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CORRELATIONS AMONGST TRAITS OF ECONOMIC IMPORTANCE IN LAYER TYPE CHICKENS UNDER RECIPROCAL RECURRENT SELECTION

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ABSTRACT

The objective of this study was to estimate genetic and phenotypic correlations amongst traits in layer type chickens under reciprocal recurrent selection. Matings within pure male line and female lines were carried out to produce purebred male line (AA x AA) and female line (BB x BB). A total of 364 pullets arising from 207 hens and 23 cocks in generation 1 and 440 pullets from 70 hens and 10 cocks in generation 2 under selection were monitored in individual cage units for part period egg production up to 280 days. Parameters considered were age at sexual maturity (ASM), body weight at 20 and 40 weeks (BW 20 and BW40), egg weight average (EWTAV) and egg production up to 280 days (Egg 280). Results obtained shows that ASM had a high negative genetic (-0.52 to -0.64) and moderate phenotypic (-0.39 to -0,46) correlations with BW20 in the male line, positive genetic and phenotypic correlations with EWTAV in both male (0.41 to 0.80 and 0.07 to 0.26) and female line (0.53 and 0.09 to 0.14) and negative genetic and phenotypic correlations in both male (0.45 to -0.65 and -0.08 to -0.53) and female (-0.37 and -0.20), lines, respectively. Similarly, BW40 had positive genetic and phenotypic correlations (0.68 to 0.93 and 0.01 to 0.20) with Egg-280 in the female line. EWTAV had a negative genetic and phenotypic correlation with Egg280 in both male (-0.53 to -0.96 and -0.09 to -0.17) and female line (-0.15 to -0.27 and -0.09 to -0.15), respectively. It was concluded that the favourable correlations that exist between traits measured in this study for both male and female lines indicate the presence of non-additive genetic effects which can be utilized through selection and crossing for commercial use.

Keywords: Correlations, layer type chickens, reciprocal recurrent selection.

INTRODUCTION

Correlations permit prediction of direction and magnitude of change in the dependent trait as a correlated response to direct selection of the principal trait (Sanda *et al*., 2022). In view of this, correlations are of great interest to the animal breeder. The extent and direction of correlated selection response are determined by the genetic correlation or covariance between the concerned traits (Ilori *et al*., 2017). Therefore, for improving the total economic value of an animal, it is important to know both the effect of the trait actually being selected and its effect on the other traits. This information becomes more relevant especially in flocks that undergo continued selection and the fact that it tends to bring about change in the genetic correlations among traits (Taffa *et al*., 2022).

Reciprocal recurrent selection is designed to exploit both the additive and non-additive genetic variation (Van Rheenen *et al*., 2019). The reciprocal recurrent selection (RRS) is essentially a recurrent programme to mate selected males of line A with females of line B and males of line B with females of line A to produce test crosses. This is followed by switch mating to produce pure-line A x A and B x B half sibs of the test crosses. In reciprocal recurrent selection, the selection of purebred animals is based on the performance of A x B and B x A hybrids, the segregating populations (A and B) are utilized on both sides of the cross (Ranjan *et al*., 2019). This method of selection increases the frequency of both additive and non-additive genes, hence improve pure-line as well as cross-line performance. The main reason for this is that crossbreds often exhibit heterosis that indicates the existence of non- additive effects and the two populations under reciprocal recurrent selection do not have identical gene frequency which causes the covariance between them to be small or negative (Sulaiman, 2020).

Several authors have estimated genetic and phenotypic correlations among the different economic traits in chickens from sire component of variance, not much has been reported using estimates from dam and sire plus dam components of variance. The objective of the present study is to Estimate genetic and phenotypic correlations from sire, dam and sire plus dam components.

Materials and methods

Experimental Site

The study was carried out at the Poultry Breeding Unit of National Animal Production Research Institute (NAPRI), Shika, Zaria. The Institute is located between latitude 11º and 120º N and longitude 7º and 80 º E at an altitude of 640m above sea level. Shika is located within the Guinea savanna ecological zone of Nigeria. The mean annual rainfall is 1107mm and is seasonally distributed as follows; 0.1% in the late dry season (January – March) 25.8% in the early wet season (April – June), 69.6% in the late wet season (July – September) and 4.5% in the early dry season (October to December) (). The mean annual temperature is 24.40 C. The mean relative humidity is 21% during the period of dry cool weather called harmattan and 72% during the rainy season. (Google Earth, 2022).

Data Collection

The data used in this study were obtained from a random bred population of pedigreed female line breeder cocks and hens, which form part of the poultry breeding flock maintained at the Institute. The management operations included daily feeding of the birds, cleaning of the pens, collecting and recording marked eggs and provision of clean water to the birds *adlibitum.* A footbath of morigad Lysol was kept at the entrance of the pen daily. Furthermore, periodic vaccinations, fumigation and setting of eggs into the incubators, hatching of chicks, weighing of chickens and eggs were carried out as when due.

Matings within pure male line and female lines was carried out to produce purebred male line (AA x AA) and female line (BB x BB). A total number of 364 pullets arising from 207 hens and 23 cocks in generation 1 and 440 pullets from 70 hens and 10 cocks in generation 2 under selection were monitored in individual cage units for part period egg production up to 280 days of age. The parameters considered were age at sexual maturity (ASM), body weight at 20 and 40 weeks of age (BW 20 and BW40), egg weight average (EWTAV) which was determined by taking the average of three eggs per hen at 35, 36, 38 and 40 weeks for each genetic group and egg production up to 280 days (Egg 280).

Genetic Parameter Estimates

The genetic and phenotypic correlations between two traits were estimated by Mixed Model Least Square and Maximum Likelihood (LSMLMW) whereby the variance components were partitioned into those of sire, dam and sire plus dam (Falconer, 1996). The model fitted was of the nested or hierarchical design (Van Rheenen *et al.*, 2019). In this design, sire is regarded as random, mating (pure lines versus crossbreds) and hatch as a fixed effect.

Analysis of Data

Data obtained from this study were subjected to least squares analysis of variance using the Generalized Linear Model (PROC MIXED DATA) of SAS 9.2 software and the model used was of the form:

$$Y_{jkl} = \mu + S_j + d_{(jk)} + e_{jkl} \quad (1)$$

Where; Y_{jkl} = is the record of the ith progeny of the kth dam mated to the jth sire.

μ = the common mean,

S_j= the effect of the jth sire, $d_{(jk)i}$ = the effect of the kth dam mated to the jth sire,

e_{jkl} = uncontrolled environment and genetic deviations attributed to the individuals (All error means were random, normal, and independent with expectation equal to zero).

RESULTS

Tables 1 to 6 showed the genetic and phenotypic correlations for traits of economic importance obtained from sire components in the male and female lines in generation 1, 2 and combined generations, respectively. Results revealed that age at sexual maturity had 3 negative genetic correlation (-0.52 to -0.64) with body weight at 20 weeks of age in the male line but in the female line it had a positive genetic association with body weight at 40 weeks of age. However, it showed mostly negative phenotypic correlation in both lines with body weight at 20 weeks of age and positive with body weight at 40 weeks of age, respectively. Age at sexual maturity had positive genetic and phenotypic relationships with average egg weight in both male and female lines but revealed a negative genetic and phenotypic correlation in both male and female lines with egg 280 days.

Body weight at 20 weeks had positive genetic and phenotypic correlations with body weight at 40 weeks of age in both male and female lines. Its genetic and phenotypic association: with egg 280 days were negative in both male and female lines. Body weight at 20 weeks of age revealed a negative genetic correlation with egg weight in the female line. Body weight at 40 weeks showed positive genetic and phenotypic correlations in both male and female lines with egg weight and had positive genetic correlations with egg 280 days in the female line. However, a negative genetic and phenotypic correlation was observed between egg weight and egg 280 days both in the male and female lines.

DISCUSSION

***Age at sexual maturity with other economic traits*:** Highly negative genetic and phenotypic relationship observed in the male line and a non-consistent genetic relationship in direction obtained in the female line could be attributed to lower body weights attained by the pullets of both the male (713 to 989g) and female (715 to 1013g) lines at 20 weeks of age. This showed that environmental factors, such as the hens physiological thresholds essential to start egg production which are dependent on body weight and age, have very important role to play in the phenotypic expression of this trait. Positive genetic and phenotypic correlations observed in the female line between age at sexual maturity and body weight at 40 weeks of age and positive genetic and phenotypic correlation that was observed between this trait and egg weight both in the male and female lines agreed with the findings of Werme *et al.,* (2022). High negative genetic and phenotypic correlations observed between age at sexual maturity and egg number up to 280 days in the present research corresponds well with the findings of Ukwu *et al.,* (2019). These authors asserted that the negative relationship reported could indicate that direct selection for high egg number in the two strains may possibly have a resultant beneficial effect of lowering the age at sexual maturity. Similarly, Frei (2019) also reported high negative genetic and phenotypic association between these traits. The result of this study also conforms to the findings of Yunusa and Adeoti (2014) who inferred that selection for increased egg production lowered down the age at sexual maturity concomitantly. The results of this study further agrees with the work of Shi *et al.*, (2014) who indicated that selection for earlier age at first egg is likely to be associated with moderate gain in egg production.

Body weight at 20 weeks of age with other economic traits: Moderate to high positive genetic and phenotypic correlations reported between body weight at 20 weeks with body weight at 40 weeks of age in both the male and female lines agrees with the general observation that body weight at all ages is highly heritable and are positively correlated (Sulaiman, 2020). The results of this work further correspond with the findings of Guisso ***et al.,*** (2022). These authors asserted that the pullets that attain higher body weight at 20 weeks would attain higher body weight at 40 weeks and would lay more large sized eggs.

The lack of a particular genetic correlation trend observed in the male line between body weight at 20 weeks of age with egg weight and egg production could be attributed to sampling error due to small data size. The negative genetic relationship observed between body weight at 20 weeks and egg weight in the female line could be due to low body weight which reflects poor growth of the egg forming reproductive tract that in turn would result in poor egg production and egg weight.

Body weight at 40 weeks of age with other traits: Positive genetic and phenotypic correlations observed between body weight at 40 weeks of age with egg weight and egg production up to 280 days could be attributed to improved maternal and/or sex linked effect. Hermiz and Abdullah, (2022) asserted that pullets that attain higher body weight at 40 weeks of age would lay more large sized eggs.

Egg weight with egg production up to 280 days: Negative genetic and phenotypic association observed between these traits in both male and female lines could be attributed to the presence of additive and maternal gene effect for these traits. Sanda *et al.* (2014) reported negative genetic and phenotypic correlations between egg weight and egg production up to 280days. The result of this work further corresponds with the findings of Sulaiman, (2022).

CONCLUSION

Age at sexual maturity had a positive genetic and phenotypic correlations with egg weight both in the male and female lines, but had a negative association with egg 280 days. Body weight at 20 weeks were positively correlated with body weight at 40 weeks of age both male and female lines, but had negative genetic correlations with egg 280 days both in male and female lines. Egg weight average had negative correlations with egg 280 days in both male and female lines. It was concluded that favourable heterosis exist for the traits measured in this study for both male and female lines which may indicate the presence of non-additive genetic effects which can be utilized through crossing for commercial use.

Table 1: Genetic and Phenotypic correlations for traits of economic importance obtained from sire component

in the pure bred male line

Traits	ASM	BW20	BW40	EWTAV	Egg280
ASM	-	-0.64	0.52	0.80	-0.45
BW20	0.04	-	1.28	1.40	-0.70
BW40	0.09	0.47	-	0.18	-0.62
EWTAV	0.26	0.17	0.33	-	-0.55
Egg280	-0.08	0.07	-0.14	-0.22	-

Genetic Correlations are above diagonal and phenotypic correlations are below diagonal, ASM: Age at sexual maturity, BW: Bodyweight, EWTAV: egg weight average

Table 2: Genetic sire and phenotypic correlations for traits of economic importance obtained from sire component in the pure bred male line: Generation 2

Traits	ASM	BW20	BW40	EWTAV	Egg280
ASM	-	NA	NA	0.51	-0.65
BW20	-0.39	-	NA	NA	NA
BW40	0.00	0.36	-	NA	NA
EWTAV	-0.08	0.22	0.35	-	-0.96
Egg-280	-0.53	0.38	0.05	-0.09	-

Genetic Correlations are above diagonal and phenotypic correlations are below diagonal, ASM: Age at sexual maturity, BW: Bodyweight, EWTAV: egg weight average

Table 3: Genetic sire and phenotypic correlations for traits of economic importance obtained from sire component in the pure bred male line: Combined generation

Traits	ASM	BW20	BW40	EWTAV	Egg280
ASM	-	-0.52	-0.19	0.41	-0.58
BW20	-0.46	-	0.70	-0.12	0.79
BW40	-0.07	0.42	-	0.23	-0.20
EWTAV	0.07	0.12	0.34	-	-0.53
Egg-280	-0.51	0.55	0.07	-0.17	-

Genetic Correlations are above diagonal and phenotypic correlations are below diagonal, ASM: Age at sexual maturity, BW: Bodyweight, EWTAV: egg weight average

Table 4: Genetic and Phenotypic correlations for traits of economic importance obtained from sire component in the pure bred female line: Generation 1

Traits	ASM	BW20	BW40	EWTAV	Egg280
ASM	-	NA	NA	NA	NA
BW20	0.10	-	NA	-0.29	NA
BW40	0.00	0.35	-	NA	NA
EWTAV	-0.14	0.09	-0.03	-	NA
Egg-280	0.03	0.42	0.29	0.03	-

Genetic Correlations are above diagonal and phenotypic correlations are below diagonal, ASM: Age at sexual maturity, BW: Bodyweight, EWTAV: egg weight average

Table 5: Genetic and Phenotypic correlations for traits of economic importance obtained from sire component in the pure bred female line: Generation 2.

Traits	ASM	BW20	BW40	EWTAV	Egg280
ASM	-	NA	0.75	0.53	-0.37
BW20	-0.00	-	NA	NA	NA
BW40	0.03	0.35	-	0.66	0.93
EWTAV	0.14	0.46	0.46	-	-0.27
Egg-280	-0.20	0.23	0.01	-0.15	-

Genetic Correlations are above diagonal and phenotypic correlations are below diagonal, ASM: Age at sexual maturity, BW: Bodyweight, EWTAV: egg weight average

Table 6: Genetic and Phenotypic correlations for traits of economic importance obtained from sire component

in the pure bred female line: Combined generation.

Traits	ASM	BW20	BW40	EWTAV	Egg280
ASM	-	NA	NA	NA	NA
BW20	-0.12	-	0.77	-0.10	0.51
BW40	-0.01	0.35	-	0.12	0.68
EWTAV	0.09	0.18	0.23	-	-0.15
Egg-280	-0.20	0.66	0.20	-0.09	-

Genetic Correlations are above diagonal and phenotypic correlations are below diagonal, ASM: Age at sexual maturity, BW: Bodyweight, EWTAV: egg weight average

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