens reared on LF exhibited slightly higher EWT (44.38 g) and markedly higher HDEP (57.52%) compared to those in CG (43.95 g; 41.53%). Significant genotype × rearing system interactions ($p < 0.05$) indicated that performance varied among genotypes under different housing environments. Age exerted a strong effect on both traits ($p < 0.0001$), with significant age × system and age × genotype interactions ($p < 0.001$). Peak productivity occurred at 27 -29 weeks of age (EWT: 46.5 g; HDEP: 62.4%). These findings demonstrate that genotype, rearing system, and age collectively and interactively influence egg weight and laying performance in pure chicken lines, emphasizing the importance of integrating genetic selection and housing management strategies to improve productivity and sustainability in local poultry breeding programs.

Keywords: Egg weight, hen-day egg production, rearing system, village chicken

Introduction

Rearing systems play a critical role in influencing both growth and reproductive traits of chickens; however, the effects vary depending on breed and management practices. Local village chickens are commonly reared under diverse management systems, ranging from organic free-range to semi-intensive and intensive systems.

Egg quality is determined mostly by genetic background, rearing environment, and management conditions, making it essential to compare performance across different systems (Ahmad *et al*., 2019). Despite their adaptability, the productivity of local village chickens remains lower than that of commercial breeds, particularly in egg production. To address this limitation, improved local breeds such as MARDI's dual-purpose Ayam Saga chicken have been developed, showing increased productivity and adaptability to both LF and CG systems (Roziatul *et al*., 2021).

The LF system, widely used allows natural movement and social interaction, can enhance hen welfare such as dustbathing, scratching, and social interaction. Despite its welfare benefits, LF system exposes birds to environmental stressors such as ammonia accumulation, poor air quality, pathogen proliferation, and heat stress caused by high temperature and humidity, which may negatively impact feed intake, egg production, and overall egg quality (Wang Lai-di *et al*., 2021; Bhadauria *et al.,* 2019)

Meanwhile, individual CG systems provide greater control over feed intake and enable accurate monitoring of egg production yet limit the hen's ability to perform natural behaviours. As a result, egg production and quality outcomes may vary between these systems due to the trade-off between welfare and management precision. Previous studies conducted in tropical regions have reported similar observations. Some research has shown that hens in CG systems produce heavier eggs compared to those in LF systems, while other findings suggest the opposite, with hens in LF produced heavier eggs (Susilo *et al*., 2025; Rakonjac *et al.,* 2021; Ahmad *et al*., 2019).

Therefore, this study aims to evaluate the egg production performance of different pure line local village chickens under different rearing systems, providing valuable insights to support breeding improvements and management strategies for sustainable local chicken production.

Materials and Methods

Animal Ethics

The experiment was carried out in compliance with established animal welfare guidelines and approved by the MARDI Animal Ethics Committee (Approval No. 20210827/R/MAEC00099).

Animals, Management and Experimental Design

Since 2008, three pure lines of village chickens have been developed at MARDI Muadzam Shah: Group A, originating from the southern region of Malaysia; Group B, originating from the northern region; and Group D, representing the Ayam Saga chicken line. All day-old chicks (DOCs) from each group were obtained from the Poultry Unit, MARDI Muadzam Shah, Pahang, and reared separately in brooder floor pens bedded with sawdust. All birds were managed under a standard vaccination schedule, which included Marek's disease, Newcastle disease virus, Infectious Bronchitis virus (Bio-Vac ND/IB), Infectious Bursal disease virus (IBA-Vac), fowl pox (Vaiol-Vac), infectious coryza, and infectious laryngotracheitis (Larvac). Vaccination against Egg Drop Syndrome (EDS) was administered at 16 weeks of age, prior to the onset of lay.

At 10 weeks of age, pullets from the three pure lines (Groups A, B, and D) were selected based on phenotypic traits characteristic of each line. A total of 65 birds per line were used, and treatments were arranged in a Completely Randomised Design (CRD). Birds were assigned to two rearing systems: individual cages (CG) and litter floor pens (LF). This study was conducted until the birds reached 36 weeks of age. All birds were given a commercial grower diet from 10 to 15 weeks of age, followed by a breeder diet from 16 weeks onward, with clean water provided *ad libitum*.

Feed intake measurements were not conducted due to differences in housing systems, which may have resulted in variable levels of feed wastage, particularly in litter floor pens, that could not be fully quantified during the study period. Environmental parameters such as temperature and litter condition were maintained under standard MARDI farm protocol, but were not continuously recorded.

Individual Cage System (CG)

A total of 60 birds were reared in the CG system using two tier A type layer chicken cages. Twenty birds of each group were allocated randomly in individual cages (20 individual birds × 3 groups) with each cage 12 × 16 × 20 inches.

Litter Floor System (LF)

Fifteen birds were housed per pen and with three replicates per group were randomly reared in litter floor pens. Each pen measured 120 × 180 cm in the LF system (15 birds per pen × 3 replicate × 3 group).

Egg Production

Daily egg production was recorded from 18 to 36 weeks of age, and each egg collected was weighed using a digital weighing balance between 9 and 10 am. Hen-day egg production (HDEP) was calculated as the percentage of total eggs produced during a given period divided by the number of live hens in that same period, adjusted for mortality.

HDEP = (Total number of eggs produced during the period/ Total number of hen-days (alive) in the same period) × 100

Statistical Analysis

Data on egg weight (EWT) and hen-day egg production (HDEP) were assessed for normality using PROC UNIVARIATE in the Statistical Analysis System (SAS) software, version 9.4 (SAS Institute Inc., Cary, NC, USA). Data on HDEP were log-transformed prior to analysis to meet the assumption of normality. All data were analysed using the General Linear Model (PROC GLM), in which the main effects of genotype, rearing system, and their interaction were included in the model. Least squares means (LSMEANS) were computed, and pairwise comparisons were adjusted using the Tukey–Kramer test at a significance level of $p < 0.05$.

Results and Discussion

Egg quality plays a crucial role in consumer acceptance, and the economic success of egg producers is determined by the total number and quality of eggs sold. Several studies have demonstrated that egg quality traits, including egg weight, have a strong genetic basis and vary significantly among different strains or genotypes of hens, indicating the influence of genetic background on egg characteristics (Akintunde & Toye, 2022; Ahmad *et al*., 2019; Islam & Dulta, 2010). Additionally, housing systems have been shown to affect egg quality, with LF or CG systems often producing slightly heavier eggs than free-range or organic systems, although such differences are generally modest and influenced by factors such as feed quality and stress levels (Islam *et al*., 2024; Rakonjac *et al.,* 2021; Dong *et al*., 2017). Therefore, understanding both genetic and environmental factors is essential for optimizing egg quality and ensuring commercial success.

In Table 1, the effects of different pure lines (Group A, B, and D) and rearing system on egg weight showed significant differences ($p< 0.0001$ and 0.0016, respectively). These findings are consistent with previous studies, which have shown that different rearing systems significantly affect egg weight (Ahmad *et al*., 2019; Rafiqul *et al*., 2024; Kakar *et al*., 2025). As shown in Table 1, egg weight varies between groups, where Group B produced the heaviest eggs (45.17 g), followed by Group A (44.45 g) and Group D (42.87 g), while type of rearing system, hens reared on the LF produced significantly heavier eggs (44.38 g) compared to those housed in CG (43.95 g).

This finding is similar to Ahmad et al. (2019), who reported significant effects of both genotype and rearing system on EWT as well. Their study compared three genotypes: purebred Naked Neck (NN) and two crosses, Rhode Island Red × Naked Neck (RNN) and Black Australorp × Naked Neck (BNN). They also studied three types of rearing systems: free-range (FR), semi-intensive (SI), and a three-tier battery cage system (CG) as an intensive system. EWT showed significantly different ($p < 0.0001$) between genotypes, where in RNN and BNN hens (53.16 g and 53.13 g, respectively) compared to NN hens (46.68 g). However, in contrast to rearing systems, the CG system had the heaviest eggs (51.54 g), followed by SI (51.31 g) and FR (50.11 g), with a significant difference at $p < 0.0001$.

Meanwhile, results were similar to findings by Susilo et al. (2025), as Lohman Brown hens show differences in EWT across rearing systems. Hens reared in LF (53.7 g) had heavier EWT (p

< 0.04) compared to those in CG (53.1 g); however, there was no interaction between the rearing system and hens' age ($p > 0.05$). The observed differences in egg weight may be associated with variations in nutrient allocation and physiological responses under different rearing conditions. Birds raised in less restrictive systems may experience improved welfare and greater opportunities to express natural behaviours, which can influence feed utilisation efficiency and support the egg formation process. In addition, genetic differences among pure lines may contribute to variation in nutrient deposition into the yolk and albumen, resulting in differences in egg weight.

Table 1. Effects of rearing system on LS mean egg weight (g) of three pure line local village chicken (A, B and D) from 18 to 36 weeks of age chicken

Item		EWT (g)	p-value
Group	A	44.45[b]	<.0001
	B	45.17[a]	
	D	42.87[c]	
Rearing system	CG	43.95[b]	0.0016
	LF	44.38[a]	
Group*rearing system			<.0001

Means in a column with different superscripts differ significantly at p<0.05. LS mean: Least squares mean, EWT: egg weight, CG: individual cage, LF: litter floor pen.

Results from Table 2 show the effects of different pure lines (Groups A, B, and D) and rearing systems on HDEP, with significant differences at $p < 0.0001$, respectively. HDEP from Group B and D (51.92% and 50.05%, respectively) was significantly higher compared to Group A (46.60g). This is similar to the findings by Susilo et al. (2025), which showed that the type of rearing system had a significant effect on HDEP ($p < 0.05$), where hens reared on LF had a higher HDEP (76.7%) compared to those in the CG (67.4%).

The findings of the present study agreed with previous reports that had a significant influence of rearing systems and genotypes on hen-day egg production (HDEP). As reported by Kakar et al. (2025), HDEP of three chicken genotypes (full feather (FF), crossbred, partial feather (PF), and Naked Neck (NN) were significantly affected ($p<0.05$) by different housing systems, with production values ranging from 44.73% to 45.48%. Similarly, Ahmad et al. (2019) observed that variations in housing conditions, including FR, SI, and CG systems, had a significant effect ($p< 0.0001$) on the productive performance of three chicken genotypes, resulting in HDEP values between 46.68% and 60.71%.

Table 2. Effects of rearing system on LS mean hen-day egg production (%) of three pure line local village chicken (A, B and D) from 18 to 36 weeks of age chicken

Item		HDEP (%)	p-value
Group	A	46.60^{b}	<.0001
	B	51.92^{a}	
	D	50.05^{a}	
Rearing system	CG	41.53^{b}	<.0001
	LF	57.52^{a}	
Group*rearing system			<.0001

Means in a column with common superscript differ significantly at p<0.05. LS mean: Least squares mean, HDEP: Hen-day egg production.

In accordance with these findings, Rakonjac *et al.* (2021) reported that the rearing system, genotype, and their interaction had a significant effect ($p < 0.05$) on hen-day egg production (HDEP) in Isa Brown and New Hampshire laying hens. These results collectively confirm that both genetic basis and environmental management factors contribute substantially and interactively to the productive performance of laying hens. In a related study, Ademola *et al.* (2023) observed that pullets transferred to individual battery cages produced significantly ($p < 0.05$) larger eggs in purebred Goliath (GG) and Sussex (SS) strains (64.89 g and 64.85 g, respectively), whereas smaller eggs (39.12–39.38 g) were obtained from purebred Yoruba Ecotype chicken (YEC) and crossbred GG×YEC and SS×YEC hens ($p < 0.05$).

The significant differences in HDEP among pure lines and rearing systems may be explained by variations in reproductive efficiency, nutrient utilisation, and the ability of hens to adapt to different environmental conditions. Genetic differences among pure lines can influence ovarian activity, age at sexual maturity, laying persistence, and the efficiency of converting dietary nutrients into egg production, which may explain the higher HDEP observed in Groups B and D compared to Group A. In addition, rearing systems may affect production through differences in bird movement, feeding behaviour, stocking density, and stress exposure, all of which influence endocrine responses related to reproduction. Birds reared in less restrictive environments may experience improved welfare conditions and greater behavioural expression, which can support sustained laying performance and higher egg production.

Table 3, shows the interaction effects of both CG and LG systems with 3 groups (A, B, and D) on EWT and HDEP ($p<0.05$). Similarly, findings by Ahmad *et al*. (2019) shows EWT and HDEP had interaction effects on different genotype × housing systems ($p<0.05$). According to Kakar *et al*., (2025) findings, HDEP also show an interaction between rearing system (aviary, backyard, and open sided) with different chicken genotypes (3 housing systems × 3 genotypes) ($p<0.05$) but in contrast with interaction effects on EWT ($P>0.05$).

Table 3. Interaction effects (rearing system x group) on LS mean EWT (g) and HDEP (%) of three pure line local village chicken (A, B and D) from 18 to 36 weeks of age chicken

Item	CG			p-value	LF			p-value
	A	B	D		A	B	D	
EWT (g)	43.48^{b}	46.39^{a}	41.99^{c}	<.0001	45.43^{a}	43.96^{b}	43.75^{b}	<.0001
HDEP (%)	38.30^{b}	44.38^{a}	42.91^{a}	0.007	55.96^{b}	59.34^{a}	57.06^{ab}	0.0207

Means in a row with different superscripts differ significantly at p<0.05. LS mean: Least squares mean, EWT: egg weight, HDEP: Hen-day egg production, CG: individual cage, LF: litter floor pen

Table 4 indicates that age, the interaction between age and rearing system, age and group, and age, group, and rearing system significantly affected EWT (p< 0.0001, < 0.0001, 0.012, and < 0.001, respectively) and HDEP (p< 0.0001, < 0.0001, and < 0.001, respectively), except for the three-way interaction of age, group, and rearing system on HDEP (p> 0.05). EWT and HDEP increased progressively with advancing age, reflecting the physiological maturation of the reproductive system and improved egg formation efficiency. The highest EWT (49.82 g) and HDEP (62.42%) were recorded between 27 and 36 weeks of age, indicating the attainment of peak lay during this period.

These results are consistent with the findings of Susilo *et al.* (2025), who reported significant effects of age and rearing system on both EWT and HDEP in Lohman Brown hens between 21 and 30 weeks of age under LF and CG systems. However, their study did not observe a significant interaction between the rearing system and age (p > 0.05), suggesting that age-related productivity trends are relatively consistent across rearing environments. In contrast, the present study (Table 4) demonstrated significant interaction effects, indicating that the rate of increase in EWT and HDEP with age varies depending on genotype and housing condition.

Similarly, Bhadauria *et al.* (2019) observed that rearing systems influenced HDEP differently across age periods. Individually caged hens exhibited higher production at 28–32 weeks (p< 0.05), while colony-reared hens showed superior HDEP at 32–36 weeks (p< 0.01). In the current study (Table 4), a comparable trend was observed, where production peaked between 27 and 29 weeks (range 61.21%- 62.42%) before gradually declining, aligning with typical laying patterns reported in commercial and indigenous breeds.

Collectively, these findings confirm that age is a critical determinant of both egg weight and laying performance, and its effects are further modulated by genotype and rearing system. Understanding these interactions is essential for optimizing management and feeding strategies to maintain consistent productivity throughout the laying cycle.

Table 4. Effects of age on LS mean egg weight and egg production (%) of three pure line local village chicken (A, B and D) from 18 to 36 weeks of age village chicken

Item		EWT (g)	HDEP (%)	p-value	
				EWT	HDEP
Age	18	34.50^{k}	21.46^{h}		
	19	35.80^{k}	30.17^{h}		
	20	37.68^{j}	40.10^{fg}		
	21	39.63^{i}	46.05^{efg}		
	22	41.18^{h}	60.29^{ab}		
	23	41.52^{h}	49.26^{cdef}		
	24	43.00^{g}	55.90^{abcd}		
	25	43.52^{g}	51.42^{bcde}		
	26	44.78^{f}	55.49^{abcd}		
	27	45.47^{ef}	62.21^{a}	<.0001	<.0001
	28	46.07^{ed}	62.42^{a}		
	29	46.52^{cd}	61.21^{a}		
	30	47.08^{bc}	56.72^{abc}		
	31	47.76^{b}	54.25^{abcde}		
	32	48.04^{b}	47.33^{cdefg}		
	33	46.94^{bcd}	39.63^{g}		
	34	47.93^{b}	46.52^{defg}		
	35	49.59^{a}	50.31^{cde}		
	36	49.82^{a}	50.24^{cde}		
Age*rearing system				<.0001	<.0001
Age*group				0.0012	<.0001
Age*Group*Rearing system				<.0001	0.0766

Means in a column with different superscripts differ significantly at p<0.05.
LS mean: Least squares mean, EWT: egg weight, HDEP: Hen-day egg production, CG: individual cage, LF: litter floor pen

Conclusion

This study demonstrated that genotype, rearing system, and age significantly influenced egg weight and hen-day egg production in three pure-line Malaysian local village chickens during the early laying period (18–36 weeks of age). Group B showed superior productive performance, producing heavier eggs and achieving higher hen-day egg production compared with Groups A and D. Hens reared under the litter floor system exhibited greater egg weight and hen-day egg production than those maintained in individual cages. In addition, significant interaction effects among genotype, rearing system, and age indicate that productive responses varied according to both genetic background and housing environment.

These findings further suggest that optimizing rearing systems according to genotype-specific requirements may enhance egg production efficiency and overall flock performance and may potentially improve hatchability, as egg size and quality are associated with embryo viability and chick development. Overall, the results highlight the importance of integrating genetic selection with appropriate rearing strategies to optimize laying performance in local chicken breeding programmes. This study provides useful baseline information for improving productivity and supporting the sustainable development of local chicken production systems.

Acknowledgement

Sincere appreciation would like to be expressed to all officers and staff of the Poultry Unit at MARDI Muadzam Shah and MARDI Kluang for their support and assistance in conducting this project. Furthermore, utmost appreciation to Malaysia Ministry of Agriculture (KPKM) for funding this project under 12th Malaysia Development Plan Grant (PRL-523).

Conflict of Interest

The authors declare that there are no conflicts of interest.

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