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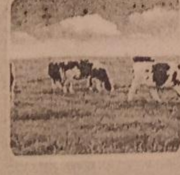



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57 MODELLING OF PHENOTYPIC TRAITS AS DETERMINANTS OF BREEDING POTENTIALS OF CATTLE UNDER LOW EXTERNAL INPUT

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ABSTRACT

The breeding potentials of bulls and cows are determined by relationships between body and testicular measurements which are being used as traits for selection of the cattle. Therefore, the objective of this study is to determine the relationship between the body condition score (BCS), live weight (LW), scrotum circumference (SC) and linear body measurements, body length (BL) and heart girth (HG) in bulls under low external input operation for modelling predictive equation for breeding selection. A total of 40 bulls and cows each selected in two agroecological zones of Nigeria were used for the study. Data collected on body measurements and were subjected to Pearson's correlation to establish relationships between the LW, BL, HG, BCS and SC in bulls and between the LW, BL, HG and BCS in cows; while Multiple regression analysis was used to develop selection models for both the bulls and cows. Pearson's correlation results indicated that BCS had positive statistical correlation with SC ($r = 0.54$) and LW also indicated statistical correlation with HG ($r = 0.99$) in the bulls. In the cows, the result obtained indicated that LW was positively correlation with HG ($r = 0.97$), BL ($r = 0.69$) and BCS ($r = 0.60$). The regression model developed were Testis Circumference = -71.84 + 2.32Age + 2.73Hearth Girth + 0.03Body Length – 0.32Live Weight + 2.56Body Condition Score for bulls, and Age at first calving = 0.75 +1.22LW + 4.73BCS – 3.2Age – 1.07HG -7.76BL + 1.00Age at puberty for the cows. The correlation findings suggest that increasing SC, BCS, LW and HG, and the models developed for these traits could be used for selection of bulls and cows for breeding.

Keywords: *Breeding potentials, Low external input, modelling, Phenotypic traits, Body linear measurement*

INTRODUCTION

The increase in population and decrease in fertility rates of bulls are factors associated with limiting cattle production in developing countries including Nigeria (Faith et al., 2016). Bull fertility can be a major limiting factor in a breeding program. Infertility rates in bulls are estimated to be between 15 to 25 percent in the United States and Canada (Thundathil et al., 2016). The cattle production system in developing countries is not robust enough to overcome this challenge because the production system is smallholder operated and thrives on the use of low external input (Leroy et al., 2016). Hence, for cattle producers to be economical and contribute effectively to food security, this research focuses on the relationship between scrotal circumference, body condition score, age, and body measurement using regression analysis to determine if the breeding potentials of bulls under low external input production system support selection and determining the potential bulls to be used in reproduction programme.

The low external input production system of cattle is described with poor availability of quality pasture veterinary services, and indiscriminate use of drugs and vaccines; this is because most farmers often buy drugs at local markets from unskilled traders and majorly the efficiency of these therapeutic agents are erratic (Vaarst and Alrøe, 2012). Therefore, the primary aims of low external input operations are herd survival and sustained productivity to generate income for the provision of off-farm basic needs of the household (Thundathil et al., 2016). The evaluation of bull for breeding soundness is a vital aspect of reproductive management practice to exploit the maximum genetic potential in any livestock industry there is utmost need to assess the male (Asmare et al., 2013).

Sperm production is related to testicular development as shown by a positive correlation between testicular weight, sperm production and gonadal and extragonadal sperm reserves (Ommati et al., 2022). The heavier and larger the testes amount to the rate of sperm production. Testicular weight provided an accurate amount of the sperm-producing parenchyma in the testis of bulls (Ommati et al., 2022). The testicular weight was greater in certain breeds of animals with higher ovulation (Waqas et al., 2019). Since the testis weight cannot be measured directly in the male, scrotum circumference was found to be significantly correlated to testis weight (Chacko & Schneider, 2019), the circuitous technique of measuring scrotal circumference has been exploited. Scrotal circumference dimensions are well correlated with paired testis weight, which in turn is directly and extremely correlated with daily sperm production and high semen quality traits (Waqas et al., 2019).

A body condition score is an essential measure of the fitness of an animal for evaluating the body reserves in an animal (Silva et al., 2021). Condition score uses physical palpation of tissues cover over the backbone and the short ribs behind the last long ribs. Body condition score is not exercised on the farms, and its relationship with body weight and testicular traits is not known (Tyasi, 2022).

METHODOLOGY

The current study was conducted in two different agroecological zones of Nigeria namely; the southern guinea savanna and the Derived guinea savanna. The southern guinea savanna is characterized by the annual rainfall of 1140mm – 1520mm (March – November) while the derived savanna receives an average of 1275 – 1030 mm rainfall per annum. Qualitative data was collected by exploring both individual questionnaires and Focus group discussions (FGD) among the local farmers on the farms. In the FGD conducted, 6 – 10 farmers were interviewed as described by Nabukenya et al. (2014). Fifty farmers were interviewed and four FGD were conducted in both agroecological zones. Indigenous bulls kept raised on a low external input system of production of age 2 – 5 years were used as experimental animals. Body length (BL) was measured diagonally across the body of the bull using a flexible measuring tape in centimetres. Heart Girth (HG) measurement was taken by measuring the circumference of the girth using a measuring tape in centimetres. Scrotal circumference (SC) was measured with a flexible tape in centimetres (cm) at the maximum point of dimension round the pendulous scrotum after pushing the testes firmly into the scrotal sac as described by Nwachi Akpa (2013). Body condition score (BCS) was taken on the bulls based on the procedure for body condition scoring recommended by Soares & Dryden (2011) which states that a range of 1-9 scores.

Data

Data were collected from 80 indigenous cattle comprising 40 bulls and 40 cows from the southern guinea savanna and derived savanna using a measuring tape for phenotypic measurements. Statistical Packa for Social Sciences version 26.0 (IBM SPSS, 2019) was used for data analysis. Descriptive analysis (average mean, standard deviation, standard error of mean and coefficient of variance) were calculated for the traits measured in both bulls and cows. Pearson's correlation was used to calculate the relationship between live weight, heart girth, body length, and body condition score in cows but with testis circumference in bulls.

Descriptive Data

Data from the measured traits were used in predictive modelling. Multiple regression was used to develop different models for selection of bulls and cows for breeding program using $y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \ldots.. b_nX_n$. Where y is the dependent variable, a is the regression intercept, $b_1 - b_n$ is the coefficients of regression, and $X_1 - X_n$ is the independent variables.

The following models were developed for bulls:

Testis Circumference = -71.84 + 2.32Age + 2.73Hearth Girth + 0.03Body Length – 0.32Live Weight + 2.56Body Condition Score

BCS = 9.96 – 0.57Age – 0.45HG + 0.08BL + 0.05LW + 0.21TC

LW = -356.15 + 2.10Age + 8.58HG + 2.68BL – 1.31TC + 2.68BCS

HG = 41.25 + 0.72Age – 0.31BL + 0.12LW + 0.15TC – 0.30BCS

BL = 77.25 + 0.72Age – 1.19HG + 0.14LW + 0.01TC + 0.21BCS

Age = 0.11 – 0.27HG + 0.19BL + 0.03LW + 0.14TC – 0.40BCS

Models developed for cows are as follows:

LW = -546.55 – 0.44Age + 9.60HG + 5.92BL – 6.14BCS – 1.44Age at Puberty + 0Age at first calving

BCS = -24.88 – 0.03Age + 0.50HG + 0.19BL + 1.30Age at puberty + 0Age at first calving – 0.04LW

Age = 4.78 + 0.19HG – 0.21BL + 0.26Age at puberty + 0Age at first calving – 0.01LW – 0.05BCS

HG = 53.60 – 0.51BL – 0.06Age at puberty + 0Age at first calving + 0.01LW + 0.76BCS + 0.19BCS

BL = 73.27 + 0.09Age at puberty + 0Age at first calving + 0.11LW + 0.53BCS – 0.37Age – 0.96HG

Age at Puberty = - 0.75 + 1Age at first calving – 1.4LW + 2.37BCS + 4.39Age + .19HG + 7.76BL

Age at first calving = 0.75 +1.22LW + 4.73BCS – 3.2Age – 1.07HG -7.76BL + 1.00Age at puberty

Where TC is testis circumference, LW is live weight, BCS is body condition score, HG is heart girth and BL is body length.

RESULTS

Table I shows the phenotypic correlation between LW, BCS and body linear measurements of indigenous bulls while Table II shows the correlation between LW, BCS and phenotypic body measurements of cows. The result indicated that HG had a high positive correlation (p < 0.01) with LW. Also, the result presents a positive statistical correlation (p< 0.05) between TC and BCS.

Table I. Phenotypic correlation between live weight, body condition score, testis circumference and body measurements of bulls

Traits	LW	HG	BL	BCS	TC
LW	-				
HG	0.99**	-			
BL	0.35	0.24	-		
BCS	0.37	0.38	0.15	-	
TC	0.04	0.05	-0.30	0.54*	-

**, Significant at P < 0.01; LW, Live weight (kg); *, Significant at P < 0.05; HG, Heart girth (cm); BL, Body length; BCS, Body condition score; TC, Testis circumference (cm).

Table II indicated a high positively statistical correlation ($p < 0.01$) between LW and HG, BL and BCS. The result also shows that there is a high correlation ($p < 0.01$) between BCS and HG. Lastly, BL had a positive correlation ($p < 0.05$) with HG.

Table II. Phenotypic correlation between live weight, body condition score and body measurements of cows

Traits	LW	HG	BL	BCS
LW	-			
HG	0.97**	-		
BL	0.69**	0.52*	-	
BCS	0.60**	0.72**	0.17	-

**, Significant at P < 0.01; LW, Live weight (kg); *, Significant at P < 0.05; HG, Heart girth (cm); BL, Body length; BCS, Body condition score.

Discussion

Cattle are mostly reared for meat, milk and farm power, and they play a worthy role in food security, and socio-economic activities in the lives of farmers and masses (Rehman et al., 2017). This study was conducted to build models and examine the relationship between LW, Body linear measurements in cows and testicular measurement traits in bulls as a result of breeding value dependency on those traits. Our result obtained from the study shows that there is a highly remarkable relationship between LW and HG because LW can be estimated more accurately as reported by Tyasi (2022) . Similarly, there is a significant relationship between BCS and the TC of the bulls. A similar report was reported by Tyasi (2022) in Dorper Sheep. Faith et al. (2016) reported that LW had a significant correlation with SC. Tariq & Bajwa (2012) also reported that BCS had a remarkable correlation with the LW of indigenous Mengali sheep of Pakistan. The variation might be due to age, breed, and management differences. Faith et al.(2016); Tyasi (2022) reported that rams with larger testicular measurement traits might have larger LW. The results also showed that there remarkable correlation between LW, BCS, and body measurements. This study suggests that TC can be used to improve the BCS in bulls while the increase in LW and HG can be used in improving the BCS in cows. Phenotypic variations in traits of animals are due to joint effects of genetics and environment, and genetic and environmental factors independently (Barghi et al., 2020).

CONCLUSION

Pearson's correlation results suggest that Body Condition Score are positively and highlycorrelation with testis circumference. Correlation findings suggested that increasing testis circumference might improve the body condition score while the body condition score might improve the live weight of the bulls. The results also suggested that the body condition score is highly correlated to the heart girth, and live weight of the cows and this denotes that an increase in live weight improves the body condition score, heart girth and body length. Therefore, the findings of this study might be useful in the selection of bulls and cows for breeding purposes.

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