International Journal of Advances in Science, Vocational & Technical Education (IJASVOTE)
www.ijasvote-fce.com
Volume 3; Issue 2; August 2026; Page No. 51-60.

HERITABILITY ESTIMATES OF GROWTH TRAITS OF DIALED CROSSES BETWEEN NOILER AND HEAVY ECOTYPE CHICKENS REARED IN NSUKKA, ENUGU STATE, NIGERIA

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ABSTRACT

The dearth of literature on Noiler breed combination crosses with indigenous heavy ecotypes in Nsukka, Enugu State, Nigeria necessitated the evaluation of the heritability estimates of growth traits of dialed crosses between Noiler and heavy ecotype chickens for possible genetic improvement of production traits. A total of 84 mature chickens comprising of 42 Noiler chickens (36 females and 6 males) and 42 Heavy-Ecotypes chickens (36 females and 6 males) were randomly assigned into four (4) different breeding groups in a completely randomized design: Noiler-x-Noiler (NN), Heavy-Ecotype-x-Heavy Ecotype (HH), Noiler-x-Heavy-Ecotype (NH) and Heavy-Ecotype-x-Noiler (HN) with a mating ratio of 1:6. The cocks were trained for semen collections while artificial insemination was used for breeding. Data on body weights and biometer traits of the offspring of the four genotypes from birth to 16 weeks of age were collected and subjected to analysis of variance using the SPSS Package version 26. Duncan's New Multiple Range Test was used in the separation of significance means. The results showed Noiler (NN) had the highest body weight at 16 weeks (2523.95 $\pm$53.03g), NH showed the lowest body weight across all ages. The heritability estimates of body weight at different ages of the genotype showed that Noiler chicken had the highest heritability estimate at 12 weeks (0.64 $\pm$ 0.19) while heavy-ecotype chickens had higher heritability estimates for body linear measurements compared to Noiler and their crosses. These findings support the potential of NN and HH for selective breeding in poultry improvement programs and environmental optimization for crossbred populations.

Keywords: Heritability Estimates, Diallel Cross, Noiler Chicken, Heavy Ecotype, Growth Traits.

INTRODUCTION

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The need to produce more animal protein in the country has been a burden to many successive governments in Nigeria as a result of the ever-rising population. The Nigerian poultry industry requires better improved chicken breeds that combine the adaptability of indigenous chickens with the superior growth performance of exotic breeds. This study was carried out to estimate heritability and other genetic parameters for some growth traits in diallel crosses between Noiler and Nigerian Heavy Ecotype chickens to inform breeding strategies.

Heritability values for poultry growth traits are moderate to very high (Okafor, 2025). The estimated heritability of weight at 4 weeks of age was moderate. This may, in part, explain the significant improvement in growth performance achieved in this species through genetic selection (Sulaiman, 2020). Other factors that have contributed to and accelerated this genetic gain are the small size of the animals, allowing thousands of animals to be raised in the same environment, and especially their prolificacy coupled with a short reproductive cycle. This would not have been possible without the consequent contribution of the field of health and nutrition (Maladin, 2023).

Although a high heritability estimate value predicts a rapid response to this selection. This value refers only to the group of animals on which it has been estimated in relation to their environment (Guisso et al, 2022). Indigenous chickens have desirable traits such as disease resistance, pleasantly flavoured meat and egg, and ability to withstand adverse environmental conditions (Tahawy and Habash, 2021).

Crossing Nigerian local chickens with Noiler strains which are for commercial purpose one could take advantage of high egg productivity, early maturity, and better meat type development. Cross breeds that result from the best performing parental breeds should lead to the production of birds that will be superior in growth and egg production in a tropical environment. Also hybrid could be used to develop new hybrid strains of chickens (EL-Tahhawy & Habsh, 2021).

Methodology

Location of the study

The experiment was conducted at the Poultry Unit of the Department of Animal Science, Teaching and Research Farm, University of Nigeria, Nsukka.

Experimental Animals, Design and Management

A total of 84 birds comprising of 48 Noiler chickens (36 females and 6 males) and 42 Nigerian Heavy Ecotype chickens (36 females and 6 males) in a mating ratio of 6:1 were selected from the poultry Unit of Animal Science Departmental Farm University of Nigeria, Nsukka. A detailed breeding procedure was set up to generate four genotypes, and artificial

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insemination was employed to fertilize the hens. The birds were housed in battery cages. Layers birds were fed with hybrid layers while the cocks were fed with hybrid growers. The experimental birds were vaccinated against New castle diseases (NDV). Prophylactic drugs were given to the birds to check or inhibit the incidence of some diseases like coccidiosis. Proper hygiene was maintained adequately.

Table 1: Mating Ratio

Breeding groups/ Genotypes	No of Cocks	No Hens	Breeder Group
Noiler x Noiler (NN)	1	6	Noiler
Heavy Ecotype x Heavy Ecotype(HH)	1	6	Heavy Ecotype
Noiler x Heavy Ecotype(NH)	1	6	Main Cross
Heavy Ecotype x Noiler (HN)	1	6	Reciprocal Cross

The cocks were trained for semen collection at the interval of two days in a week by abdominal message technique as according to Burrows Quinn (1937). The semen was diluted with saline water and inseminated with 1m syringe through hen's left vent of its genital organ when the abdominal regions gently pressurized until the vent pull ups. The offspring from the mating, their body weights and biometric traits of the four genotypes from birth to 16 weeks of age were recorded. The data collected were subjected to analysis of variance (ANOVA) in completely randomised design using the SPSS package version 26. The significant means were separated using the Duncan's new multiple Range Test (Duncan, 1955).

Results and Discussion

Heritability Estimates

Heritability estimates of body weight (table 4.3) at different ages varied across the four genotypes, with Noiler chickens (NN) showing the highest values at most points. At 12 weeks of age, NN exhibited the highest heritability estimate for body weight (0.64±0.19), indicating a strong genetic influence on growth performance in this genotype. Noiler chickens recorded a low to high heritability of body weight from 4weeks to 16weeks

Table: 2 Results on Heritability Estimates of Genetic Parameters

Body Weight	Noiler x Noiler	Heavy x Heavy	Noiler x heavy	Heavy x Noiler
4 weeks	0.17±0.05	0.13±0.06	0.13±0.06	0.15±0.13
8 weeks	0.45±0.13	0.15±0.02	0.22±0.05	0.18±0.06
12 weeks	0.64±0.19	0.12±0.05	0.12±0.06	0.18±0.09
16 weeks	0.54±0.26	0.17±0.01	0.30±0.0 3	0.16±0.13

Table: 3

Body length	Noiler x Noiler	Heavy x Heavy	Noiler x heavy	Heavy x Noiler
4 weeks	0.29±0.06	0.10±0.0 2	0.04±0.03	16±0.02

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8 weeks	0.26±0.13	0.21±0.09	0.14±0.03	0.21±0.06
12 weeks	0.11±0.01	0.24±0.13	0.21±0.03	0.13±0.4

Table: 4

Wing length	Noiler x Noiler	Heavy x Heavy	Noiler x heavy	Heavy x Noiler
4 weeks	0.08±0.01	0.27±0.09	0.13±0.01	0.19±0.02
8 weeks	0.12±0.09	0.17±02.02	0.17±0.05	0.10±0.01
12 weeks	0.18±0.02	0.15±0.06	0.13±0.02	0.10±0.02

Table: 5

Shank length	Noiler by Noiler	Heavy x Heavy	Noiler x heavy	Heavy x Noiler
4 weeks	0.15±0.04	0.11±0.01	0.08±0.06	0.14±0.01
8 weeks	0.04±0.01	0.17±0.01	0.16±0.05	0.16±0.04
12 weeks	0.14±0.03	0.14±0.03	0.30±0.04	0.44±0.15

Table: 6

Keel length	Noiler by Noiler	Heavy x Heavy	Noiler x heavy	Heavy x Noiler
4 weeks	0.41±0.09	0.23±0.01	0.51±0.04	0.39±0.04
8 weeks	0.63±0.10	0.02±0.06	0.40±0.02	0.46±0.02
12 weeks	0.77±0.19	0.48±0.07	0.50±0.04	0.48±0.02

Table: 7

Thigh length	Noiler by Noiler	Heavy x Heavy	Noiler x heavy	Heavy x Noiler
4weeks	0.15±0.02	0.11±0.03	0.10±0.02	0.11±0.04
8weeks	0.16±0.09	0.15±0.02	0.11±0.01	0.20±0.01
12weeks	0.18±0.04	0.11±0.01	0.13±0.04	0.21±0.05

As birds mature, genetic differences become more prominent, leading to highest heritability (0.45±0.13 to 0.54±0.26) at ages 8weeks to 16weeks respectively. Noiler chickens exhibited superior growth traits, with significant heritability observed for body weight, indicating strong genetic influences on these traits (Sanda *et al*., 2022). Also because of their genetic background which promotes better health and productivity (Adamu *et al*., 2021). This agrees with Rotimi *et al*. (2016) who reported that heritability estimates for body weight for Noiler ranged from 0.17±0.07 to 0.57 ± 0.26 from 4 to 20 weeks of age respectively. This indicated that breeders can effectively select for improved body weight in Noiler chickens at 8 weeks of age (Adamu *et al*., 2021). Also it follows the report of Sand *et al* (2023) who mentioned that heritability estimates were generally low in the early stages and increase with increasing ages in chickens.

In contrast, HN had the lowest heritability (0.05±0.13 to 0.16±0.13) of body weight at 4 weeks to 16 weeks suggesting that environmental factors (nutritional effects, maternal effects,

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brooding condition, hormonal influence and lack of expression of genetic potential) played a greater role in early growth stages for this crossbred birds. Low heritability of body weight at 4-8 weeks suggested that management, environmental and maternal factors played a dominant role over genetic factors. The above result suggested that selection for body traits is most effective when birds are above 8weeks of ages. This makes them amenable to genetic improvement through selection at these ages.

The observed higher heritability values at 12 and 16 weeks suggest that genetic selection for body weight would be more effective if applied at mid to late growth stages rather than at early ages. Conversely, the weaker heritability in NH and HN crossbreeds suggested that these hybrids may require better environmental management strategies to optimize growth performance. The variability in heritability estimates between purebred and crossbred birds may be attributed to heterosis effects, genetic incompatibilities, or greater sensitivity to environmental factors.

Heritability estimates for body length among the genotypes are presented in Table 2. The results showed that HH genotype had the highest heritability (0.24±0.13), signifying strong genetic control over body length. NH exhibited the lowest heritability (0.04±0.03), suggesting greater environmental influences. The result of this study is in accordance with the report of Tiamiyu et al. (2024) who discovered that heavy ecotype chickens exhibited larger body length dimensions. They further reported that heavy breeds generally have higher feed consumption and lower feed conversion ratio compared to higher breeds like the Noiler, indicating their larger size and morphometric potentials (Tiamiyu et al., 2024).Heavy ecotype chickens are larger in body length compared to Noiler and other breed crosses of chickens reflecting their breeding purpose for meat production versus the dual-purpose nature of Noiler. At 20 weeks of age, Noiler chickens average body length was approximately 16.51cm for males and 16.06cm for females for heavy ecotype chickens, average body length of 24.14cm at the same age was reported (Adamu *et al*., 2024). Tiamiyu *et al*. (2024) reported that other local breeds such as Fulani ecotype generally showed smaller body length than Noilers and heavy ecotype chickens. Heavy ecotype chickens exhibited higher heritability for body length, wing length, shank length and body girth compared to Noiler and their crosses due to several genetic factors especially at maturity.

Noiler chicken has higher heritability on thigh length and keel length compared to heavy ecotype chickens and their crosses due to hybrid genetic background. Combining traits from Nigerian indigenous chicken and White Plymouth Rock. This cross breeding enhances their adaptability and growth rates resulting in superior morphometric traits (Adamu *et al*., 2021). Also, due to their robust growth patterns, efficient feed conversion ratio and improved growth traits which caused increased meat yield. Heavy ecotype chickens are specifically bred for size and growth traits enhancing their heritable characteristics (Agu *et al*., 2012).

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The heritability estimates for wing length across the genotypes. HH exhibited the highest total heritability (0.27±0.09), suggesting a strong genetic basis for wing length in this genotype. NH had the lowest heritability estimate (0.07±0.09), indicating that environmental factors significantly influence wing length in crossbred chickens. The findings align with previous studies that reported higher heritability for wing length in heavy breeds compared to dual-purpose and crossbred birds (Rotimi *et al*., 2022). Selection for this trait is expected to be more effective in HH than in Noiler or hybrid genotypes.

The heritability estimates of shank length as presented above, HH had the highest heritability (0.44±0.15), followed by HN (0.24±0.19). NN exhibited the lowest heritability (0.14±0.03).The moderate heritability in HH suggests that genetic selection for leg structure would be highly effective in this genotype. The lower estimate in NN suggests a greater influence of environmental factors on shank length (Adeleke *et al*., 2023). Generally, heritability estimates of shank length in all the genotype is between moderate to low. The report in this study was different from the report of Sanda *et al.* (2022), who reported that both Noiler and heavy ecotype chickens demonstrated moderate to high heritability for shank length, making them suitable candidates for selective breeding programs aimed at improving in this trait. The higher heritability estimates for shank length have several implications for poultry breeds and production. For instance, it could result to genetic program, efficiency of selection resource allocation and adaptation to environmental conditions (Sanda*et al*., 2023).

In contrast, NN exhibited lower heritability for shank length (0.11 ± 0.15) and thigh length (0.16 ± 0.24), suggesting that these traits are more influenced by environmental factors such as feed composition and rearing conditions. Similar findings were reported by Tiamiyu *et al*. (2024), who noted that leg and bone traits tend to have moderate heritability in dual-purpose breeds, as these breeds prioritize both meat and egg production. The lower heritability of shank and thigh length in NN suggests that genetic selection for these traits may be less effective, and improvement strategies should focus more on nutritional management, exercise, and skeletal health interventions (Udeh *et al*., 2022).

Heritability estimates for morphometric traits varied significantly across genotypes and ages, highlighting the relative influence of genetic and environmental factors in shaping these traits. The classification of traits into low, moderate, and high heritability provides insight into which traits can be effectively improved through selection and which require better management practices. The heritability estimates for keel length, HH showed the highest total heritability (0.61±0.34), followed closely by NN (0.60±0.16). HN exhibited the lowest heritability (0.44±0.28). While the main cross (NH) has 0.47 ± 0.33, of keel length in all the genotypes However, the heritability varied between moderate to high heritability. The

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findings suggest that both HH and NN have strong genetic control over keel length, making them good candidates for selection aimed at improving carcass yield (Sanda*et al*., 2024). Adeniyi *et al*. (2022), reported that Noiler chickens heritability estimates for kneel length of 0.72 at week 8, indicating a moderate to high genetic influence on this trait. In contrast, they said heavy ecotype chickens show heritability estimates for kneel length ranging from 0.64 to 0.74, which suggests a similar level of genetic influence on this research result presented above. Heavy Ecotype chickens (HH) exhibited the highest heritability for body measurements, including body length (0.26 ± 0.20), wing length (0.27 ± 0.09), and keel length (0.61 ± 0.34). These findings align with studies by Adeleke *et al*. (2023), which suggest that structural traits have stronger genetic control in heavy breeds due to their primary selection for meat production.

The high heritability of keel length (0.61 in HH and 0.60 in NN) suggests that selection for this trait would lead to significant genetic improvements in carcass yield. Since keel length is a key determinant of breast muscle mass and overall meat production, these findings highlight the potential for genetic selection to enhance commercial meat yield in these breeds (Udeh *et al*., 2022) Keel length heritability remained moderate across all ages in NH and HN, indicating that hybrid vigor (heterosis) may contribute to maintaining these values. Heritability for keel length remained high across all ages, indicating consistent genetic expression throughout the growth period. At 12 and 16 weeks, keel length heritability was highest in NN and HH, making these the optimal ages for selection (Xin *et al*., 2019).

The heritability estimates for thigh length, HN exhibited the total heritability of (0.17±0.15); NN (0.16 ±0.15; HH (0.01±0.15) while NH had (0.11±0.23). The heritability in all the genotypes were low. The low heritability in all the genotype may be due to increased environmental variability (Bamidele *et al*., 2024). An average thigh length of heavy ecotype chicken at 20 weeks of age was 14.50 cm was reported by Adamu *et al.* (2021). With Noiler breeds, an average of thigh length of 14.48cm for males and 14.13cm for females was reported (Adamu *et al*., 2021). This is indicative of their growth characteristics as a dual-purpose breed, which is hybrid between indigenous Nigerian chicken and white Plymouth Red. There are help benefits of high heritability in Chickens

Traits and Genotypes with Low Heritability ($h^2 < 0.20$) were: wing length of NH (0.07), NN (0.16), HN (0.19) recording low values while for shank Length NH (0.14), NN (0.11) had low heritability and for thigh length NH (0.11), HH (0.14). Crossbred genotypes (NH and HN) consistently exhibited low heritability for several morphometric traits, indicating that these traits are more influenced by environmental factors in hybrids. NN showed low heritability

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for shank length (0.11), suggesting that this trait is highly dependent on external factors like nutrition and rearing conditions in Noiler chickens.

Traits and Genotypes with Moderate Heritability ($h^2 = 0.20 – 0.40$) were body length of NN (0.22), HN (0.16); wing length of HH (0.27), shank length of HH (0.26), HN (0.24); Keel Length: NH (0.47), HN (0.44) and Thigh Length: NN (0.16), HN (0.19). The study revealed that HH showed moderate heritability for wing and shank length, suggesting that genetic selection can moderately improve structural growth in Heavy Ecotype chickens. Keel length in NH and HN had moderate heritability (0.44 – 0.47), meaning that selection could improve these traits over multiple generations. Traits and Genotypes with High Heritability ($h^2 > 0.40$) Keel Length: NN (0.60), HH (0.61). NN and HH exhibited the highest heritability for keel length, suggesting that this trait is largely determined by genetics rather than environmental factors. No crossbred genotype (NH or HN) exhibited high heritability, reinforcing that genetic stability is stronger in purebred lines. Keel length in NN and HH should be prioritized for genetic selection, as it will respond well to breeding efforts. Selection should be applied at 12–16 weeks when heritability is highest. These findings are useful for improving carcass yield in poultry breeding programs.

CONCLUSION/RECOMMENDATION

The NH cross combined superior growth with good maternal reproductive performance and it is recommended for developing an improved dual-purpose strain for small holder systems. It is noted that growth traits in Noiler x Heavy Ecotype crosses are moderately to highly heritable and can be improved through selection, especially from 6-8 weeks of age.

These findings are useful for improving carcass yield in a poultry breeding programs. Breeding local pullets with Noiler Cocks improves and gives a better reproductive performance, it also makes this cross suitable for growth improvement programs in Nigeria. The superior performance of cross bred over pure bred suggests genetic improvement potential for Nigeria poultry production.

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