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# Egg Production Characteristics of Nigerian Indigenous Chickens, Rhode Island Red and Their Crossbred Progenies

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## ABSTRACT

**Background and Objective:** The crossbreeding program in livestock production as it is the likely genetic basis of hybrid vigor. It is also expected to be one of the factors causing the genetic relationships between crossbred and purebred performance characteristics. This study was focused on egg production characteristics of pure Nigerian indigenous chickens, Rhode Island Red and their crossbred progenies in the derived guinea savanna environment of Nigeria. **Materials and Methods:** A total of 100 birds were sourced and used as parents for the experiment. This consists of 5 cocks and 15 hens each of naked neck-NN, normal feather-NF, frizzled feather-FF, Fulani ecotype-FE and Rhode Island Red-RIR chickens. Data were obtained on egg production characteristics (body weight at first egg, age at first egg, weight of first egg, egg number, hen day egg production and hen housed egg production). **Results:** The obtained results depicted a significant ($p<0.05$) difference in egg production parameters, frizzled feather (FF) had the lighter body weight at first egg (1258.33 g), RIR×FF comes to lay earlier (140 days) while RIR had the highest weight of first egg (45.33 g), hen-day (80.35%) and hen-housed (75.35%). The parameters on fertility and hatchability also indicated that crossbred NN×NN had the highest fertility and hatchability rates of 95.24 and 100%, respectively. **Conclusion:** It was concluded that RIR genetics component may be used to improve the local stocks of egg production characteristics in the derived savanna environment of Nigeria.

## KEYWORDS

Egg production, laying attributes, Nigerian indigenous chicken, Rhode Island Red, crossbred progenies, derived savanna



## INTRODUCTION

The use of crossing to initiate a broad inheritable basis for the development of a new type of lines and to find superior crossbreds was recently common among the poultry industry globally. The motive behind

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crossing is to induce superior crosses to upgrade the productive performance of local chickens and to integrate different breed attributes in crosses having a valuable performance for growth or egg production[1]. Since indigenous chickens have better survival ability compared to exotic under minimum feeding regimens to establish much genetic diversity, especially in adaptive characteristics[2]. The genetic-economic improvement of laying hens is still the primary trait for egg production and this is a complex metric attribute revealing numerous variations during the stage of production of the pullet. The research on egg production and its related characteristics such as age at sexual maturity, rate of lying and egg characteristics attracted the attention of many researchers that affirmed there were wide variations in egg production characteristics within and between various breeds and/or strains of chickens[3].

The conversational system of keeping chickens for egg production in the villages has proved to be very low due to the inadequate quantity and quality of feeds, diseases and social behavior of the chickens that lay eggs[4]. Meanwhile, the production of eggs under an intensive system has been affirmed to be 20 eggs year$^{-1}$ while the age at sexual maturity in the cage system, was 151 days[5]. Adetayo and Babafunso[6] also reported mean age at first egg of 157, 160 and 165 days, respectively for hens from derived savannah, Guinea savannah and rain forest zone of Nigeria. Rasheed[7] further noted that frizzled chickens in the tropical environment attained earlier maturity than normal-feathering, naked neck and Fulani ecotype chickens. Among the factors that determined variation in egg production is the age of pullet in attainment of sexual maturity that was attributed to the system of management[8] and productive characteristics[9]. However, egg weight was another factor and Goger *et al.*[10] and Fayeye *et al.*[11] claimed that the weight of eggs was higher in the heavy ecotype when compared with light ecotype chickens which also had the ability to lay more eggs than its counterpart heavy ecotype chickens. The laying attribute of early sexual maturity usually ends egg laying production earlier than those late sexual maturities which has also been reported by Adetayo and Babafunso[6] with indigenous chickens consuming more feeds than the crossbred chickens in producing a dozen eggs. Therefore, this study aims to determine the genetic evaluation of Nigerian indigenous chickens, Rhode Island Red and their crossbred progenies in the derived savanna environment of Nigeria for egg production characteristics.

## MATERIALS AND METHODS

**Site of experiment:** The study was carried out at the Poultry Unit of Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso Town, Oyo State, Southwestern Nigeria. Ogbomoso lies on the Plateau of Yorubaland (elevation 1,200 feet 366 m) in an area of derived savanna with latitude and longitude coordinates are 8.142165 and 4.245186, respectively. The experiment lasted between February and December, 2018.

**Experimental birds and their management:** The experimental chickens that were used for the study were local and exotic breeds. The local strains are the frizzled feather, naked neck, normal feather and the Fulani ecotype. The local birds were selected from the available chicken population in the study area while the exotic chicken (Rhode Island Red cocks and hens) were acquired from a reputable farm at 18 weeks of age. A total of 100 birds were sourced and used as parents for the experiment. This consists of 5 cocks and 15 hens each of naked neck, normal feather, frizzled feather, Fulani ecotype and Rhode Island Red chickens. These pure breeds of chickens were later distributed among each other to generate their $F_1$ crossbred (straight and reciprocal crosses). Each chicken was properly identified using a wing tag made from industrial galvanized aluminum. The experimental birds were strictly under the intensive management system of production and they were one by one housed in a 2-tiers galvanized battery cage with a cell space dimension of 0.14×0.14×0.28 m$^2$ spacing. Prior to the arrival of the experimental parent birds, the pen and cage were properly disinfected with formalin® and morigard® as instructed by the manufacturer.

**Feeds and feeding:** The standard commercial breeders and layers mash containing (16% crude protein and 2600 kcal/kg metabolizable energy) and (16% crude protein and 2800 kcal/kg metabolizable energy) were fed *ad libitum* to the cocks and hens, respectively while clean and cool water was also provided *ad libitum*.

**Mating technique:** The sire's vents were trimmed to clean up their feathers around the vent at 2 weeks' intervals and the semen was collected through the method of artificial insemination (AI) by the massage technique from the sires from 22 weeks by applying pressure at the back towards the tail many times before sperm production. The semen obtained was immediately inseminated into a doughnut shape in the left vent of the dams while 0.1 mL of undiluted fresh semen collected was used for insemination each time with an inseminator which was monitored twice a week in the evening.

**Mating design:** Pure, straight and reciprocal crosses were carried out amongst the Nigerian local chickens and Rhode Island Red to get the $F_1$ progenies while the mating procedures adopted were below.

**Pure breeds:**

- Rhode Island Red (sire)×Rhode Island Red (dam): $RIR_s \times RIR_d$
- Frizzled feather (sire)×Frizzled reather (dam): $FF_s \times FF_d$
- Fulani ecotype (sire)×Fulani ecotype (dam): $FE_s \times FE_d$
- Naked neck (sire)×Naked neck (dam): $NN_s \times NN_d$
- Normal feather (sire)×Normal feather (dam): $NF_s \times NF_d$

**Crossbreeds**
**Straight crossing:**

- Rhode Island Red (sire)×Frizzled feather (dam): $RIR_s \times FF_d$
- Rhode Island Red (sire)×Naked neck (dam): $RIR_s \times NN_d$
- Rhode Island Red (sire)×Fulani ecotype (dam): $RIR_s \times FE_d$
- Rhode Island Red (sire)×Normal feather (dam): $RIR_s \times NF_d$

**Reciprocal crossing:**

- Frizzled feather (sire)×Rhode Island Red (dam): $FF_s \times RIR_d$
- Normal feather (sire)×Rhode Island Red (dam): $NF_s \times RIR_d$
- Naked necked (sire)×Rhode Island Red (dam): $NN_s \times RIR_d$
- Fulani ecotype (sire)×Rhode Island Red (dam): $FE_s \times RIR_d$

**Egg collection and incubation:** Total number of 3210 eggs was collected on a daily basis and batches and tagged to identify eggs belonging to each hen. The eggs were stored at room temperature for a few days and were set in the incubator (Aspero Automatic Dual Power 2189 incubator) in a reputable hatchery in Ibadan, Oyo State, Nigeria. Eggs were candled on the 5th and 18th day of incubation for the identification of fertile eggs and clear eggs using a Candler fixed with a neon fluorescent tube carried out in a dark room.

**Management of the chicks:** At hatch, chicks were also tagged according to their sires and were randomly placed into brooder compartments for brooding. All the chickens were reared intensively under natural light while vaccination and medication programs were duly observed from day old.

**Feed and feeding of the chicks:** During brooding stage, the standard commercial chick mash of 18% crude protein and 2650 kcal/kg metabolizable energy was fed *ad libitum* from day old to eight weeks of age. The chicks were assigned to a feeder at the rate of 100 birds to one tray or 1 pan of tube feeder and one drinker of 2 to 4 L capacity. From eight weeks of age, birds were fed standard commercial growers mash containing 16% crude protein and 2700 kcal/kg metabolizable energy. However, at 18 weeks of age, layers were fed commercial layers' mash containing 16% crude protein and 2800 kcal/kg metabolizable energy and water was supplied *ad libitum*.

**Ethical consideration:** The animals were maintained under hygienic conditions and were confined throughout the experimental period. The experiment was approved by the Ethical Committee of the Departments of Animal Production and Health and Animal Nutrition and Biotechnology of Ladoke Akintola University of Technology, Ogbomoso, Oyo, Nigeria.

**Data collection:** Data were also obtained from 30 randomly selected birds per genotype on the following parameters as soon as the birds started laying; body weight at first egg, age at first egg, weight of first egg, egg number, hen day egg production and hen housed egg production as described by FAO[12].

**Statistical analysis:** Data obtained from growth, reproductive and egg quality traits was subjected to analysis of variance for the fixed effects of genotype using the One-way Analysis of Variance (ANOVA) while the least significant difference was determined using the 2018 version of Duncan's multiple range test. The significance level was at $p<0.05$, while fertility and hatchability traits were determined through frequency and percentages. The following model was adopted:

$$Y_{ijk} = \mu+\alpha_i+\beta_j+e_{ijk}$$

Where,

$Y_{ij}$ = Observed value of a dependent variable

$\mu$ = General mean

$\alpha_i$ = Fixed effect of the $i^{th}$ genotype (i = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13)

$e_{ijk}$ = Random error common to measurement in each bird and assumed to be normally and independently distributed with a mean of zero and variance $\delta^2$

## RESULTS

The least-square mean values and standard errors of egg production traits as affected by pure, straight and reciprocal crosses of chickens were shown in Table 1. Genotype significantly ($p<0.05$) affected the egg production traits measured. The RIR birds had the heaviest body weight (1854.35 g), delayed age at first egg (192 days), best weight at first egg (45.22 g), highest hen-day (80.35%) and highest hen-housed (75.35%) than other groups of birds involved. However, the lowest values for body weight at first egg and age at first egg were observed for FF (1258.33 g) and RIR×FF (140.50 days) birds, respectively. The results imply that FF birds were favored in respect to body weight at first egg since genetically lighter birds attain sexual maturity than heavy-bodied ones, RIR×FF crossbred comes to lay earliest than other genotypes, RIR and NN×RIR birds were better for the weight of first egg since bigger birds normally laid larger eggs than those with smaller body weights while RIR chickens among the pure and NN×RIR among the crosses were favored in terms of hen-day and hen-housed percentages than other genetic groups.

Table 2 indicated the absolute values and percentage of egg set, fertility and hatchability estimated in different genotypes of pure, straight and reciprocal $F_1$ crosses. Frizzled feather chicken had the highest number of egg sets (350) followed by those of the FFRIR genotype. Out of the number of egg set in all the genetic stocks, RIRNN birds had the highest percentage (95.24%) of fertility followed by FE chickens

Table 1: Least square mean values and standard errors of egg production traits as affected by different genotypes of pure, straight and reciprocal $F_1$ crosses of chickens

| Genotype | N | BWF (g) | AFE (days) | WFE (g) | Hen-day (%) | Hen-house (%) |
|---|---|---|---|---|---|---|
| FF | 80 | 1258.33±97.48$^{e}$ | 173.68±5.95$^{b}$ | 38.33±3.41$^{c}$ | 73.88±1.23$^{ab}$ | 74.47±1.11$^{ab}$ |
| RIR | 80 | 1854.35±21.33$^{a}$ | 192.10±9.35$^{a}$ | 45.22±3.67$^{a}$ | 80.35±0.99$^{a}$ | 75.35±1.78$^{a}$ |
| FE | 80 | 1517.36±57.69$^{c}$ | 173.65±3.11$^{b}$ | 37.73±2.96$^{c}$ | 73.44±2.93$^{ab}$ | 69.38±0.78$^{ab}$ |
| NN | 80 | 1617.36±85.56$^{b}$ | 190.20±4.61$^{ab}$ | 39.20±2.64$^{c}$ | 59.45±1.67$^{c}$ | 53.22±1.23$^{c}$ |
| NF | 80 | 1287.83±55.23$^{e}$ | 164.08±2.97$^{c}$ | 34.83±1.70$^{c}$ | 52.35±1.56$^{d}$ | 49.03±0.56$^{d}$ |
| RIR×FE | 80 | 1615.32±68.11$^{b}$ | 162.00±4.20$^{c}$ | 41.65±2.01$^{b}$ | 66.86±1.89$^{bc}$ | 62.43±1.34$^{bc}$ |
| RIR×FF | 80 | 1319.00±95.66$^{de}$ | 140.50±5.15$^{d}$ | 31.25±0.25$^{d}$ | 68.25±1.22$^{b}$ | 64.28±2.45$^{b}$ |
| RIR×NN | 80 | 1405.00±95.66$^{de}$ | 160.75±5.15$^{c}$ | 44.33±2.41$^{ab}$ | 71.88±2.78$^{b}$ | 68.97±0.19$^{b}$ |
| RIR×NF | 80 | 1602.75±67.64$^{b}$ | 152.13±3.64$^{cd}$ | 37.88±1.35$^{c}$ | 65.67±0.67$^{bc}$ | 62.77±1.56$^{bc}$ |
| FE×RIR | 80 | 1610.00±78.11$^{b}$ | 162.10±2.75$^{c}$ | 38.33±1.41$^{c}$ | 61.05±1.89$^{c}$ | 60.17±2.88$^{c}$ |
| FF×RIR | 80 | 1398.75±95.66$^{de}$ | 165.25±5.13$^{c}$ | 40.75±2.97$^{b}$ | 73.83±2.89$^{ab}$ | 69.49±1.89$^{ab}$ |
| NN×RIR | 80 | 1800.50±135.28$^{ab}$ | 150.50±7.28$^{cd}$ | 44.50±2.86$^{a}$ | 76.47±0.99$^{ab}$ | 70.35±0.56$^{ab}$ |
| NF×RIR | 80 | 1635.01±140.38$^{b}$ | 154.50±7.28$^{cd}$ | 37.00±4.18$^{c}$ | 65.65±0.66$^{bc}$ | 61.47±1.34$^{bc}$ |

$^{abcde}$ Means along the same column with different superscripts are significantly different ($p<0.05$), BWF: Body weight at first egg (g), AFE: Age at first egg (days), WFE: Weight of first egg (g), Hen-day at 100 days, Hen-house at 100 days, RIR: Rhode Island Red, FF: Frizzled feather, FE: Fulani ecotype, NN: Naked neck, NF: Normal feather, RIR×FE: Rhode Island Red Fulani ecotype crossbred, RIR×FF: Rhode Island Red frizzled feather crossbred, RIR×NN: Rhode Island Red naked neck crossbred, RIR×NF: Rhode Island Red normal feather crossbred, FE×RIR: Fulani ecotype Rhode Island Red crossbred, FF×RIR: Frizzle feather Rhode Island Red crossbred, NN×RIR: Naked neck Rhode Island Red crossbred and NF×RIR: Normal feather Rhode Island Red crossbred

Table 2: Percentage fertility and hatchability traits as affected by different genotypes of pure, straight and reciprocal $F_1$ crosses

| Genotype | Number of egg set | Fertile egg | Fertile (%) | Infertile egg | Infertile (%) | Hatched egg | Hatched (%) | Dead in shell | Dead in shell (%) |
|---|---|---|---|---|---|---|---|---|---|
| RIR | 240 | 140 | 58.33 | 100 | 41.66 | 120 | 85.71 | 20 | 14.29 |
| NN | 330 | 290 | 87.87 | 40 | 12.12 | 210 | 72.41 | 80 | 27.59 |
| FF | 350 | 270 | 77.14 | 80 | 22.86 | 220 | 81.48 | 50 | 18.52 |
| NF | 260 | 230 | 88.46 | 30 | 11.54 | 230 | 100.00 | 0 | 0.00 |
| FE | 290 | 270 | 93.10 | 20 | 6.90 | 270 | 100.00 | 0 | 0.00 |
| RIR×NN | 210 | 200 | 95.24 | 10 | 4.76 | 200 | 100.00 | 0 | 0.00 |
| RIR×FF | 240 | 90 | 37.50 | 30 | 62.50 | 90 | 100.00 | 0 | 0.00 |
| RIR×NF | 220 | 180 | 81.81 | 40 | 18.19 | 180 | 100.00 | 0 | 0.00 |
| RIR×FE | 260 | 120 | 46.15 | 140 | 53.85 | 120 | 100.00 | 0 | 0.00 |
| NN×RIR | 170 | 90 | 52.94 | 80 | 47.06 | 70 | 77.77 | 20 | 22.23 |
| FF×RIR | 340 | 170 | 50.00 | 170 | 50.00 | 170 | 100.00 | 0 | 0.00 |
| NF×RIR | 300 | 270 | 90.00 | 30 | 10.00 | 250 | 92.59 | 20 | 7.41 |
| N | 3210 | 2320 | | 890 | | 2030 | | 190 | |

RIR: Rhode Island Red, FE: Fulani ecotype, NN: Naked neck, NF: Normal feather, RIR×FE: Rhode Island Red Fulani ecotype crossbred, RIR×FF: Rhode Island Red frizzled feather crossbred, RIR×NN: Rhode Island Red naked neck crossbred, RIR×NF: Rhode Island Red normal feather crossbred, FE×RIR: Fulani ecotype Rhode Island Red crossbred, FF×RIR: Frizzle feather Rhode Island Red crossbred, NN×RIR: Naked neck Rhode Island Red crossbred and NF×RIR: Normal feather Rhode Island Red crossbred

with 93.10%. Infertility was observed to be highest in FFRIR hens with 50.00% infertility while the lowest infertility was obtained in RIR hens. Out of the fertile eggs in each genetic stock, highest hatchability was observed in the NF, FE, RIRNN, RIRFF, RIRNF, FERIR, RIRFE and FFRIR with 100% hatchable eggs followed by NFRIR eggs with 92.59% hatchable eggs. This shows that NF and FE eggs performed better with respect to hatchability among the pure eggs while RIRNN, NNRIR, RIRFF, RIRNF, FERIR, RIRFE and FFRIR were better among the crosses in terms of hatchability followed by NFRIR eggs in all the genotypes involved. Dead-in-shell was highest in NN eggs at 38.10% while the lowest dead-in-shell was obtained in NF, FE, RIRNN, RIRFF, RIRNF, RIRFE, FFRIR and FERIR eggs of 0%, respectively.

## DISCUSSION

The significant variations in the egg production traits as affected by pure, straight and reciprocal crosses of chickens in this current study. This study had earlier been affirmed by Rasheed[7], Hailemariam *et al.*[13], Habte *et al.*[14], Melesse *et al.*[15] and Tongsiri *et al.*[16]. These authors revealed significant variations in the egg production performance among different pure and crossbred chickens in their various studies. The current findings indicated that RIR birds as expected had the heaviest body weight and delayed in age at first egg. These results agreed with the observations of final body weights of RIR documented by Melesse *et al.*[15] and Tongsiri *et al.*[16], who reported heavier final body weight for RIR over its pure counterpart's birds and this might due to the fact that exotic birds have outstanding performance over the local birds coupled with the merits of the better genetic make-up of the exotic birds. These results contradicted the observations of Amao[5], El-Tahawy and Habashy[3] and Moula *et al.*[17]. The authors claimed that crossbred chickens were better in terms of body weights than exotic chickens and the higher body weight obtained in their various studies might be due to the superior genetic constitution which has been set up after crossbreeding of local and exotic birds. The superiority exhibited by RIR×FF birds with respect to laid earlier than other genetic groups was by the observations of Rasheed[7], Soliman *et al.*[18], Khawaja *et al.*[19] and Egahi *et al.*[20]. The excellent performance of crosses involving RIR×FF birds might due to the maternal inheritance from FF birds utilized in developing the crosses. These observations agreed with the findings of Kuda[2], Abdel A'al *et al.*[21], who claimed earlier laying ability for local chicken in Egypt and Rhode Island Red, Montazah and White Leghorn chickens, respectively, all these local birds lay earlier than exotic or their crossbreds and this is one of the better attributes of local chickens.

The outstanding performance of both FF and RIR birds for hen-day and hen-housed percentages over other pure and crossbred chickens in this current finding could be attributed to the fact that both birds might be of great genetic make-ups. These reports were in accordance with the studies of Tadesse *et al.*[22] for exotic chickens, Itafa *et al.*[23] for crossing Koekoek and Sasso birds, El-Tahamy and Habashy[3] for two-way crosses of Egyptian and commercial layers, Munisi *et al.*[24] for ISA Brown and indigenous chickens, Melesse *et al.*[15] for local Kei chicken, Rhode Island Red and Fayoumi chickens, Niknafs *et al.*[25] for Mazandaran native chickens, Das *et al.*[26] for Hilly and Fayoumi chickens, who affirmed that local and exotic birds were better than their crossbred chicken in respect to hen-house and hen-housed percentages, respectively.

The data obtained on egg set, fertility and hatchability traits of eggs laid by different genotypes of pure, straight and reciprocal $F_1$ crosses revealed significant genotype differences in fertility and hatchability traits. These traits measured are highly influenced by genetic factors and this observation agreed with the findings of Tongsiri *et al.*[16], Adedeji *et al.*[27] and Balcha *et al.*[28]. The variation in the fertility and hatchability traits of these eggs in all the crosses can also be associated to different genetic background. The superiority in the number of egg sets exhibited by pure frizzled feather birds over other pure and crossbred birds denoted that they have better egg production than other genetic groups. The result was in line with studies of Wolde *et al.*[29] and Ahmad *et al.*[30] that different genetic constitution was main determinant of variations in the fertility and hatchability attributes in chickens.

Meanwhile, superiority exhibited by RIR×NN birds in fertility and hatchability coupled with the lowest dead-in-shell over the other genotypes showed that improved local breed has a good combining gene effect with Rhode Island Red (exotic) when used a male line rather than a female line. The results of this investigation noted that the exotic strain can be combined significantly well with the local breed to achieve an improved fertility and hatchability performance as a maternal line rather than a paternal line. It also established that RIR exotic strain can transmit the gene for fertility and hatchability performance into its progenies[31]. Meanwhile, the current findings that favored crossbred chickens were contradicted by the investigations of Melesse *et al.*[15], Balcha *et al.*[28] and Wolde *et al.*[29] that pure local chicken, Fayoumi crosses and Rhode Island Red crosses, respectively were better in terms of fertility and hatchability traits than their counterpart crossbred chickens in different studies.

The study will therefore have recommended that frizzled feather chicken for better combination with Rhode Island Red chicken for good egg production traits of coming earlier to lay and lighter body weight than any other genetic components produced and sexual maturity and lighter body are good indicators for egg production. It was discovered that for fertility and hatchability characteristics, pure frizzled feather birds had better performance for these traits over other pure and crossbred birds denoted that they have better egg production than other genetic groups while RIR×NN birds had the lowest dead-in-shell over the other genotypes. However, apart from the qualitative view, the molecular analysis of this study could be an option in the near future.

**CONCLUSION**

The study revealed that there are significant variations among the genetic components of the progenies produced from pure and crossbred chickens. The study further depicted the superior potential of frizzled feather chicken for better combination with Rhode Island Red chicken for good egg production traits of coming earlier to lay and lighter body weight than any other genetic components produced and the sexual maturity and lighter body are good indicators for egg production. It was discovered that for fertility and hatchability characteristics, pure frizzled feather birds had better performance for these traits over other pure and crossbred birds denoted that they have better egg production than other genetic groups while RIR×NN birds had the lowest dead-in-shell over the other genotypes.

**SIGNIFICANCE STATEMENT**

The Nigerian indigenous chickens possess desirable characteristics for their resistance to some diseases, good meat flavor and taste coupled with a better survival rate than the exotic chickens under local production conditions but they lack egg production attributes. Rhode Island Red (RIR) breed of chicken is well adapted to hot climates under free-range management and can be incorporated into crossbreeding programs to improve the genetic components for egg production attributes. This study focused on enhancing their egg production traits using a crossbreeding program between four Nigerian indigenous chickens and RIR chickens. The results obtained revealed that the combination of RIR chickens was at best with frizzled feather chicken for lighter weight and early laying traits as indicators for egg production.

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