

## Growth performance, genetic parameters and selection index of pure and crossbred populations of Red Sokoto and West African Dwarf goats

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### Abstract

*In 2008, a breeding programme was designed to develop hybrid goat suitable for the rainforest agro-ecological zone of South-Eastern, Nigeria. Two indigenous goat breeds namely, Red Sokoto (RS) and West African Dwarf (WAD) goats were utilized and mated in a main (RS x WAD), reciprocal (WAD x RS) and pure line (RS x RS and WAD x WAD) fashion. A total of 74 progenies were generated from the matings and were evaluated for 12 week growth performance. As part of the ranking procedure, a selection index was constructed based on two major body components namely body weight (BWT) and heart girth (HGT) to objectively determine the genetic worth of the growing pure and crossbred progenies of Red Sokoto and West African Dwarf kids. The results showed that average body weight (BWT) of RS x RS ( $5.29 \pm 0.13$ kg) and RS x WAD ( $5.14 \pm 0.21$ kg) buck kids were similar but significantly ( $P < 0.05$ ) heavier than that of their WAD x RS ( $4.84 \pm 0.17$ kg) and WAD x WAD ( $4.79 \pm 0.17$ kg) counterparts. The performance of crossbred RS x WAD compared to WAD x RS and WAD x WAD buck kids indicate that the main crossbred kids sired by Red Sokoto bucks but nursed by WAD dams received superior sets of genes from their large-sized sire. The RS x WAD buck kids in particular, had significantly longer body length (BLT), height-at-withers (HWT) and HGT than WAD x RS and WAD x WAD kids. The phenotypic and genetic correlations of BWT and HGT in both sexes for the different genotypes were high and positive which were indicative of the nature of association between these conformation traits in goats. Heritability estimates ( $h^2$ ) for BWT and HGT in males and females kids ranged from 0.31 – 0.36 versus 0.28 – 0.30, respectively in most of the growing kids. The relative economic values (REV) of chosen traits were generally higher for male kids compared to their female counterparts. Phenotypic variances for BWT and HGT in male and female kids ranged from 0.65 – 0.80. The selection index values were highest in male and female kids of RS x RS, followed by RS x WAD, while WAD x RS kids ranked low and WAD x WAD kids ranked the least. Thus, indicating that selection and improvement of growth traits in these pure and crossbred kids would be in favour of the RS x RS and RS x WAD individuals.*

**Key words:** Indigenous goats, crossbreeding, genetic parameters, selection index, growth traits.

### Introduction

Goat is the most populous farm animal in South-East and South-South Nigeria, with more than 92% of the farm families raising

goats (Ukpabi *et al.*, 2000). The West African Dwarf (WAD) goat known to be trypano-tolerant is the dominant type of goat kept in the humid rainforest

environment. The productive Red Sokoto (RS) goat is native and predominant in the Sudan and parts of the Sahel savannah (Zahradden, *et al.*, 2007). Goats play vital role in the economy of small holder farmers who keep them in small herds in units varying from 10 to 13 goats (Momoh and Ochaba, 2002). The preponderance and popularity of these indigenous goats in different agro-ecological areas of Nigeria where they served as source of family income, financial stability and supply of basic animal protein for households keeping them (Omojola and Attah, 2006) have necessitated the need to investigate their productivity and possible genetic improvement. Productivity in meat goats has often been measured in terms of their economically important traits such as body weight and other body conformation parameters (Hamayun, *et al.*, 2006).

Banerjee (1998) had noted that livestock improvement could be achieved by limiting the reproduction of inferior animals while choosing superior ones for mating to produce virile progenies which would become parents to future generation. Ibe (1998) applauded selection index as a veritable tool for ranking test animals and described it as best linear predictor (BLP) of breeding value (genetic worth) of individual animals in a mating population. The productive capacity and physical outlook of a goat type can be changed by selective breeding but more remarkably by crossbreeding (Banerjee, 1998). Improvement of farm animal species and selection of individuals which would serve as future parents in a breeding flock has often been evaluated using basic genetic tools such as heritability estimates, repeatability of production records and correlation of associating traits. Estimates derived from these genetic parameters have been found very useful in objective ranking

of test animals (Fadlemoula *et al.*, 2011). The selection index method of scoring individual animals in a breeding population is known to be a more reliable method of multi-trait assessment (Gjederm, 1972). The efficiency of estimating the breeding value or genetic worth of prospective animal(s) in a flock is a major concern of animal breeders and informed stockmen.

Nigeria as an emerging economy in Sub-Saharan Africa must consider developing her animal genetic resources (AnGR) in all the agro-ecological zones of the country, if animal protein demand for her ever teeming human population is to be met. It is against this background that a breeding programme aimed at developing suitable crossbred meat type goats for the rainforest zone which would combine the productivity of the Red Sokoto and adaptive potentials of West African Dwarf goats has been considered. Success in this regard would definitely impact on the livelihood and well-being of rural farm families whose economy is dependent to some extent on goat farming. This study therefore was undertaken to evaluate growth performance of pure and crossbred kids of Red Sokoto and West African Dwarf goat and their objective ranking for purpose of selection in the rainforest agro-ecological zone of South-East, Nigeria.

### **Materials and Methods**

This research was carried out in the Goat Unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Umudike is geographically located on latitude 05° 29'N and Longitude 07° 33'E. It is within the zone characterized by an annual rainfall of about 2177mm, over a period of 8 - 9 months and relative humidity of 50 to 90% depending on the season of the year. The ambient temperature ranges from 27°C-38°C during

the dry season (December – March) and 18° C – 26° C during the rainy season (April – November). The daylight and night (D: N) ratio is 12:12 hours. The meteorological data were obtained from the Meteorological Station of the National Root Crop Research Institute Umudike, Abia State. This agro-ecological zone has been aptly described as a warm – wet rainforest environment.

*Management of breeding stock*

The breeding stock consisted of 34 matured goats made up of 18 Red Sokoto (RS) goats (2 bucks and 16 does) and 16 West African Dwarf (WAD) goats (2 bucks and 14 does). They were housed in a conventional dwarf walled house partitioned into pens. The breeding animals were quarantined for 3 weeks, treated against ecto- and endo-parasites, using injectable Ivermectin during which period also, they were vaccinated against *Pest des petit ruminant (PPR)* disease. A total of 74 kids were generated from the breeding stock consisting of 20 kids each of RS x RS and WAD x WAD, while RS x WAD and WAD x RS had 17 kids each. These kids were allowed with their individual dams for the 12 weeks period of experiment. The breeding dams and their kids were maintained on daily feed allowance of 25% concentrate ration and 75% fresh fodders made up of *Panicum*

*maximum* and a mixture of other browse plants. Apart from a daily feeding allowance of 300g /doe/day, additional 100g /kid/day was added for the number of kids each doe nursed. The composition of the concentrate ration fed to breeding RS and WAD goats is shown in Table 1. Kids were also treated against ecto- and endo-parasites using injectable Ivermectin administered subcutaneously at 8 weeks, while vaccination against *Pest des petit ruminant (PPR)* was done at 12 weeks of age.

*Mating scheme*

The mating scheme employed involved pure line, main cross and reciprocal cross mating. The mating arrangement is shown in Table 2.

*Data collection*

The following data were collected from individual kids in each of the genetic group namely: body weight (BWT), recorded as weekly weight changes of kids taken with a top-loading scale of 25g sensitivity. Body length (BLT) was determined as distance from the centre of the cranial region to the base of the tail. Heart girth (HGT) was measured as the circumference of the girth close to the forelegs. Height-at-withers (HTW) was also measured as the distance from the withers to the base of the

**Table 1: Percentage composition of concentrate ration fed to breeding goats.**

Feed Ingredients	Percentage (%)
Maize offal	50.00
Wheat offal	10.00
Palm kernel cake	30.00
Bone meal	2.00
Soya bean meal	6.50
Oyster shell	1.00
Mineral salt	0.25
Vitamin/ mineral premix	0.25
Total	100.00
% Crude Protein	13.60
ME (Kcal/kg)	2900

**Table 2: Mating schemes and mating ratio for pure line, main and reciprocal crossing.**

Mating types	Genotype	Mating ratio
Pure line	RS x RS	1:8
	WAD x WAD	1:7
Main crossing	RS x WAD	1:7
Reciprocal crossing	WAD x RS	1:8

hoof of the right foreleg while the animal stood erect on a wooden platform. All linear body measurements were taken with a Tailor's tape in centimeters (cm).

#### Statistical data analysis

Data generated were subjected to analysis of variance using SPSS (2007) version 16.0 in order to obtain means and their associated standard errors for measured parameters. Significant means were separated using Duncan's New Multiple Range Tests (Duncan, 1955). Total variance component ( $\sigma_p^2$ ), sire variance component for BWT [ $\sigma_{s(BWT)}^2$ ], HGT [ $\sigma_{s(HGT)}^2$ ], error variance ( $\sigma_e^2$ ) and sire covariance component between BWT and HGT [ $COVs_{(BWT,HGT)}$ ] and covariance error (COVe) were computed by random effect analysis of variance (ANOVA) for BWT and HGT using Nested procedure of Statistical Analytical System, (SAS, 1998). The ANOVA results were further used to

compute heritability ( $h^2$ ), genetic correlation ( $\Upsilon_G$ ) and phenotypic correlation ( $\Upsilon_p$ ) between BWT and HGT as outlined by Becker (1992):

Relative Economic Value (REV) for the two traits (BWT and HGT) was determined by the procedure outlined in Van Vleck *et al.* (1987). In order to determine the b's required to set up the index equation, estimates of (co)variances were condensed into matrices and vector form  $\underline{b} = P^{-1}G\underline{v}$ , where (refer to page 15);

The entries for the matrices and vectors were subjected to analysis of Mathcad (2007) in order to determine the b's. These b's were finally used to construct a selection index for each genetics group as shown in Table 6.

#### Results and Discussion

The weight of the body and that of the three major linear body parameters of buck kids for the four genetic groups

$$\text{Heritability } (h^2) = \frac{4\sigma_s^2}{\sigma_p^2}; \text{ Genetic correlation } (\Upsilon_G) = \sqrt{\frac{\sigma_{s(BWT)}^2 \cdot \sigma_{s(HGT)}^2}{\sigma_{s(BWT)}^2 \cdot \sigma_{s(HGT)}^2}}$$

Phenotypic correlation ( $\Upsilon_p$ ) between BWT and HGT was estimated by:

$$\Upsilon_p = \frac{COVs_{(BWT, HGT)} + COVe_{(BWT, HGT)}}{\sqrt{[\sigma_{e(BWT)}^2 \cdot \sigma_{s(BWT)}^2] \cdot [\sigma_{e(HGT)}^2 \cdot \sigma_{s(HGT)}^2]}}$$

$$P = \begin{pmatrix} \sigma^2_{P(BWT)} & \sigma_{P(BWT,HGT)} \\ \sigma_{P(BWT,HGT)} & \sigma^2_{P(HGT)} \end{pmatrix}; G = \begin{pmatrix} \sigma^2_{G(BWT)} & \sigma_{A(BWT,HGT)} \\ \sigma_{A(BWT,HGT)} & \sigma^2_{G(HGT)} \end{pmatrix} \text{ and } \underline{v} = \begin{pmatrix} REV_{(BWT)} \\ REV_{(HGT)} \end{pmatrix}$$

namely, RS x RS, RS x WAD, WAD x RS and WAD x WAD at 12 weeks of age are shown in Table 3. There was no significant difference in body weight of buck kids of RS x RS (5.29 ± 0.13kg) and RS x WAD (5.14 ± 0.21kg) while those RS sired buck kids weighed significantly (p<0.05) heavier than WAD x RS (4.84 ± 0.17kg) and WAD x WAD (4.79 ± 0.17kg) kids. This superior body weight of the RS x RS buck kid was common observation since their parents had heavier body weights than the pure WADs. However, the higher body weight of the RS x WAD buck kids compared to their WAD x RS and WAD x WAD counterparts showed that the main crossbred buck kids sired by the Red Sokoto bucks but nursed by the WAD dams received favourable set of genes for growth. This finding was consistent with the conventional principle of upgrading farm animals or top-crossing which involved the use of superior males on poor performing or unimproved females (Ibe, 1998). Main-cross or sire-influenced heterosis was common in livestock breeding and had often been exploited by animal breeders and informed stockmen, especially in development of meat-type animals (Nwachukwu and Okoji, 2012). The morphometric traits namely, body

length (BLT), height-at-withers (HWT) and heart girth (HGT) were significantly higher for the RS x RS kids, followed by RS x WAD kids. This observation was indicative of concomitant increases in body weight and those of the linear body parameters. Evidence of positive association of body weight and most morphometric traits in goats and other farm animals had been variously reported (Jeffrey and Berg, 1972; Nwachukwu and Okoji, 2012) and had resulted in utilizing these parameters in evaluating growth and development of the body and other body components in farm livestock (Suleiman *et al.*, 1990) and in poultry (Nwachukwu *et al.*, 2006). The phenotypic and genetic correlations between BWT and HGT in males and female kids of pure and crossbred of RS and WAD goats are shown in Table 4. The phenotypic values obtained were high and positive ranging from (0.87 – 0.99) in males and (0.60 – 0.96) in females, respectively. These values were higher than those reported by Hamayun *et al.*, (2006) for Sudan desert goats (0.16 – 0.70). The high and positive correlations between BWT and HGT across the four genetic groups indicated that BWT and HGT were highly associated and improvement in one would give rise to positive change

in the other trait. Such a correlated response in growth traits had been reported in sheep (Salako, 2006; Mokhtar and Farhad, 2011). Considering the magnitude of the genetic correlation coefficients between BWT and HGT in these growing kids, the latter trait could conveniently be utilized in predicting live weight of kids as noted by Fadlemoula *et al.* (2011).

The phenotypic variances for body weight in males and females kids in all the genetic groups (Table 5) ranged from 0.06 – 0.19 and 0.05 – 0.08, respectively. These values were lower than those reported by Mokhtar and Farhad (2011) for yearling weight ( $fi_p^2 = 14.95$ ) in Makoooci sheep in Iran. The genotypic variances for these kids were also low ranging from 0.02 – 0.07 and 0.02 – 0.03 in male and female kids at 12 weeks. These low values seemed to indicate that evaluation of the genetic worth of goats could be more effective at an older age than at younger age as in the case of this study.

The heritability estimates for BWT and HGT in male and female kids of the four genetic groups (Table 5) ranged from 0.34 – 0.36 versus 0.28 – 0.30 respectively. These estimates were higher than heritability estimates reported for BWT (0.22) and HGT (0.21) in 12 months old sheep by Mokhtar and Farhad (2011) but lower than heritability estimates for BWT (0.74) and HGT (0.70) reported by Mandal *et al.* (2008) for weaning lambs. The heritability of conformation traits were expected to be high and predictable; however, prevailing

environment especially management factors and physiological state might affect estimates of heritability (Sivakumar and Saundarajan, 2007).

The relative economic values (REV) of the traits considered in this study were generally higher for the male kids compared to their female counterparts. The RS x WAD groups recorded impressive REVs for BWT (339 units) and HGT (285 units) which were even higher than values for the RS x RS (317 units for males and 281 units for females). Report by Sivanadian and Smith (1997) showed that response to selection is greater with traits that had higher heritability and relative economic value. It followed that traits like BWT and HGT which were all conformation traits would lend themselves to fast genetic and economic gains per generation (Gjederm, 1972).

Selection index obtained for pure and crossbred male and female kids by various genotypes are shown in Table 6. These values were higher for males and females of the RS x RS and RS x WAD individuals than those of WAD x RS and WAD x WAD counterparts (Table 6). This indicated that selection would be in favour of offspring sired by the Red Sokoto bucks as against those sired by the WAD bucks. It was obvious that genetic improvement in these test groups would be in favour of the crossbred RS x WAD which had the attributes of both breeds of indigenous goats utilized in the study and which ranked next to the superior RS x RS individuals.

## **Conclusion**

It is evident from the study that the pure RS x RS and crossbred RS x WAD kids outperformed their WAD x RS and WAD x WAD counterparts with respect to body weight and linear body parameters considered. This indicated that RS sired kids received superior sets of genes for growth compared to the WAD sired kids. The estimates of heritability for bodyweight and heart girth showed that improvement in body weight and heart girth was possible through selection. High and positive correlation coefficients between bodyweight and heart girth in various genetic groups also showed that these growth traits were positively associated and therefore, selection for any of them would lead to improvement in the other. The relative economic values (REV) of these two traits were generally higher for the male kids than for the females in their respective genetic groups. The selection index values were highest in male and female kids of RS x RS followed by RS x WAD and least in the WAD x WAD kids, thus indicating that selection and improvement in this population of pure and crossbred kids would be in favour of the RS x RS and RS x WAD individuals.

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