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Comparative Growth Performance and Feed Efficiency of Nigerian Indigenous Chickens and Their Crosses with Arbor Acre Broiler Breeders Hens

***Ukwu Henry Okechukwu and Audu Ochefije Mercy**

Department of Animal Breeding and Physiology, College of Animal Science, Federal University of Agriculture Makurdi, Benue State, Nigeria

*Corresponding authors' email: ukwu.henry@uam.edu.ng

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ABSTRACT
This study compared the growth performance and feed efficiency of Nigerian indigenous chickens (NIC) and their crosses with Arbor Acre broiler breeders (NIC×AA) from hatch to 12 weeks of age. Sixty chicks per genetic group were reared under a deep litter system in a completely randomized design with three replicates of 20 birds each. Body weight, feed intake, weight gain, and feed conversion ratio (FCR) were recorded weekly and analyzed using independent samples t-tests and a repeated measure analysis of variance (ANOVA). NIC×AA chicks were significantly heavier than NIC at hatch, and remained significantly heavier throughout the rearing period, reaching 1,923.11 g at week 12 compared with 726.46 g for NIC ($P < 0.001$). Total weight gain and average daily gain were significantly higher in NIC×AA than pure NIC birds over the entire period ($P < 0.001$). Feed conversion ratio deteriorated markedly in NIC across the production phases (2.37 to 5.96), whereas NIC×AA maintained a comparatively stable and superior FCR (1.67 to 2.54), yielding an overall FCR of 2.24 versus 4.21 for NIC ($P < 0.001$). Repeated measures ANOVA revealed a significant genetic group × week interaction ($P < 0.001$; partial $\eta^2 = 0.993$), confirming that the two genotypes diverged progressively in growth rate rather than differing only in absolute body weight. These findings indicate that crossbreeding Nigerian indigenous chickens with Arbor Acre broiler breeders substantially improves growth performance and feed efficiency. This therefore represents a practical and economically viable strategy for enhancing poultry meat production among smallholder farmers in Nigeria

Keywords: Nigerian Indigenous Chicken, Arbor Acre, Crossbreeding, Growth Performance, Feed Conversion Ratio

INTRODUCTION

Poultry production is among the most dynamic and efficient livestock sectors globally, contributing substantially to food security, income generation, and nutritional supply, particularly in developing countries. In sub-Saharan Africa, and specifically Nigeria, poultry production plays a critical role in alleviating animal protein deficiency due to its relatively low capital requirement, rapid turnover, and high feed conversion efficiency compared to other livestock species (Atansuyi et al., 2022; FAO, 2023). Indigenous chickens dominate rural and peri-urban production systems, accounting for a large proportion of the poultry population because of their adaptability to harsh environmental conditions, resistance to endemic diseases, and ability to thrive under low-input management systems. Despite these advantages, their productivity is constrained by poor growth performance, low mature body weight, and inefficient feed utilization, which limit their commercial potential for meat production (Ogunpaimo et al., 2021; Padhi, 2016).

Growth performance traits such as body weight, average daily gain, feed intake, and feed conversion ratio (FCR) are fundamental indicators of efficiency and profitability in poultry production systems. These traits are quantitatively inherited and influenced by complex interactions among genotype, nutrition, and environmental conditions, with genotype playing a central role in determining growth potential and metabolic efficiency. Commercial broiler strains, including Arbor Acre, have been intensively selected for rapid growth, superior feed efficiency, and high carcass yield, enabling them to reach market weight within a short production cycle. In contrast, indigenous chickens exhibit slower growth rates and higher maintenance energy requirements, resulting in lower productivity under intensive production systems (Dzungwe et al., 2024).

To address these limitations, crossbreeding has been widely adopted as a genetic improvement strategy aimed at combining the desirable traits of indigenous and exotic breeds. The underlying principle of crossbreeding lies in the exploitation of heterosis (hybrid vigor) and breed complementarity, where crossbred progeny may outperform their parental lines in economically important traits such as growth rate and feed efficiency. Empirical studies across tropical production environments have demonstrated that crossing indigenous chickens with commercial broiler strains significantly improves growth performance, feed utilization, and carcass characteristics, while retaining adaptive traits necessary for survival under local conditions (Amao et al., 2024; Dzungwe et al., 2024). These improvements are attributed to both additive genetic effects and non-additive gene interactions, which enhance nutrient utilization efficiency and physiological performance in crossbred birds. Specifically, studies comparing body weight variations in improved indigenous broiler crosses (FUNAAB Alpha) with crossbreds and exotic chicken strains, including Arbor Acre, have demonstrated genotype-dependent differences in growth trajectories, with Arbor Acre chickens consistently achieving heavier body weights at early stages of growth (Ogunpaimo et al., 2020).

Nevertheless, the magnitude and direction of crossbreeding effects are highly dependent on the specific genetic combinations, mating design, and production environment, indicating that performance outcomes cannot be generalized across all crossbreeding programs. In Nigeria, several studies have reported improved growth performance in crossbred chickens relative to pure indigenous lines; however, there remains a paucity of detailed comparative evaluations involving specific commercial broiler lines such as Arbor Acre, particularly with respect to longitudinal growth patterns and feed efficiency under controlled experimental conditions (Ogunpaimo et al., 2021; Sanda et al., 2023). Moreover, many existing studies have focused primarily on endpoint measurements such as final body weight or carcass traits, with limited emphasis on weekly growth dynamics and feed intake, which are critical for understanding growth trajectories and optimizing feeding strategies.

From a conceptual standpoint, growth performance in poultry can be viewed within a genotype–environment interaction framework, where genetic potential (purebred indigenous versus crossbred genotypes) directly influences phenotypic expression of growth traits, while environmental and management factors modulate this expression. In this context, crossbreeding indigenous chickens with Arbor Acre broiler breeders is expected to result in heterotic effects that enhance growth rate and feed efficiency compared to pure indigenous chickens. However, without empirical evaluation of these effects across the growth period, particularly under tropical production conditions, the practical value of such crossbreeding strategies remains insufficiently defined.

This gap in knowledge presents a critical challenge for the development of sustainable poultry breeding programs in Nigeria, where there is a need to balance improved productivity with environmental adaptability and resource efficiency. Consequently, a systematic comparison of growth performance and feed utilization between purebred indigenous chickens and their crossbreds with Arbor Acre broiler breeders is essential to provide evidence-based recommendations for genetic improvement strategies. Such information is particularly important for smallholder and semi-intensive production systems, where feed cost constitutes a major proportion of total production expenses and efficiency gains can significantly enhance profitability.

Therefore, this study was designed to comparatively evaluate the growth performance and feed efficiency of Nigerian indigenous chickens and their crossbreds with Arbor Acre broiler breeders, using weekly body weight and feed intake measurements up to 12 weeks of age. The outcome of this study contributes to a better understanding of genotype-driven differences in growth and feed utilization, thereby supporting the development of efficient and sustainable poultry production systems in tropical environments.

MATERIALS AND METHODS

Experimental Location

The study was conducted at the Teaching and Research Farm, College of Animal Science, Joseph Sarwuan Tarka University, Makurdi, Nigeria. The location lies within the Southern Guinea Savannah agro-ecological zone of Nigeria at approximately 7.73° N latitude and 8.52° E longitude, with an elevation of about 84–91 m above sea level (Geodatos, 2024). The climate is tropical wet and dry, characterized by a mean annual rainfall of approximately 785 mm, distributed primarily between May and September, with a dry season from November to March. Mean daily temperatures range between 21.8°C and 39.4°C, with peak heat occurring during the late dry season, particularly in March (Weather Atlas, 2024).

Experimental Birds and Breeding Procedure

Twelve (12) Arbor Acre (AA) broiler breeder hens in active lay were artificially inseminated using pooled semen collected from five (5) mature Nigerian indigenous chicken (NIC) cocks to produce the crossbred group (NICxAA). Twenty-five (25) normal feathered Nigerian indigenous chicken hens already in lay were inseminated with pooled semen collected from the same five (5) indigenous cocks to produce the purebred group.

Semen was collected using the abdominal massage technique, pooled, and diluted with fresh coconut water at a ratio of 1:1 (semen: coconut water) to enhance viability prior to artificial insemination. Artificial insemination was carried out following standard poultry reproductive procedures.

Management of Experimental Chicks

Sixty (60) chicks from each genetic groups were brooded and managed under identical environmental conditions in a deep litter system. A commercial chick mash was provided during the starter phase (early growth stage), while a commercial grower mash was introduced during the grower phase (5 to 8 weeks) to meet increasing nutrient requirements. A commercial finisher feed was provided during the finisher phase (9 to 12 weeks). Feed and clean drinking water were provided *ad libitum* throughout the experimental period. Routine health management was observed, including the administration of anticoccidial medications to prevent coccidiosis, and antibiotics to control bacterial infections. All chicks were reared under identical housing, feeding, and health management conditions. Each chick was tagged for proper tracking of weekly body weight.

Experimental Design

The study was arranged as a Completely Randomized Design (CRD) with two genetic groups:

Purebred Nigerian indigenous chickens and Crossbred chickens (Nigerian indigenous cocks♂ × Arbor Acre breeder hens♀). Each genetic group was replicated thrice with 20 chicks per replicate.

Data Collection

Data were collected on growth performance and feed utilization traits as follows:

Body Weight (g)

Individual birds were weighed at day-old and weekly thereafter up to 12 weeks using a sensitive digital weighing balance with 0.1 g accuracy.

Feed Intake (g)

Weekly feed intake was calculated as the difference between feed supplied and feed remaining at the end of each week.

Weekly Weight Gain (g)

Determined as the difference between successive weekly body weight measurements.

Feed Conversion Ratio (FCR)

Calculated as the ratio of feed intake to weight gain.

Statistical Analysis

Data collected on growth performance were analyzed using the following statistical model:

$Y_{ij} = \mu + G_i + e_{ij}$

Where:

Y_{ij} = observed value of growth or feed trait

μ = overall mean

Gi = fixed effect of genetic group (i= NIC, and NICxAA crossbred)
eij = random error associated with individual bird.
Assumptions of normality and homogeneity of variance were considered satisfied.
Prior to analysis, the assumption of normality was assessed using the Shapiro–Wilk test, and homogeneity of variance between groups was evaluated using Levene's test for equality of variances. Differences in growth performance and feed efficiency traits between the two genetic groups were determined using the independent samples t-test. Where Levene's test indicated equal variances (P > 0.05), the pooled-variance t-statistic was reported; where variances were unequal (P ≤ 0.05), the Welch–Satterthwaite corrected degrees of freedom were applied. Means were declared significantly different at P < 0.05. To evaluate whether the body weight growth trajectories of Nigerian indigenous chickens (NIC) and their crosses with Arbor Acre broilers (NIC×AA) differed over time, a mixed-model repeated measures analysis of variance (ANOVA) was performed using the General Linear Model (GLM) procedure. Genetic group (NIC vs. NIC×AA) was specified as the between-subjects factor, and week (13 levels: hatch weight and weeks 1 through 12) was specified as the within-subjects factor, with the replicate (pen) as the experimental unit (n = 3 replicates per group; total n = 6). The Genetic group × Week interaction term was included in the model to determine whether the rate of body weight change over time differed significantly between the two genetic groups.
Mauchly's test of sphericity was used to assess the assumption that the variances of the differences between all possible pairs of repeated measurements were equal. To provide a more robust analysis, Greenhouse–Geisser corrected degrees of freedom were also applied to all within-subject effects, including the main effect of week and the Genetic group × Week interaction, following the recommendation of Field (2018) for designs in which the number of subjects approaches or is smaller than the number of repeated measures. Effect sizes were expressed as partial eta-squared (partial η^2). Significant interaction effects were interpreted as evidence that body weight growth trajectories differed between genetic groups across the rearing period. All analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY).

RESULTS AND DISCUSSION

Starter Phase Growth Performance (Hatch to Week 4)

The effects of genetic group on growth performance and feed efficiency during the starter phase are presented in Table 1. Hatch weight differed significantly between groups (P = 0.006), with NIC×AA chicks (37.20 g) being heavier than NIC chicks (28.72 g) at day of hatch. By the end of week 4, body weight of NIC×AA (421.05 g) was significantly (P < 0.001) greater than that of NIC (169.18 g). Consequently, total body weight gain and average daily weight gain were both significantly (P < 0.001) higher in NIC×AA than in NIC, with NIC×AA recording a total weight gain of 383.84 g compared with 140.47 g for NIC, and an average daily gain of 13.71 vs. 5.02 g/bird/day, respectively. Feed intake and average daily feed intake were also significantly (P < 0.001) greater in NIC×AA than in NIC. Despite consuming more feed, NIC×AA achieved a markedly superior (P < 0.001) feed conversion ratio (1.67) compared with NIC (2.37), indicating substantially better feed efficiency during the starter phase.

Table 1: Growth Performance of Nigerian Indigenous Chickens (NIC) and their Crosses with Arbor Acre broilers (NIC×AA) during the Starter Phase (Hatch to Week 4) (Mean ± SEM)

Variable	Genetic group		*P*-value
	NIC	NIC×AA	
Hatch weight (g)	28.72±1.58	37.20±0.14	0.006
Body weight at week 4 (g)	169.18±5.61	421.05±4.18	<0.001
Total body weight gain (g)	140.47±6.03	383.84±4.27	<0.001
Average daily weight gain (g/bird/day)	5.02±0.22	13.71±0.15	<0.001
Feed intake (g/bird)	333.28±15.36	642.16±8.73	<0.001
Average daily feed intake (g/bird/day)	11.90±0.55	22.93±0.31	<0.001
Feed conversion ratio	2.37±0.01	1.67±0.00	<0.001

NIC = Nigerian indigenous chicken; NIC×AA = NIC crossed with Arbor Acre broiler; SEM = standard error of the mean,

Grower Phase Growth Performance (Weeks 5–8)

Growth performance and feed efficiency during the grower phase are shown in Table 2. Body weight at week 8 was significantly (P < 0.001) higher in NIC×AA (1,033.90 g) than in NIC (439.29 g). Total body weight gain and average daily weight gain during this phase were both significantly (P < 0.001) greater in NIC×AA than in NIC. Again, NIC×AA recorded a total weight gain of 612.85 g during the grower phase compared with 270.10 g for NIC, corresponding to average daily gains of 21.89 and 9.64 g/bird/day, respectively. Feed intake and average daily feed intake were significantly (P < 0.001) higher in NIC×AA than NIC. The feed conversion ratio of NIC (3.31) was significantly higher than that of NIC×AA (2.17; P < 0.001), indicating progressively declining feed efficiency in NIC relative to the crossbreds as the rearing period advanced.

Table 2: Growth performance of Nigerian indigenous chickens (NIC) and their crosses with Arbor Acre broilers (NIC×AA) during the grower phase (weeks 5 to 8) (Mean ± SEM).

Variable	Genetic group		*P*-value
	NIC	NIC×AA	
Body weight at week 8 (g)	439.29±10.83	1,033.90±11.02	<0.001
Total body weight gain (g)	270.10±7.18	612.85±10.06	<0.001
Average daily weight gain (g/bird/day)	9.65±0.26	21.89±0.36	<0.001
Feed intake (g/bird)	892.53±20.84	1,328.73±22.11	<0.001
Average daily feed intake (g/bird/day)	31.88±0.74	47.45±0.79	<0.001
Feed conversion ratio	3.31±0.01	2.17±0.01	<0.001

NIC = Nigerian indigenous chicken; NIC×AA = NIC crossed with Arbor Acre broiler; SEM = standard error of the mean.

Finisher Phase and Overall Growth Performance (Weeks 9–12 and Hatch to Week 12)

The effects of genetic group on growth performance during the finisher phase and over the entire 12-week rearing period are presented in Table 3. During the finisher phase, body weight at week 12 was significantly ($P < 0.001$) higher in NIC×AA (1,923.10 g) than in NIC (726.46 g). Total body weight gain and average daily weight gain during weeks 9–12 were both significantly ($P < 0.001$) greater in NIC×AA than in NIC. Feed intake and average daily feed intake during the finisher phase were also significantly ($P < 0.05$) higher in NIC×AA than in NIC. The feed conversion ratio of NIC (5.96) was significantly ($P < 0.001$) more than twice that of NIC×AA (2.54) during this phase, reflecting a marked deterioration in feed efficiency in NIC birds as they approached market age.

Over the entire study period (hatch to week 12), NIC×AA recorded a total body weight gain of 1,885.90 g, which was significantly ($P < 0.001$) greater than the 697.74 g recorded for NIC. Average daily weight gain was similarly superior in NIC×AA (22.45 g/bird/day) compared with NIC (8.31 g/bird/day; $P < 0.001$). Total feed intake and average daily feed intake over the 12-week period were significantly higher in NIC×AA than in NIC ($P = 0.001$). The overall feed conversion ratio of NIC (4.21) was significantly ($P < 0.001$) higher than that recorded for NIC×AA (2.24), confirming that NIC×AA crossbreds were consistently more feed-efficient than pure Nigerian indigenous chickens across all phases of the production cycle.

Table 3: Growth Performance of Nigerian Indigenous Chickens (NIC) and their Crosses with Arbor Acre Broilers (NIC×AA) during the Finisher Phase (Weeks 9 to 12) and Overall Study Period (Hatch to Week 12) (Mean ± SEM)

Variable	Genetic group NIC	NIC×AA	*P*-value
Finisher phase (weeks 9–12)			
Body weight at week 12 (g)	726.46±15.91	1,923.11±46.00	<0.001
Total body weight gain (g)	287.17±8.04	889.20±48.17	<0.001
Average daily weight gain (g/bird/day)	10.26±0.29	31.76±1.72	<0.001
Feed intake (g/bird)	1,707.81±23.40	2,258.94±126.17	0.013
Average daily feed intake (g/bird/day)	60.99±0.84	80.68±4.51	0.013
Feed conversion ratio	5.96±0.16	2.54±0.01	<0.001
Overall (hatch to week 12)			
Total body weight gain (g)	697.74±16.45	1,885.90±46.12	<0.001
Average daily weight gain (g/bird/day)	8.31±0.20	22.45±0.55	<0.001
Total feed intake (g/bird)	2,933.61±56.15	4,229.83±129.14	0.001
Average daily feed intake (g/bird/day)	34.92±0.67	50.36±1.54	0.001
Overall feed conversion ratio	4.21±0.04	2.24±0.01	<0.001

NIC = Nigerian indigenous chicken; NIC×AA = NIC crossed with Arbor Acre broiler; SEM = standard error of the mean.

During the finisher phase (weeks 9–12), Figure 1 reveals a notable change in trajectory pattern for NIC. While NIC×AA continued its near-linear ascent, the NIC growth curve visibly flattened, with weekly increments decreasing progressively toward week 12. This deceleration in NIC reflects the approach of the indigenous birds to their genetic growth ceiling. In contrast, NIC×AA showed no such deceleration within the 12-week study period, suggesting that the growth plateau of the crossbreds extends well beyond week 12.

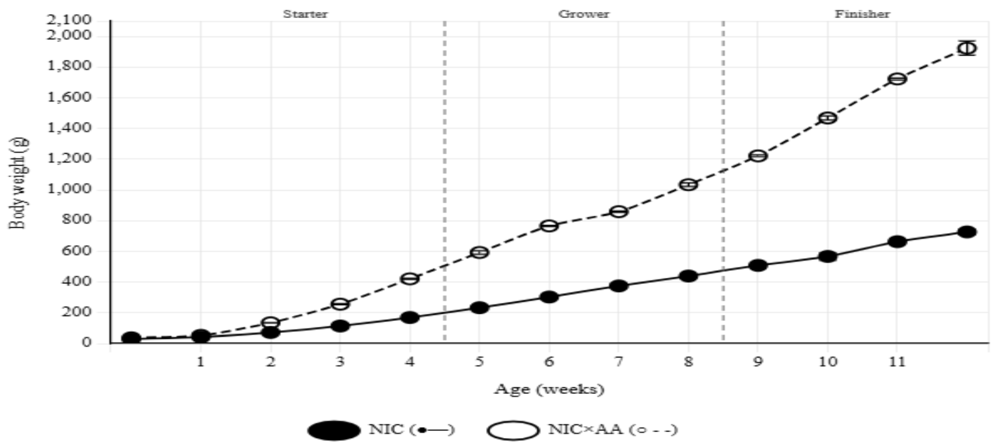

Figure 1: Growth trajectory of NIC and NICxAA

Growth Performance Trajectory

Between-Subjects Effect

The between-subjects effect of genetic group was highly significant ($P < 0.001$), indicating that NIC×AA was substantially heavier than NIC when body weight was averaged across the entire 12-week rearing period (Table 4). A partial η^2 of 0.998 means that 99.8% of the variance in average body weight between subjects was attributable to genetic group membership.

Table 4: Repeated Measures Analysis of Variance (ANOVA) for Body Weight of Nigerian Indigenous Chickens (NIC) and their Crosses with Arbor Acre broilers (NIC×AA) from Hatch to Week 12.

Source of variation	*df*	MS	*F*-value	*P*-value	Partial η^2
Between-subjects effects					
Genetic group (NIC vs. NIC×AA)	1	4,503,483.68	2,588.24	<0.001	0.998
Error (between subjects)	4	1,739.98	—	—	—
Within-subjects effects					
Week	12	1,151,821.96	2,690.62	<0.001	0.999
Greenhouse–Geisser correction	*1.09*	—	*2,690.67*	*<0.001*	*0.999*
Genetic group × Week	12	236,486.95	552.43	<0.001	0.993
Greenhouse–Geisser correction	*1.09*	—	*552.44*	*<0.001*	*0.993*
Error (within subjects)	48	428.09	—	—	—

Within-subjects Effect

The within-subjects effect of week was also highly significant ($P < 0.001$) after Greenhouse–Geisser correction ($\varepsilon = 0.091$), confirming that body weight increased significantly across the 13 time points (hatch to week 12) regardless of genetic group as presented in Table 4. The very large partial η^2 of 0.999 indicates that virtually all within-subject variance was explained by the passage of time. The very small Greenhouse–Geisser epsilon ($\varepsilon = 0.091$, close to the lower bound of $1/12 = 0.083$) reflects severe violation of the sphericity assumption, which is typical of longitudinal growth data where measurements at adjacent weeks are highly correlated and variances of differences between time points are markedly unequal. Reporting GG-corrected degrees of freedom (df = 1.09 rather than 12) is therefore the conservative and methodologically appropriate choice (Field, 2018), and the significance of the week effect is robust across both uncorrected and corrected tests.

Genetic Group × Week Interaction

There was significant genetic group × week interaction ($P < 0.001$) as shown in Table 4. This interaction confirms that NIC and NIC×AA did not simply differ in overall body weight, but grew at fundamentally different rates across the 12-week rearing period. A partial η^2 of 0.993 indicates that 99.3% of the variance in the rate of weight change over time was attributable to genetic group, leaving only 0.7% explained by random error. This demonstrates that the performance gap between NIC and NIC×AA was not fixed at hatch but widened progressively and systematically as rearing advanced, driven by the diverging growth physiology of the two genotypes.

Discussion

The significantly higher hatch weight of NIC×AA (37.20 g) compared with NIC (28.72 g) is consistent with documented differences between indigenous and exotic-cross chickens at hatch, which reflect the greater egg size and maternal nutrient deposition capacity of Arbor Acre breeder dams relative to indigenous hens (Ngambi *et al*., 2013). Ajayi (2010) noted that Nigerian local chickens are characteristically small-bodied and slow-growing, with inferior feed conversion relative to exotic counterparts, a phenotype whose origins are detectable as early as hatch weight. The superior body weight of NIC×AA at week 4 reflects the expression of additive genetic effects and heterosis contributed by the Arbor Acre broiler dam line. Studies involving Arbor Acre broiler sire lines crossed with Nigerian indigenous chicken dams have consistently reported significantly higher body weight, weight gain, and better feed conversion ratio in F1 crossbreds relative to their purebred indigenous counterparts (Nwachukwu and Ogbu, 2021), with the Arbor Acre contribution driving superior growth performance across genotype combinations. The average daily weight gain of NIC×AA (13.71 g/bird/day) was approximately thrice greater than NIC (5.02 g/bird/day) during the starter phase, a magnitude of difference consistent with reports of heterosis for growth traits in crosses between exotic broiler lines and tropical indigenous chickens. In a review of indigenous chicken improvement strategies in developing countries, crossbreeding consistently improved body weight and growth rate relative to purebred indigenous lines (Padhi, 2016). The superior FCR of NIC×AA (1.67) relative to NIC (2.37) during the starter phase indicates that crossbred chicks converted a greater proportion of consumed feed toward productive growth, consistent with the higher anabolic potential inherited from the broiler sire genome.

The performance advantage of NIC×AA widened substantially during the grower phase, with body weight at week 8 reaching 1,033.90 g — a 135.4% advantage over NIC (439.29 g; $P < 0.001$). This accelerating divergence between genetic groups is characteristic of the exponential growth phase in fast-growing genotypes and reflects the progressive expression of additive and dominance genetic effects from the Arbor Acre broiler sire line. Evaluation of F1 progenies from Arbor Acre broiler cocks crossed with Nigerian indigenous hens reported body weights for Arbor Acre × naked neck crossbreds (AANN) and Arbor Acre × normal feather crossbreds (AANF) of 456.20 g and 302.73 g respectively at 8 weeks of age (Ifanega et al., 2024), values considerably lower than the 1,033.90 g recorded for NIC×AA in the present study, likely reflecting the higher genetic merit of the Arbor Acre breeder line used as the dam in the current study compared with the cocks used in prior work. The FCR of NIC deteriorated from 2.37 in the starter phase to 3.31 during the grower phase, while that of NIC×AA increased only marginally from 1.67 to 2.17. This phase-dependent increase in FCR in the NIC group is consistent with the well-documented growth physiology of indigenous chickens, in which the proportion of maintenance energy to total energy requirement increases as body weight rises, leaving proportionally less energy available for productive weight gain. Chicken growth generally follows a sigmoid trajectory in which the inflection point and the approach to the asymptote coincide with the onset of physiological maturity (Aggrey, 2002). In multi-breed evaluation of tropically adapted dual-purpose chickens in Nigeria, Akinsola *et al*. (2021) found that local genotypes, although consistently lighter in absolute body weight than faster-growing breeds, were metabolically older at comparable ages than improved genotypes. This pattern is consistent with the present finding that NIC approaches its growth plateau at a lighter weight and a more advanced degree of physiological maturity than NICXAA, leaving it with comparatively less scope for further efficient weight gain in the grower phase. The higher feed intake of NIC×AA during the grower phase (1,328.73 vs. 892.53 g/bird) reflects the greater nutrient demands of a faster-growing genotype and is consistent with the established positive relationship between growth rate and voluntary feed intake in broiler crosses.

The performance divergence between the genetic groups attained its most significant level during the finisher phase. At 12 weeks of age, NIC×AA attained a body weight of 1,923.10 g in contrast to 726.46 g for the pure Nigerian indigenous chickens (NIC). This shows that the growth advantage of the crossbred genotype became progressively more pronounced with the advancement of age. This observation is consistent with the findings of Momoh *et al*. (2010), who reported that crossbred Nigerian local chickens increasingly surpassed their purebred counterparts from 12 to 20 weeks of age, thereby indicating that the manifestation of heterosis for growth becomes more conspicuous during the later developmental stages. Although the body weight of NIC was significantly lower than that of NIC×AA, the recorded value of 726.46 g at 12 weeks is comparable to the lower range of mature body weights reported for the light ecotype of Nigerian indigenous chickens (0.68–1.50 kg) (Momoh *et al*., 2010). This suggests that the intensive deep-litter management employed in the current study facilitated enhanced early growth relative to the scavenging production systems typically utilized for rearing indigenous chickens. Environmental factors, particularly nutrition and management, have been acknowledged as critical determinants of growth performance in Nigerian indigenous chickens. The FCR of NIC rose sharply to 5.96 during the finisher phase, compared with 2.54 for NIC×AA. This marked deterioration in NIC feed efficiency during the finisher phase reflects the increasing proportion of feed energy directed toward maintenance rather than production as indigenous birds approach physiological maturity. Dzungwe *et al*. (2022), evaluating crosses between Sasso and Wassache indigenous chickens over 12 weeks, reported that the pure exotic Sasso genotype recorded significantly higher values in all growth parameters studied compared with the indigenous Wassache, while the F1 reciprocal crosses showed intermediate performance, confirming that the magnitude of crossbreeding advantage is proportional to the genetic distance between the exotic sire and indigenous dam. The significantly higher feed intake and average daily feed intake of NIC×AA during the finisher phase ($P = 0.013$), whilst the least significant finding across all comparisons in this study, nonetheless reflects the substantially greater nutritional requirements of the heavier crossbred genotype during this phase. Dzungwe *et al*. (2024) similarly reported that within reciprocal crosses of Sasso and Wassachie chickens evaluated over 12 weeks, carcass weights and final body weights of hybrids were intermediate between pure exotic and pure indigenous parents, with genotype significantly influencing growth economics, supporting the view that the NIC×AA crosses in the present study represent a commercially viable intermediate genotype for smallholder poultry production.

Over the entire 12-week study period, NIC×AA achieved a total body weight gain of 1,885.90 g with an overall FCR of 2.24, compared with 697.74 g and FCR of 4.21 for NIC. This disadvantage in overall FCR for NIC relative to NIC×AA is of considerable practical significance for smallholder farmers operating under resource-limited conditions, where feed represents the single largest cost of production. Crossbreeding has been established as a tool capable of boosting body weight, growth rate, viability, and adaptation in farm and on-station environments, with hybrid vigour frequently observed in production and reproductive traits. The results of the present study corroborate this position and demonstrate that a single-cross programme using Arbor Acre broiler breeders as the dam line can deliver substantial improvements in growth performance and feed efficiency over pure Nigerian indigenous chickens under deep litter management. Ajayi (2010) confirmed that crossbreeding with exotic breeds improved body weight greatly at 12 weeks of age in Nigerian indigenous chickens, a finding strongly supported by the higher body weight advantage recorded for NIC×AA at week 12 in the present study. The total feed intake of NIC×AA (4,229.83 g/bird) was higher than that of NIC (2,933.61 g/bird) over the entire period, yet the crossbreds converted this feed at nearly half the FCR of the indigenous birds. This confirms that the economic advantage of crossbreeding extends beyond growth rate alone to encompass feed cost efficiency. Momoh and Nwosu (2008) noted that crossbreeding rather than selection may be the more appropriate strategy for improving weight gain in Nigerian local chickens. Given the relatively low heritability of growth traits observed in unimproved indigenous populations, the superior overall performance of NIC×AA in the present study fully supports the assertion by Momoh and Nwosu (2008) that crossbreeding may be the more appropriate strategy for improvement of weight gain in Nigerian native chickens. These findings collectively suggest that systematic crossbreeding of Nigerian indigenous chickens with Arbor Acre broiler breeders under a deep litter management system represents a practically deployable and economically justifiable strategy for improving poultry meat production among smallholder farmers in Nigeria.

The significant effect of genetic group on growth trajectory patterns confirms genetic group as the dominant source of variation in this study. This is consistent with on-farm evidence (Ajayi *et al*., 2020) from Nigeria showing that indigenous chicken genotypes attain substantially lower body weight than exotic and crossbred genotypes under comparable management conditions. Ajayi (2010) attributed this disparity to the slow growth physiology of indigenous birds, characterized by low feed intake capacity, poor nutrient partitioning toward muscle deposition, and an earlier approach to physiological maturity compared with exotic broiler-derived crosses. The significant interaction is visually evident in Figure 1, which reveals three distinct phases of trajectory divergence. During the starter phase (hatch to week 4), both genetic groups showed modest but progressively widening growth curves, with NIC×AA rising from a mean hatch weight of 37.20 g to 421.05 g at week 4, compared with 28.72 g to 169.18 g for NIC. The trajectories were approximately parallel in log-scale terms during this early phase, reflecting the initial expression of additive genetic effects from the Arbor Acre line before the full deployment of hybrid vigour for growth traits.

The most striking divergence occurred during the grower phase (weeks 5–8), where the NIC×AA curve steepened markedly while the NIC curve maintained a more gradual and nearly linear ascent. By week 8, NIC×AA had reached 1,033.90 g, more than double the 439.29 g achieved by NIC. This rapid separation of the two curves during the grower phase is consistent with the pattern reported by Nwachukwu and Ogbu (2021) for Arbor Acre × native chicken crosses in humid tropical conditions, where the most pronounced heterotic advantage for growth was expressed during the middle growth phase when muscle fibre hypertrophy is most active.

CONCLUSION

The findings obtained from this study show that the interbreeding of Nigerian indigenous chickens with Arbor Acre broiler breeders within a deep litter management system resulted in F1 crossbreds (NIC×AA) that demonstrated a statistically significant improvement across all indicators of growth performance and feed efficiency characteristics throughout the starter, grower, and finisher stages of production, in contrast to pure Nigerian indigenous chickens (NIC). The performance superiority of NIC×AA was both systematic and progressive, reaching a final body weight of 1,923.10 g in NIC×AA, compared to 726.46 g for NIC. Feed efficiency showed a notable decline in NIC throughout the production phases, with the Feed Conversion Ratio (FCR) rising from 2.37 during the starter phase to 5.96 in the finisher phase, whereas NIC×AA maintained a relatively stable and superior FCR throughout the production phase. The overall FCR for NIC×AA was 2.24 in comparison to 4.21 for NIC. Future research should evaluate the carcass characteristics, meat quality attributes, and economic returns of the NIC×AA cross in relation to purebred NIC under village and semi-intensive management contexts to establish a more comprehensive framework for advocating this crossbreeding strategy at the smallholder level.

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REFERENCES

Aggrey, S. E. (2002). Comparison of three nonlinear and spline regression models for describing chicken growth curves. *Poultry Science*, 81(12): 1782 – 1788.

Ajayi, F. O. (2010). Nigerian indigenous chicken: A valuable genetic resource for meat and egg production. *Asian Journal of Poultry Science*, 4(4): 164–172. https://doi.org/10.3923/ajpsaj.2010.164.172

Ajayi, F. O., Bamidele, O., Hassan, W. A., Ogundu, U., Yakubu, A., Alabi, O. O., Akinsola, O. M., Sonaiya, E. B., and Adebambo, O. A. (2020). Production performance and survivability of six dual-purpose breeds of chicken under smallholder farmers' management practices in Nigeria. *Archives Animal Breeding*, 63: 387– 408. https://doi.org/10.5194/aab-63-387-2020

Akinsola, O. M., Sonaiya, E. B., Bamidele, O., Hassan, W. A., Yakubu, A., Ajayi, F. O., Ogundu, U., Alabi, O.O. and Adebambo, O. A. (2021). Comparison of five mathematically models that describe growth in tropically adapted dual-purpose breeds of chicken. *Journal of Applied Animal Research*, 49(1): 158 – 166. https://doi.org/10.1080/09712119.2021.1915792

Amao, S. R., Oyewumi, S. O., Adebimpe, A. T. and Oyewo, S. O. (2024). Slaughter performance, meat quality and organoleptic indices of crossbred progenies from meat-type chicken and Nigerian indigenous chicken breeds. *Asian Journal of Biological Sciences*, 17(3): 314–323. https://doi.org/10.3923/ajbs.2024.314.323

Atansuyi, A. J., Ilori, O. D., Chineke, C. A., and Adebayo, O. T. (2022). Growth performance and profitability analysis of five chicken strains in South Western Nigeria. *International Journal of Poultry Science*, 21: 38 – 49. https://doi.org/10.3923/ijps.2022.38.49

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.

Dzungwe, J. T., Tozo, K., and Chrysostome, C. (2022). Growth performance, mortality, and carcass yield evaluation of pure and reciprocal crosses between Sasso and Wassache chickens. *Tropical Animal Health and Production*, 54: 298. https://doi.org/10.1007/s11250-022-03272-x

Dzungwe, J. T., Adjei-Mensah, B., Chrysostome, C. A. A. M., and Tozo, K. (2024). Effect of crossbreeding on growth performance, meat quality, and the economics of production of the pure and reciprocal crosses between the Sasso and Wassachie chickens. *Poultry Science*, 103(8): 103823. https://doi.org/10.1016/j.psj.2024.103823

Field, A. (2018). Discovering statistics using IBM SPSS Statistics (5th ed.). SAGE Publications.

Geodatos. (2024). Geographic coordinates of Makurdi, Nigeria. Retrieved June 2026, from https://www.geodatos.net/en/coordinates/nigeria/makurdi

IBM Corp. (2019). IBM SPSS Statistics for Windows, Version 26.0. IBM Corp.

Ifanegan, O. D., Ojedapo, L. O., Adedibu, T. M., Fasasi, A. O., Popoola, A. D., Oyetoro, B. A., and Abdulrauf, B. O. (2024). Evaluation of growth performance traits of F1 progenies derived from crossbred of an exotic chicken with Nigerian Indigenous chicken. *Brazilian Journal of Science*, 3(8): 43 – 51.

Momoh, O. M., and Nwosu, C. C. (2008). Genetic evaluation of growth traits in crosses between two ecotypes of Nigerian local chicken. *Livestock Research for Rural Development*, 20(10). http://www.lrrd.org/lrrd20/10/momo20158.htm

Momoh, O. M., Nwosu, C. C., and Adeyinka, I. A. (2010). Comparative evaluation of two Nigerian local chicken ecotypes and their crosses for growth traits. *International Journal of Poultry Science*, 9(8): 738 – 743. https://doi.org/10.3923/ijpsaj.2010.738.743

Ngambi, J. W., Thamaga, M. W., Norris, D., Mabelebele, M. and Alabi, O. J. (2013). Effects of egg weight on hatchability, chick hatch weight and subsequent productivity of indigenous Venda chickens in Polokwane, South Africa. *South African Journal of Animal Science*, 43(5): S69 – S74.

Nwachukwu, E. N., and Ogbu, C. C. (2021). Effect of feathering genes on growth performance of F2 backcrosses and comparison of F1 and F2 crosses of Arbor Acre broiler breeder × native chickens in humid tropical environment. *Nigerian Journal of Animal Production*, 41(2): 19 – 33. https://doi.org/10.51791/njap.v41i2.770

Ogunpaimo, O., Wheto, M., Ojoawo, H., Adebambo, A., Adebambo, O., and Durosaro, S. (2020). Use of growth models to predict the body weight of FUNAAB Alpha (Fα) broiler, its crossbreds and two other exotic broiler chickens at early stage of growth. *FUDMA Journal of Sciences*, 4(1): 686 – 694.

Ogunpaimo, O. J., Ojoawo, H. T., Ogunpaimo, O. R., Wheto, M. Y., and Adebambo, A. O. (2021). Comparative evaluation of growth performance and feed utilization of improved Nigerian indigenous broiler and different crossbreds. *Tanzania Veterinary Journal*, 36(2): 11 – 23. https://doi.org/10.4314/tvj.v36i2.2

Padhi, M. K. (2016). Importance of indigenous breeds of chicken for rural economy and their improvements for higher production performance. *Scientifica*, 2016: 2604685. https://doi.org/10.1155/2016/2604685

Razali, N. M., and Wah, Y. B. (2011). Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling tests. *Journal of Statistical Modeling and Analytics*, 2(1): 21 – 33.

Sanda, A. J., Adebayo, S.V., Adenaike, A. S., Kheto, M., Durosaro, S. O. and Olowofeso, O. (2023). Performance indices of four crossbred broiler chickens intensively managed in South West, Nigeria. *Nigerian Journal of Animal Science*, 22(1): 1 – 9. Retrieved from https://njas.org.ng/index.php/php/article/view/737

Weather Atlas. (2024). Makurdi, Nigeria climate. Retrieved June 2026, from https://www.weather-atlas.com/en/nigeria/makurdi-climate