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Original Article

Impact of backcrossing on morphometric traits in mating involving indigenous ecotype and exotic chicken

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Abstract

Morphometric measurements are growth indicators in livestock production and they are used sometimes to predict body weight. This research was designed to study the body weight and morphometric traits of crosses between Fulani Ecotype (E) and Isa Brown (B) chickens and their backcrosses to Isa brown (straight – BEB and reciprocal crosses -EBB). A total of 137 crossbred (EB) chickens, 89 Isa brown sired backcrossed (BEB) chickens and 98 F1 sired reciprocal (EBB) chickens were used for the study. Data were taken on body weight (BW), body length (BL), breast girth (BG), keel length (KL), shank length (SL), thigh length (TL) and wing length (WL) on a 4-week interval. The F1 (crossbred) chickens had significantly ($P<0.05$) superior BW at day-old (37.56g), an advantage over the backcrossed chickens up till the 16th week after which the backcrossed (sired by Isa brown) produced significantly ($P<0.05$) highest BW (1480.45g). In spite of having the highest significant ($P<0.05$) BW in crossbred chickens their morphometric traits measurements were lower than the backcrossed by Isa brown in most instances. The backcrossed by Isa brown recorded the highest morphometric growth measurements from day-old to 20-week of age; BL (6.86-29.90cm), BG (8.11-27.69cm), KL (1.00-12.72cm), SL (2.30-11.36cm). A very high positive ($P<0.001$) correlation was recorded between BW and other variables ranging between 0.67 and 0.99. The result of the study showed that the crossbred had the best performance in BW, while backcrossed by Isa brown performed better in morphometric traits.

INTRODUCTION

Poultry production is an acceptable enterprise to people all over the world because it is easy to start with little capital. It also provides an excellent source of protein and livelihood, particularly for poor rural communities. Poultry birds are good converter of feed into usable protein in form of meat and egg (Abanikannda *et al*., 2007). The growth rate per time in relation to feed consume is higher in poultry when compared with ruminants and other monogastric animals (Braenkaert *et al*., 2000). Poultry is the cheapest, the commonest and the best source of animal protein (Ojo, 2003). Approximately, 800 million chickens are currently found on the African continent, of which 80% are kept under traditional scavenging production systems (Petrus *et al*., 2011). These scavenging production systems are common in virtually all rural communities in Africa, providing the needed protein for the growing population in terms of egg and meat and as a source of livelihood (Moreki, 2010).

In Nigeria, the importance of these indigenous chickens cannot be overemphasized because out of the 120 million poultry birds found in the country, 80% are of native origin. These indigenous chickens are known for their adaptation superiority as it relates to environmental stress, resistance to endemic diseases and other harsh environmental conditions like poor husbandry practices (Sonaiya and Swan, 2004). It seems therefore, a laudable proposition that more attention should be given to the genetic improvement and development of the largely neglected native birds in order to ameliorate the acute animal protein shortage (Fayeye *et al*., 2005). Reports have shown that indigenous chicken possesses great potentials for genetic improvement through breeding programmes such as selection and crossbreeding (Peters, 2000; Adedeji *et al*., 2008; Adebambo *et al*., 2009).

The Fulani-ecotype chicken, an example of indigenous breed of chicken mostly found in the

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savannah part of Nigeria, has been described as a meat broiler chicken type because of the body conformation with average mature body weight of 1.2 and 2.0kg for female and male, respectively (Olawunmi *et al*., 2008; Jesuyon and Salako, 2013). The Fulani-ecotype chicken has been reported to possess intrinsic growth potential that can be tapped in commercial chicken production and potential for egg production (Fayeye *et al*., 2005). Therefore, selection along these two directions may help to develop indigenous strains of meat and egg type chicken.

Selection through crossbreeding could lead to production of birds that will be better in growth rate, efficiency of feed conversion and reproductive traits without sacrificing adaptation to the local environment and optimizing production cost (Adebambo *et al*., 2011). Morphometric traits are in whole, the determinant of the final weight of any bird. In this part of the world, affinities are given to some chicken parts as a social class in the community. Thus the resulting morphometric traits could be better in terms of the forms, structure, shape and size of the animal in contrast to the parent and an ultimate traits of interest in profitability marketing. This study was aimed at investigating the impact of backcrossing on morphometric traits in mating involving indigenous ecotype and exotic chickens as sire breeds.

MATERIALS AND METHODS

Experimental site

The study was carried out in a farm located in the derived savannah zone of Nigeria on longitude 4°15' East and latitude 8°5 ' Northeast of the Greenwich meridian. The altitude is between 300 and 600m above sea level. The mean annual rainfall and temperature are 1247mm and 27°C, respectively.

Mating procedure

A total of ten male chickens (5 Fulani ecotype- E and 5 Isa brown -B) and 25 Isa brown female chickens were used to establish the mating stock for the study. The hens were artificially inseminated with semen samples obtained from the male chickens. The semen was collected through massage technique by applying slight pressure at the back of the chicken towards the tail as described by Bakst and Long (2010). The semen were used immediately after collection by applying 0.1ml of the undiluted semen to each hen once a week. The Fulani Ecotype (E) was used as the sire strain to mate the female Isa Brown (B) to produce the F1 (EB) offspring.

Mating procedures are as shown below:

F1 (crossbred) chickens:

Fulani Ecotype (E) sire X Isa Brown (B) dam = F_1 crossbred (EB)

Backcross (I) sired by Isa Brown:

B (sire) X F1 (dam) = BEB (F_2)

Backcross (II) sired by F1 (crossbred):

F1 (sire) X B (dam) = EBB (F_2)

Egg collection and incubation

Eggs were collected along the genotype line and stored in a cool room with ambient temperature of between 18 and 20°C before transferring to the hatchery for incubation. The incubator was set at a temperature of between 27 and 39°C and relative humidity of 55 - 66% for the first eighteen days. The temperature was subsequently increased to between 29 and 40°C with relative humidity of 70 - 75% for the last three days. Candling was carried out on the 3rd and 18th day of incubation for identification of clear and fertile eggs. After hatching, the number of hatched chicks including the normal, weak, abnormal and dead chicks were recorded.

Management of the birds

All chicks resulting from each crossing were properly identified and wing tagged along sire lines and placed separately in a brooding pen. The chicks were brooded for a period of four weeks and fed commercial chicks mash while grower mash was given thereafter for the 20 weeks the experiment lasted. Feed were given *ad libitum* and water was given freely. Medication and vaccination were done as and when needed. A total of 137 EB chickens, 89 BEB chickens and 98 EBB chickens were used for the study.

Data Collection and Statistical Analysis

Data were obtained on 4-week basis on the progenies generated from the mating for a period of 20 weeks. The Body weight (BW) was measured with the aid of a sensitive scale with accuracy of 0.01g. Morphometric traits were measured with the aid of measuring tape. The following morphometric traits were measured: body length (BL), breast girth (BG), keel length (KL), shank length (SL), thigh length (TL), and wing length (WL) according to the procedures described by Olawunmi *et al*. (2008) and Yakubu and Salako (2009). Since the chickens were not hatched at the same time, the effect of genotype, sex and season were determined using the following model:

$Y_{ijk} = \mu + A_i + B_j + Z_k + e_{ijkl}$

Where

Y_{ijk} = individual observation within the genotype

μ = overall mean

A_i = fixed effect of ith genotype

B_j = fixed effect of jth season

Z_k = fixed effect of kth sex

e_{ijkl} = experimental error

The phenotypic correlations were obtained using the expression:

$$r = \frac{\Sigma(X_i Y_i)}{\sqrt{\Sigma X_i \Sigma Y_i}}$$

Where

r = pearson correlation

X_i = first variable of the ith parameter

Y_i = second variable of the ith parameter

The analysis was carried out with one-way ANOVA using general linear model of SAS (2003) software at 5% probability level while means were compared with the Duncan Multiple Range Test option of the software.

RESULTS AND DISCUSSION

Table 1 presents the BW and morphometric traits of crossbred and backcrossed chickens as affected by genotype, sex and season at day-old. From the Table, it was observed that BW was significantly (P<0.05) affected by genotype and sex. The crossbred chickens at day-old, despite having the significantly (P<0.05) highest BW (37.56g), recorded the lowest morphometric traits. The superior body weight could be due to other traits not captured by the morphometric traits measured or the chickens may be carrying more feathers than the other genotypes. Furthermore, hybrid vigour and better genetic composition of the crossbred over the backcrossed may be responsible for the weight superiority. Ayorinde and Oke, (1995) reported that variation in body weight within a flock can be attributed to genetic variation and environmental factors that impinge on the individual genetic traits. Backcrossed (I), which is next in body weight to the crossbred had the longest BL (6.83cm), BG (8.11cm) and SL (2.30cm) compared to other genotypes. These traits are all indicators for heaviness of a bird. Also, increased gene contribution from Isa brown sire chickens had advantages on these morphometric traits. Morphometric traits such as SL and shank diameter are good indicators of leg development while BG is an indicator of breast development.

With respect to sex, male chickens recorded relatively higher and significant (P<0.05) values in BW and the morphometric traits considered, except in WL. Tagirov and Golovan (2015) reported that sex-specific development occurs from the onset of embryogenesis where male had the superior edge. Seasonal significant (P<0.05) differences were only recorded in BW, BG, SL and WL with early rain producing the best performance. This may be due to the fact that birds tend to eat more and gain more weight when the weather is cool because discomfort may result in improper expression of genetic potential in birds (Kataria *et al*., 2008).

Table 1: Means and standard errors of means for growth performance of crossbred and backcrossed chickens as affected by genotype, sex and season at day-old

iables	BW	BL	BG	KL	SL	TL	WL
iotype							
crossbred	37.56 ±1.39^a	5.96 ±0.07^b	6.61 ±0.11^c	1.00 ±0.01	1.94 ±0.03^b	2.23 ±0.09^b	4.87 ±0.20^b
kcross (I)	34.92 ±0.54^b	6.86 ±0.11^a	8.11 ±0.07^a	1.00 ±0.01	2.30 ±0.03^a	3.20 ±0.04^a	5.00 ±0.05^b
kcross (II)	33.17 ±0.05^c	6.13 ±0.05^a	7.53 ±0.09^b	1.00 ±0.01	1.96 ±0.05^b	3.35 ±0.09^a	5.83 ±0.24^a
	34.60 ±0.32^a	6.65 ±0.04	8.10 ±0.05	1.00 ±0.01	2.12 ±0.05	3.24 ±0.09	5.12 ±0.06^a
	33.31 ±0.28^b	6.49 ±0.05	7.84 ±0.95	1.00 ±0.01	2.11 ±0.06	3.07 ±0.03	5.97 ±0.06^a
son							
	33.85 ±0.80^a	6.17 ±0.04^a	7.10 ±0.04^b	1.00 ±0.01^a	1.73 ±0.07^b	3.29 ±0.08^a	4.99 ±0.07^b
	34.56 ±0.27^a	6.50 ±0.04^a	8.00 ±0.05^a	1.00 ±0.01^a	2.26 ±0.06^a	3.17 ±0.08^a	5.21 ±0.06^a

^{a,b,c,} Means having the different letters along the column for a given trait differ significantly (p<0.05)

BW = Body weight; BL = Body length; BG = Breast girth; KL = Keel length; SL = Shank length; TL = Thigh length; WL = Wing length;

F1 crossbred (EB) = Fulani Ecotype X Isa Brown; Backcross (I) (BEB) = Isa Brown X F1 crossbred; Backcross (II) (EBB) = F1 crossbred X Isa Brown;

M = Male; F = Female; ER = Early Rain; LR = Late rain.

Shown in Table 2 are the growth performance of crossbred and backcrossed chickens as affected by genotype, sex and season at 4 weeks old. The crossbred had the highest BW (195.00g) while the least BW (157.71g) was obtained in backcrossed (II). With the exception of SL, the crossbred chicken had the highest measurements in all the morphometric traits considered and was also significantly (p<0.05) different from other genotypes. This was in contrast to what was obtained at day-old, giving a correct reflection of the body size attained at 4 weeks. It has been reported that morphometric traits are a practical technique which can be used to derive the bird's body weight (Semacula *et al*., 2011). It could further be deduced from this study that the injection of Isa brown genes as sire strain for backcross (I) performed better than the backcrossed (II). Male chickens had higher values in all the traits considered which described the actuality of sexual dimorphism in differences between male and female animals and it is believed that males grow faster than females at the early stages of growth. Season had significant (P<0.05) effect on BW, BL, CG and KL. However, early rain produced better performance in all the traits in terms of the values. The temperature was most likely cooler during early raining season, thus making birds gain more weight than during hot weather.

Table 2: Means and standard error of means for growth performance of crossbred and backcrossed chickens as affected by genotype, sex and season at 4 weeks old

iables	BW	BL	BG	KL	SL	TL	WL
otype							
rossbred	195.00 ±8.75[a]	11.87 ±0.48[a]	13.20 ±0.18[a]	5.10 ±0.10[a]	4.09 ±0.10[a]	6.80 ±0.20[a]	17.51 ±0.75[a]
kcross (I)	163.44 ±4.62[b]	11.46 ±0.10[a]	12.77 ±0.11[b]	5.03 ±0.08[a]	4.30 ±0.09[a]	5.92 ±0.11[b]	16.98 ±0.17[b]
kcross (II)	157.71 ±6.20[c]	10.67 ±0.27[b]	12.50 ±0.13[b]	4.55 ±0.07[b]	4.30 ±0.09[a]	6.36 ±0.12[a]	17.05 ±0.31[b]
	173.52 ±2.56[a]	11.27 ±0.07[a]	13.07 ±0.07[a]	4.68 ±0.03[a]	4.21 ±0.23[a]	6.37 ±0.05[a]	17.36 ±0.10[a]
	155.28 ±1.98[b]	11.00 ±0.06[a]	12.71 ±0.07[b]	4.66 ±0.14[a]	4.02 ±0.01[a]	6.18 ±0.05[a]	16.95 ±0.09[b]
on							
	178.78 ±7.86[a]	11.79 ±0.14[a]	13.05 ±0.12[a]	4.39 ±0.07[a]	4.73 ±0.11a	6.67 ±0.14[a]	17.28 ±0.28[a]
	165.60 ±1.89[b]	11.35 ±0.05[a]	13.03 ±0.05[a]	3.92 ±0.02[b]	4.03 ±0.03b	6.25 ±0.04[a]	17.09 ±0.07[a]

[a,b,c,] Means having the different letters along the column for a given trait differ significantly (p<0.05)
BW = Body weight; BL = Body length; BG = Breast girth; KL = Keel length; SL = Shank length; TL = Thigh length; WL = Wing length;
F1 crossbred (EB) = Fulani Ecotype X Isa Brown; Backcross (I) (BEB) = Isa Brown X F1 crossbred;
Backcross (II) (EBB) = F1 crossbred X Isa Brown;
M = Male; F = Female; ER = Early Rain; LR = Late rain.

The growth performance of crossbred chickens and backcrossed as affected by genotype, sex and season at 8 weeks' old are presented in Table 3. The result from the Table showed no significant (P>0.05) different in KL, TL and WL. However, the crossbred was significantly (P<0.05) different in BW (511.67g) with higher values in TL (9.22cm) and WL (25.81cm). Backcrossed (I) performed relatively better than backcrossed (II). It could be recalled that the crossbred chickens had the advantage of having the highest weight at day-old and this played till 8 weeks. Khan *et al*. (2007), opined that Wilson (1991) reported that the influence of egg weight remained until

Table 3: Means and standard error of means for growth performance of crossbred and backcrossed chickens as affected by genotype, sex and season at 8 weeks old

ıbles	BW	BL	BG	KL	SL	TL	WL
type							
ossbred	443.64 ±12.44[b]	16.06 ±0.17[a]	18.19 ±0.22[a]	7.53 ±0.22a	6.52 ±0.14[a]	9.19 ±0.18[a]	25.76 ±0.
cross (I)	511.67 ±27.61[a]	16.03 ±0.34[a]	18.03 ±0.42[a]	7.06 ±0.18[a]	4.86 ±0.14[b]	9.22 ±0.21[a]	25.81 ±0.
cross (II)	421.62 ±22.69[b]	14.58 ±0.27[b]	15.78 ±0.26[b]	7.63 ±0.19[a]	6.40 ±0.15[a]	9.02 ±0.17[a]	25.14 ±0.
	493.64 ±8.47a	16.22 ±0.11a	18.11 ±0.13[a]	7.55 ±0.08[a]	6.57 ±0.07[a]	9.95 ±0.10[a]	26.24 ±0.
	430.93 ±8.22[b]	15.72 ±0.09[b]	17.51 ±0.11[b]	7.01 ±0.04[b]	6.02 ±0.05[a]	9.37 ±0.08[b]	25.23 ±0.
ın							
	469.69 ±7.99[a]	16.35 ±0.81[a]	18.33 ±0.11[a]	7.27 ±0.05[a]	6.99 ±0.04[a]	10.00 ±0.07[a]	27.00 ±0.
	458.28 ±7.88[b]	16.20 ±0.09[a]	18.27 ±0.10[a]	7.25 ±0.06[a]	6.14 ±0.05[b]	9.64 ±0.08[a]	25.45 ±0.

[a,b,c,] Means having the different letters along the column for a given trait differ significantly (p<0.05)
BW = Body weight; BL = Body length; BG = Breast girth; KL = Keel length; SL = Shank length; TL = Thigh length; WL = Wing length;
F1 crossbred (EB) = Fulani Ecotype X Isa Brown; Backcross (I) (BEB) = Isa Brown X F1 crossbred;
Backcross (II) (EBB) = F1 crossbred X Isa Brown;
M = Male; F = Female; ER = Early Rain; LR = Late rain.

marketing stage when each gram advantage translated into a 2 -13 g improvement in body weight at six weeks of age. The effect of sex on the body weight is significant and the difference was getting widening as the male chickens were expressing dominance over the female chickens with respect to all the traits of interest. This further justified the fact of sexual dimorphism in chickens. Sola-Ojo *et al*. (2011) reported that male chickens were heavier in body weight, body length and body girth than their female counterparts from 6 to 20 weeks old.

Table 4 presents the growth performance of crossbred chickens as affected by genotype, sex and season at 12 weeks old. The result of BW from the Table showed that crossbred chickens performed better (P<0.05) than the backcrossed (I) and (II) chickens. The backcrossed (I) and the crossbred chickens did not differ significantly (P>0.05) from one another in KL, TL and WL but showed significant (P<0.05) difference from the backcrossed (II). Like the trend and pattern of growth recorded from day-old, 12-week growth pattern for BW and morphometric traits were not an exemption as they were relatively close in values. The male chickens were superior and significantly (P<0.05) different in BW and all the morphometric traits when compared to their female counterparts. The difference could only be attributed to sexual dimorphism because both sexes were reared together under same management system without bias to any particular sex. The result of the seasonal variation gave early rain significantly (P<0.05) higher BW compared to late raining season. It was observed that the cool weather during the study made the chickens consumed more feed and gained more weight than late rain when temperature was mostly high during the day.

Table 4: Means and standard error of means for growth performance of crossbred and backcrossed chickens as affected by genotype, sex and season at 12 weeks old

bles	BW	BL	BG	KL	SL	TL	WL
ype							
ssbred	795.56 ±23.06[b]	19.47 ±0.18[b]	21.18 ±0.21[b]	9.77 ±0.12[a]	8.83 ±0.11[a]	11.88 ±0.4[a]	32.35 ±0.32[a]
ross (I)	830.00 ±35.98[a]	20.68 ±0.43[a]	22.17 ±0.59[a]	9.38 ±0.17[a]	7.91 ±0.17[b]	12.61 ±0.29[a]	32.70 ±0.27[a]
ross (II)	643.38 ±53.45[c]	18.28 ±0.38[c]	20.19 ±0.55[c]	8.47 ±0.17[b]	7.08 ±0.20[b]	11.99 ±0.23[b]	29.39 ±0.55[b]
	848.50 ±14.61a	19.85 ±0.13[a]	21.77 ±0.14[a]	9.27 ±0.06[a]	8.42 ±0.07[a]	13.37 ±0.12[a]	32.41 ±0.17[a]
	695.86 ±11.37b	18.75 ±0.13[b]	21.23 ±0.64[b]	8.74 ±0.06[b]	7.72 ±0.06[b]	12.33 ±0.10[b]	30.66 ±0.15[b]
ı							
	769.69 ±13.99b	19.35 ±0.11[a]	21.33 ±0.11[a]	9.27 ±0.05[a]	7.99 ±0.04[a]	12.00 ±0.07[b]	31.00 ±0.15[a]
	745.25 ±13.14c	19.19 ±0.14[a]	21.23 ±0.13[a]	8.91 ±0.07[b]	7.98 ±0.07[a]	12.85 ±0.13[a]	31.14 ±0.18[a]

[a,b,c,] Means having the different letters along the column for a given trait differ significantly (p<0.05)
BW = Body weight; BL = Body length; BG = Breast girth; KL = Keel length; SL = Shank length; TL = Thigh length; WL = Wing length;
F1 crossbred (EB) = Fulani Ecotype X Isa Brown; Backcross (I) (BEB) = Isa Brown X F1 crossbred;
Backcross (II) (EBB) = F1 crossbred X Isa Brown;
M = Male; F = Female; ER = Early Rain; LR = Late rain.

The results in Table 5 showed the growth

Table 5: Means and standard error of means for growth performance of crossbred and backcrossed chickens as affected by genotype, sex and season at 16 weeks old

bles	BW	BL	BG	KL	SL	TL	WL
ype							
ssbred	1124.11 ±35.03[b]	26.17 ±3.85[a]	23.84 ±0.26[b]	10.94 ±0.16[a]	9.86 ±0.17[a]	13.75 ±0.18[b]	34.39 ±0.33[b]
ross (I)	1169.00 ±25.31[a]	22.24 ±0.28[b]	24.07 ±0.24[a]	10.33 ±0.17[a]	9.31 ±0.19[a]	15.62 ±0.22[a]	35.27 ±0.57[a]
ross (II)	844.60 ±66.13[c]	19.82 ±1.26[c]	22.64 ±0.35[c]	9.77 ±0.20[b]	8.98 ±0.17[b]	13.42 ±0.32[b]	33.01 ±0.04[c]
	1264.59 ±41.91[a]	23.42 ±0.80[a]	24.47 ±0.13[a]	11.02 ±0.08[a]	9.89 ±0.07a	15.53 ±0.12[a]	35.84 ±0.07[a]
	960.22 ±13.96[b]	21.06 ±0.11[b]	22.93 ±0.12[b]	10.12 ±0.07[b]	8.78 ±0.06[b]	13.92 ±0.90[b]	33.14 ±0.06[b]
ı							
	1101.04 ±13.37[b]	22.29 ±0.42[a]	23.76 ±0.09[a]	10.60 ±0.06[a]	9.36 ±0.05[a]	14.74 ±0.08[a]	34.52 ±0.13[a]
	2463.71 ±90.89[a]	2011 ±0.73[b]	22.29 ±0.92[b]	9.92 ±0.54[b]	8.94 ±0.33[b]	13.57 ±0.75[b]	32.93 ±1.06[c]

[a,b,c,] Means having the different letters along the column for a given trait differ significantly (p<0.05)
BW = Body weight; BL = Body length; BG = Breast girth; KL = Keel length; SL = Shank length; TL = Thigh length; WL = Wing length;
F1 crossbred (EB) = Fulani Ecotype X Isa Brown; Backcross (I) (BEB) = Isa Brown X F1 crossbred;
Backcross (II) (EBB) = F1 crossbred X Isa Brown;
M = Male; F = Female; ER = Early Rain; LR = Late rain.

performance of crossbred chickens as affected by genotype, sex and season at 16 weeks old. From the results, it could be observed that the BW (1124.11g) of backcrossed (I) chickens was almost similar to that of the crossbred chickens (1169.00g) though they were significantly (P<0.05) different from one another. Inference could be drawn from the morphometric traits. The results from the Table showed that BL had an input on BW as it relates to the crossbred chickens and the backcrossed (I). The relationship between body weight and back length agreed with the findings of Ojo *et al*. (2013) where they reported that body length was one of the best predictors of body weight in Japanese quail (*Cortunix cortunix japonica*). The crossbred chickens were significantly (P<0.05) higher than other genotypes except in BL where backcrossed (I) had the highest value of 26.17cm. Male chickens continued to performed better that their female counterparts and showed significant (P<0.05) difference in BW and all the morphometric traits. The male chickens almost doubled their weight (from 493.64g to 848.50g) within the 4weeks period and were heavier than the female chickens by one-fourth. Early rain supported increased BW and growth in all the morphometric traits measured and were significantly (P<0.05) different from late raining season.

The growth performance of crossbred chickens as affected by genotype, sex and season at 20 weeks' old are as presented in Table 6. The result revealed that the backcrossed (I) had overtaken the crossbred and was significantly (P<0.05) higher in BW (1480.45g) and BL (25.9cm) but not in CG, KL and SL, and further showed significant (P<0.05) difference from backcrossed (II). The crossbred chickens were significantly (P<0.05) different from other genotypes in TL and WL. The result of the study showed that male chickens gained approximately 100g on weekly basis while the female chickens gained about 55g per week. This means that the male chickens gained almost double the weekly weight gain of female chickens. Early raining season produced higher BW and measurements in all the morphometric trait considered,

The phenotypic correlation coefficient of BW and morphometric traits for the three genotypes are presented in Table 7. The study revealed a high positive significant correlation between BW and the morphometric traits measured for all the genotypes. The result of this study agreed with the report of Yahaya *et al*. (2012) of high and positive correlation coefficients of 0.86 - 0.97 and 0.86 - 0.97 between body weight and morphometric traits in Hubbard and Arbor Acre broiler strains. The correlation between BW and the morphometric traits were relatively high getting close to 1 with few exceptions in backcrossed (II) for BL. The result of the correlation suggested that the morphometric parameters can be used to predict BW. Furthermore, the significant phenotypic inter-correlation of BW and morphometric traits indicated that a subset of weight measurements at early age may serve as selectable markers for future performance in Fulani Ecotype chicken improvement schemes. The inter-correlation relationship among BW can be applied speedily in breeding and selection programme as suggested by Monsi (1992).

Table 6: Means and standard error of means for growth performance of crossbred and backcrossed chickens as affected by genotype, sex and season at 20 weeks old

ples	BW	BL	BG	KL	SL	TL	WL
ype							
ssbred	1480.45 ±48.07[a]	29.90 ±0.27[a]	27.69 ±0.45[a]	12.72 ±0.15[a]	11.36 ±0.18[a]	15.91 ±0.19[b]	37.14 ±0.43
ross (I)	1440.89 ±44.47[b]	25.61 ±0.16[b]	27.30 ±0.40[a]	12.17 ±0.29[a]	10.58 ±0.58[a]	17.11 ±0.31[a]	38.00 ±0.92
ross (II)	1154.46 ±67.07c	23.01 ±0.68[b]	24.40 ±0.65[b]	11.15 ±0.21[b]	8.61 ±0.27[b]	15.45 ±0.50[b]	34.78 ±0.68
	1658.65 ±23.15[a]	25.30 ±0.15a	27.41 ±0.17[a]	12.40 ±0.08[a]	10.90 ±0.09[a]	17.37 ±0.13[a]	38.18 ±0.16
	1180.61 ±18.39[b]	23.10 ±0.15[b]	25.15 ±0.18[b]	11.33 ±0.08[b]	9.44 ±0.08[b]	15.31 ±0.09[b]	35.04 ±0.17
n							
	1428.17 ±20.93[b]	24.26 ±0.14[a]	26.42 ±0.16[a]	11.91 ±0.07[a]	10.36 ±0.08[a]	16.38 ±0.10[a]	36.72 ±0.16
	1351.25 ±37.02[a]	23.79 ±0.24[b]	25.60 ±0.25[b]	11.62 ±0.13[b]	9.38 ±0.12[b]	16.02 ±0.19[a]	35.99 ±0.25

[a,b,c,] Means having the different letters along the column for a given trait differ significantly (p<0.05)
BW = Body weight; BL = Body length; BG = Breast girth; KL = Keel length; SL = Shank length; TL = Thigh length; WL = Wing length;
F1 crossbred (EB) = Fulani Ecotype X Isa Brown; Backcross (I) (BEB) = Isa Brown X F1 crossbred;
Backcross (II) (EBB) = F1 crossbred X Isa Brown;
M = Male; F = Female; ER = Early Rain; LR = Late rain.

Table 7. Phenotypic correlation coefficient of growth parameters for the three genotypes

Variables		BW	BL	BG	KL	SL	TL	WL
BW	**BEB**							
	EB							
	EBB							
BL	**BEB**	0.92						
	EB	0.96						
	EBB	0.67						
CL	**BEB**	0.95	0.97					
	EB	0.96	0.99					
	EBB	0.94	0.69					
KL	**BEB**	0.89	0.93	0.95				
	EB	0.94	0.98	0.98				
	EBB	0.92	0.68	0.96				
SL	**BEB**	0.91	0.94	0.96	0.93			
	EB	0.95	0.97	0.97	0.96			
	EBB	0.94	0.68	0.96	0.96			
TL	**BEB**	0.95	0.96	0.97	0.93	0.95		
	EB	0.97	0.98	0.98	0.97	0.98		
	EBB	0.93	0.67	0.96	0.94	0.96		
WL	**BEB**	0.91	0.95	0.96	0.95	0.97	0.96	
	EB	0.92	0.97	0.97	0.97	0.95	0.96	
	EBB	0.89	0.67	0.94	0.95	0.95	0.94	

BW = Body weight; BL = Body length; BG = Breast girth; KL = Keel length;
SL = Shank length; TL = Thigh length; WL = Wing length;
F1 crossbred (EB) = Fulani Ecotype X Isa Brown;
Backcross (I) (BEB) = Isa Brown X F1 crossbred;
Backcross (II) (EBB) = F1 crossbred X Isa Brown

CONCLUSION

It could be concluded from the study that crossbreeding of Fulani Ecotype as sire strain should be practiced by farmers if early growth performance is targeted. However, if the trait of interest is meat production in the long run, then backcrossing the crossbred to a sire strain of Isa brown would be an advantage. It would be assumed, for a further research, that the more of the genes of Isa Brown injected as a sire line, the more the performance is optimized.

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