Evaluation of body weights as related to linear body measurements in N'Dama cattle under humid tropical environment.

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Abstract

Data on Body Weights (BWT) and five linear Body Measurements traits (LBM) of N'Dama cattle between birth and 24 months of age obtained from Fashola Stock Farm in Oyo, Nigeria, between 1957 and 1961 were used to study the pattern of relationships among these traits. The linear body measurements studied include: Head to shoulder (HDS), Shoulder to tail drop (STD), Height at withers (HTW), Heart girth (HGT) and Body length (BLT). BWT and LBM of N'Dama cattle generally increased with age, with males average being consistently higher than those of the females. BWT was more variable (CV: 10.38% - 16.87%) than LBM (CV: 3.46% - 11.71%) from birth to 24 months of age. At birth, the five LBM were positive and significantly ($P < 0.001$) correlated with BWT of N'Dama male and female calves ($r = 0.27 - 0.50$). At subsequent ages, the relationships that existed between BWT and the five LBM were generally negative and followed no distinct pattern. BWT of N'Dama male calves were significantly ($P < 0.001$) predicted using HGT, STD, HTW and BLT at birth ($R^2_m = 36.5\%$), while HTW, HDS and HGT measurements significantly ($P < 0.001$) determined BWT of N'Dama female calves at birth ($R^2_m = 28.4\%$). HGT was of greater importance as a predictor of BWT at various ages in N'Dama males although the five LBM studied were generally considered as poor predictors of BWT among N'Dama females. The low levels of coefficient of determination (R^2_m) obtained in the present study imply that other sources of variation unaccounted for in the multiple regression models may be implicated. It is suggested that improve animal management and production environment in the farm could improve both the performance and accuracy of estimates.

Keywords: Body weight, linear body measurement, relationship, N'Dama cattle, humid tropics.

Introduction

The body weight of the live animal is the most comprehensive measure of growth generally available, but it is particularly subject to

availability of food and may be altered seasonally, especially if outdoor feeding is part of the husbandry regime. Linear body measurements on the other hand, tend to be affected to a lesser extent by these factors, and allow comparisons

of growth in different parts of the body (Russell, 1975). At maturity, linear body measurements are essentially constant reflecting heritable size of the skeleton (Jeffrey and Berg, 1972). Therefore, linear body measurements taken in conjunction with a comprehensive performance records can aid in evaluating the nature of body weight changes during the various stages of animal growth and development (Brown *et al.*, 1983; Orheruata and Olutogun, 1994; Mgbere, 1995). Several studies have examined various body dimensions in beef cattle to describe more thoroughly biological variation and to interpret the relationships with measures of performance and productivity (Buvanendran *et al.*, 1980; Nwosu *et al.*, 1985; Mani *et al.* 1991). The multivariate technique of principal component analysis has also been used to combine weight and body measurements into indexes for defining body size and shape (Brown *et al.*, 1973; Carpenter *et al.*, 1978; Ibe and Ezekwe, 1994).

N'Dama cattle is the most popular trypanotolerant breed of livestock found in Nigeria, which has been used in several traditional production systems. This breed of cattle offers a sustainable alternative for improved livestock production in the humid tropical environment, where trypanosomiasis is prevalent. However, the lack of measure of grade in Nigeria has presented problems in the accurate assessment of differences among the animals, especially within herds where management and similar bloodiness tend to reduce variability (Mgbere and Olutogun, 2003). But in order to effectively exploit and improve on N'Dama production potentials, there is need for collation of information on live weight changes from birth to maturity. Often this is not possible among traditional cattle rearers due to lack of weighing facilities. Consequently, the need for the estimation of this trait from simpler and more

easily measurable variables such as linear body measurements, becomes obvious as a practical field technique.

Information on the relationships between body weights and linear body measurements in N'dama cattle breed are presently scanty. This investigation was therefore taken up to establish the relationships between body weights and linear body measurements in N'Dama cattle as a step towards employing these measurements to develop prediction equations for estimating the live weight of N'Dama cattle at various ages under humid tropical environment.

Materials and Methods

Data source and management procedures

Data used for this study were obtained from production records of N'Dama cattle herd at Fashola livestock Farm near Oyo in Oyo State, Nigeria. The location, climate and vegetation of the farm have been described in detail in earlier works (Mgbere, 1995; Mgbere *et al.*, 2002).

The husbandry system practised was extensive, the animals being rotationally grazed on established grass-legume pasture. The animals were maintained in paddock according to sex, age and physiological status of cows. The pasture comprised of mixture of grass such as elephant grass (*Pennisetum purpureum*), Gamba grass (*Panicum maximum*), Giant star grass (*Cynodon plectostachium*), Gamba grass (*Andropogon pubescens*); while legumes found were mainly stylo (*stylosanthes gracilis*) and Calapo (*Calapogonium mucunoides*). Grazing was occasionally supplemented with hay, sweet potatoes, cassava and concentrate composed of guinea corn, groundnut cake, cotton seed cake, rice bran, and brewers dry grains (BDG) during the dry season. Water was provided *ad-libitum*

at the paddocks, while mineral supplementation was given year-round in the form of salt licks.

In the history of the farm, pasture mating has been the breeding practice maintained. Young heifers were exposed to bulls at 2-3 years of age and nursing cows at 45-60 days after calving. There was no restricted breeding period as bulls were allowed to run with the cows throughout the year. Calves were promptly identified at birth and necessary measurements taken. They were then allowed to run with their dam until weaning at about 6-9 months of age. Weaning was usually done in batches during the months of May and August when forages were in abundance.

Routine disease control measures comprised vaccination against endemic diseases such as Haemorrhagic septicaemia, Black quarter disease, Bovine pleuro-pneumonia and Anthrax. Endoparasitess control involved the de-worming of all animals every month, while ecto-parasites were controlled usually by dipping adult animals and spraying heavily pregnant ones, and calves every fourth night during the rainy season and every month during the dry season.

Data collection

Data on body weights and linear body measurements were periodically recorded at six months interval from birth to 24 months of age and covered the period from 1957 to 1961. Only animal with complete body weights and corresponding linear body measurements at a given age were used. Therefore, the number of records available for analyses after screening for completeness and conformity varied considerably by age and sex and are represented in Table 1.

Body weight (BWT) was taken using weighbridge. To take linear body measurement

(LBM), each animal was posed on a level platform with the four feet squarely placed so that it appeared to be standing normally without strain. The following physical measurements were made on the live animal with a flexible steel tape and a measuring stick:

- (i) Head of shoulder (HDS)- Distance from the nose to the point of the shoulder;
- (ii) Body length (BLT)-measured as the distance from the point of the scapular to the pin bone;
- (iii) Heart girth (HGT)- a circumference measurement taken immediately posterior to the shoulder
- (iv) Height at wither (HTW)- measured as the distance from the highest point on the dorsum of the animal to the ground surface at the level of the front feet;
- (v) Shoulder to tail drop (STD)-Distance from the point of shoulder to pin bone.

Statistical analysis

Data collected were initially adjusted to age-constant basis using standard test procedures (BIF, 1990) and classified according to sex. This was considered necessary since earlier study (Orheruata and Olutogun, 1994) using materials from the present source indicated significant sex effect. Consequently, variables measured were considered separately by sex in the analyses. All data were analyzed using General Linear Model (SAS, 1987) Simple statistics of body weight, linear body measurements and the relationships between them were evaluated. Multiple regression analyses were performed to develop prediction equations for body weights (BWT) of the animals from linear body measurements

Body weights and linear body measurements in N'Dama Cattle

Table 1: Mean, Standard deviation (STD) and coefficient of variation (CV) of body weight (BWT) and linear body measurement (LBM) of N'Dama cattle at various ages.

Variable ^a	Male			Female		
	Mean	STD	CV(%)	Mean	STD	CV (%)
Birth	(N=255)			(N = 297)		
BWT(kg)	19.94	2.70	13.54	18.55	2.42	13.05
HDS (cm)	24.81	1.14	4.60	24.27	1.51	6.22
STD (cm)	49.66	1.81	3.65	49.35	3.16	6.40
HTW (cm)	62.18	2.60	4.18	60.98	2.82	4.62
HGT (cm)	63.75	2.75	4.32	62.58	4.09	6.54
BLT (cm)	74.42	2.58	3.46	73.59	4.00	5.43
6 Months	(N=255)			(N = 187)		
BWT (kg)	98.76	10.25	10.38	93.32	13.07	14.00
HDS (cm)	44.44	4.99	11.23	43.84	4.97	11.34
STD (CM)	61.18	5.74	9.38	60.47	5.23	8.65
HTW (cm)	79.75	5.13	6.43	78.90	5.01	6.35
BLT (cm)	105.97	9.23	8.71	94.93	8.42	8.10
HGT (cm)	94.82	8.05	8.49	103.99	7.35	7.74
12 Months	(N = 128)			(N = 143)		
BWT (kg)	145.33	18.15	12.49	118.30	16.41	13.87
HDS (cm)	53.76	4.96	9.23	51.94	5.95	11.45
STD (cm)	71.30	6.25	8.77	69.29	4.53	6.54
HTW (cm)	90.35	5.20	5.75	88.08	4.53	5.14
HGT (cm)	111.68	8.90	7.97	110.00	12.88	11.71
BLT (cm)	124.64	8.79	7.05	121.23	8.44	6.96
18 Months	(N = 105)			(N = 133)		
BWT (kg)	168.85	18.64	11.04	149.19	19.07	12.78
HDS (cm)	60.52	4.92	8.13	58.38	4.05	6.94
STD (cm)	75.26	5.49	7.29	75.11	6.36	8.47
HTW (cm)	94.78	4.11	4.34	93.71	4.60	4.91
HGT (cm)	120.11	8.96	7.46	117.09	8.49	7.23
BLT (cm)	134.96	8.83	6.54	132.82	8.91	6.71
24 Months	(N = 62)			(N = 106)		
BWT (kg)	245.24	27.65	11.27	209.64	35.37	16.87
HDS (cm)	64.40	4.22	6.55	63.09	4.38	6.94
STD (cm)	83.94	6.78	8.08	82.96	7.20	8.68
HTW (cm)	101.07	4.06	4.02	101.10	7.07	6.99
HGT (cm)	133.92	10.34	7.72	128.27	7.52	5.86
BLT (cm)	148.47	10.68	7.19	146.82	10.41	7.09

^a HDS = Head of Shoulder; STD = Shoulder to tail drop ; HTW = Height at withers; HGT = Heart girth; BLT = Body length.

(LBM) at various ages. The general regression model used is given below:

$$Y = a + \sum_{i=1}^5 b_i X_i$$

Where: Y = Body weight at a given age;

a = Intercept;

b's = Partial regression coefficient of Y on X_i (i = 1, 2, 3, 4, 5);

X's = Linear body measurements Viz: HDS (X_1); STD(X_2); HTW(X_3); HGT(X_4) and BLT(X_5).

The regression equations were computed in a stepwise manner according to the procedure that gives a maximum coefficient of determination (R^2). At each step, one variable was added to the equation. The variable added was the one, which would give the greatest reduction in error sum of squares or equivalent, the variable that had largest partial correlation with the dependent variable, among those variable not yet, included. Two restrictions were placed on this procedure; first, for a variable to be added to the equation, its reduction in error sum of squares had to be large enough to give an F-ratio greater than or equal to one. If after additional variables were added, the F-ratio for a variable entered in an earlier step become less than one, that variable was removed. The stepwise process ended when one of the variables outside the model has an F-statistic significant at the significant level of 0.15 for entry or when the variable to be added to the model is the one just deleted from it

Results

The mean BWT and LBM of N'Dama male and female cattle along with the standard deviations and coefficients of variation (CV) are presented in Table 1. The mean BWT of N'Dama cattle from birth to 24 months of age ranged from 19.94 ± 2.7 kg to 245.24 ± 27.65 kg, and from 18.55 ± 2.42 kg to 209.64 ± 35.37 kg for males and females, respectively. At birth, LBM namely HDS, STD, HTW, HGT and BLT were 24.81 ± 1.14 cm, 24.27 ± 1.51 cm; 49.66 ± 1.81 cm, 49.35 ± 3.16 cm; 62.18 ± 2.60 cm, 60.98 ± 2.82 cm, 63.75 ± 2.75 cm, 62.58 ± 4.09 cm and 74.42 ± 2.58 cm, 73.59 ± 4.00 cm for N'Dama male and female cattle, respectively. BWT and LBM of N'Dama cattle generally increase with age with males average being consistently higher than females except for HGT at 6 months of age and HTW at 24 months of age (Table 1). The variability of the data as indicated by the coefficients of variation (CV) show that BWT of N'Dama cattle were highly variable from birth to 24 months of age with CV ranging from 10.38% to 16.87%, while a much lower variability was noted among LBM in the herd (CV=3.46 – 11.71%).

The relationship between BWT and LBM of N'Dama cattle at various ages are presented in Table 2. At birth, BWT of calves were positive and highly significantly ($P < 0.001$) correlated with the five LBM studied with values ranging from 0.33 to 0.50 and from 0.27 to 0.49 for male and female calves respectively. At six months of age, correlation values for these traits were low, negative and non-significant. While no significant relationship was observed between BWT and the five LBM among N'Dama females at 12 months of age, HTW, HGT and BLT were negative and significantly associated with BWT the same age in male calves. The correlation coefficient between HDS, HTW, BLT at 18

Table 2: Relationship between body weight (BWT) and linear body measurements (LBM) of N'Dama cattle at various ages.

Age/Sex	HDS	STD	Linear Body HTW	Measurements ^a HGT	BLT
Birth					
M	0.34 ***	0.33***	0.46***	0.50***	0.36***
F	0.35***	0.27***	0.49***	0.33***	-0.34***
6 Months					
M	-0.04	0.01	-0.02	-0.01	-0.04
F	-0.03	0.15	-0.05	-0.01	-0.06
12 Months					
M	-0.27	-0.26	-0.41***	-0.46**	-0.35*
F	0.18	0.04	0.17	0.07	0.16
18 Months					
M	-0.45*	-0.30	-0.37*	-0.18	-0.40*
F	0.17	0.17	0.21*	0.16	0.24**
24 Months					
M	-0.27	-0.58**	-0.31	-0.63***	-0.31
F	-0.04	-0.01	-0.28*	-0.10	-0.10

^aHDS = Head to Shoulder; STD = Shoulder to tail drop; HTW = Height at withers; HGT =Heart girth; BLT = Body length; M= Male; F = Female.

* = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$

months of age N'Dama male were negative and significant ($P < 0.05$) being - 0.45, -0.37 and - 0.40 respectively (Table 2). However, a fairly low, positive and significant relationship was observed among N'Dama females between BWT and HTW ($r=0.21$) and between BWT and BLT ($r=0.24$) at 18 months of age. At 24 months of age N'Dama male cattle BWT were negative and significantly ($P < 0.01$) associated with STD ($r=0.58$) and HGT ($r=0.63$), while only HTW was significantly ($P < 0.05$) associated with BWT ($r=-0.28$).

Parameter estimates from a stepwise multiple regression analyses for predicting BWT of N'Dama male and female cattle from LBM are given in Table 3 and 4. At birth, all the LBM entered the equation for predicting BWT of N'Dama male calves and accounted for only 37.3% of the total variability, with HGT making the highest partial contribution of 25%. But in N'Dama female calves, 28.4% of the variation in BWT was accounted for by HTW ($R^2_p=23.8\%$), HDS ($R^2_p=3.1\%$), and HGT ($R^2_p=1.5\%$). None of the LBM could significantly predict the BWT of N'Dama male

Table 3: Parameter estimates from regression analysis of the relationship between body weight (BWT) and linear body measurement (LBM) at various ages in N'Dama males

Variable ²	Parameter Estimate	SE	R ² p(%)	R ² m(%)	Significance
Birth					
Intercept	-26.15	3.99			
HGT	0.25	0.05	25.1	25.1	***
STD	0.53	0.17	6.2	31.3	***
HTW	0.17	0.05	3.9	35.2	***
HDS	0.49	0.18	1.3	36.5	*
BLT	-0.25	0.14	0.8	37.3	*
6 Months					
Intercept	109.40	23.69	-	-	***
HGT	0.05	0.19	0.1	0.1	NS
HTW	-0.09	0.29	0.01	0.11	NS
HDS	-0.17	0.29	0.01	0.12	NS
12 Months					
Intercept	269.86	41.51	—	—	***
HGT	-1.15	0.37	20.7	20.7	**
18 Months					
Intercept	303.88	50.03	—	—	***
HDS	-2.06	0.83	19.9	19.9	*
24 Months					
Intercept	265.63	85.88	—	—	**
HGT	-1.88	0.49	39.8	39.8	***
HTW	1.87	1.22	5.8	45.7	NS

²SE = Standard Error, R²p = Partial coefficient of determination; R²m = Model coefficient of determination. HDS = Head to shoulder; STD = Shoulder to tail drop; HTW = height at withers; HGT = Heart girth; BLT = Body length.
 * = P<0.05   ** = P<0.01;   *** = P<0.001;   NS = Not significant (P>0.05).

calves at 6 months of age, although STD accounted for only 2% of the total variation in BWT of N'Dama female calves at this age. This result may be related to the low and non-significant relationships noticed between BWT and LBM at 6 months of age (Table 2). At 12 and 18 months of age, only HGT and HDS met

the condition for entry into the equation for N'Dama male cattle with a model coefficient of determination of 20.7% and 19.9%, respectively (Table 3). For female N'Dama cattle, only BLT made a low but significant (P<0.01) contribution (R²p=5.8%) to the predictability of BWT at 18 months of age. At 24 months of age, 45.6% of

Table 4: Parameter estimates from regression analysis of the relationship between body weight (BWT) and linear body measurement (LBM) at various ages in N'Dama females

Variable	Parameter Estimate	SE	R ² p(%)	R ² m(%)	Significance
Birth					
Intercept	-3.89	1.11	—	—	***
HTW	0.10	0.02	19.4	19.4	***
HDS	0.10	0.03	3.1	22.5	***
HGT	0.03	0.01	1.9	24.4	***
6 Months					
Intercept	25.88	4.62	—	—	***
STD	0.13	0.07	2.0	2.0	NS
12 Months					
Intercept	21.32	11.96	—	—	NS
HDS	0.41	0.23	3.2	3.2	NS
18 Months					
Intercept	16.85	14.77	—	—	NS
BLT	0.27	0.11	5.6	5.6	*
24 Months					
Intercept	87.87	12.17	—	—	***
HTW	-0.26	0.12	7.6	7.6	*

SE = Standard Error; R²p = Partial coefficient of determination; R²m = Model Coefficient of determination. HDS = Head of Shoulder; STD = Shoulder to tail drop; HTW = Height at withers; HGT = Heart girth; BLT = Body length. * = P<0.05; ** = P<0.01; *** = P<0.001; NS = Not significant (P>0.05).

the observed total variation in BWT of N'Dama male cattle was attributed to HGT and HTW, while only HTW could significantly (P<0.5) predict BWT in female N'Dama cattle (R²p=7.8%) at the same age.

Discussion

The body weight and linear body measurements of N'Dama cattle as expected increased with age in both sexes, with the increment being more pronounced between birth and six months of age.

This observation is similar to those of Orheruata and Olutogun, (1994) who noted that linear body measurements of N'Dama cattle increased with age in a similar manner from birth to 30 months of age. Rapid growth in the early growth phase as noted in the present study is a time of great change in the skeletal and muscular systems. During this period, bones are continually being remolded or reshaped to meet the stresses applied by the greater muscle mass and body weight (Trenkle and Marple, 1983). However, while

the BWT of N'Dama male and female cattle in the present study were slightly higher than those reported by other workers (Fall *et al.*, 1982; Carew *et al.*, 1986; Mgbere, 1995), the LBM were similar to values observed by Orheruata and Olutogun (1994) at comparable ages.

Though body weights were generally more variable than linear body measurements at all ages (Table 1), the variations observed in the population were much lower than the range of 17-19.5% reported for West African breeds of cattle in Nigeria (Buvanendran and Olorunju, 1985). It should be noted that weight is an approximate measure of growth that vary widely with the animal's condition or fleshing; thus, animals of similar weights may have linear body measurements that differ considerably. Also, it is recognized by most workers (Carpenter, 1978; Brown *et al.* 1983; Ehoche *et al.*, 1993) that variation in fill at weighing time and environmental conditions has a much greater effect on weights than on body dimensions. These factors may have been responsible for the considerably greater variability in body weights as compared to those noted for the linear body measurements in N'Dama cattle (Table 1) and indicate that LBM taken in conjunction with a comprehensive performance record could assist breeders in their selection programmes.

At birth, the five LBM were positive and highly significantly ($P < 0.001$) associated with BWT of N'Dama male and female calves ($r = 0.27-0.50$) possibly because bone is an early growing tissue and forms the major portion of weight in newly born animals (Bhadula *et al.*, 1979). Orheruata and Olutogun (1994) reported that BLT, HTW, and STD were 40-50% matured at birth in N'Dama cattle, while Russell, (1975) noted that the estimated degree of maturity of Ayrshire cattle at birth ranged from about 25% for measures of width to 50% for measures of height, body length being intermediate at 40%. In

contrast, the bdoiy weight of N'Dama male and female calves were reported to be only 5.2% and 6.8% matured at birth (Mgbere, 1995). However, the significant correlations noted at birth in this study indicate that in general, an increase in any one-body dimension will result in a corresponding increase in BWT. Thus, LBM could be used to predict weight at birth and as an early selection criterion for growth potentials in N'Dama cattle, especially in farm situations, where weighing scales are not available. Similar pattern of relationships were noted in temperate breeds of cattle (Jeffrey and Berg, 1972; Carpenter *et al.*, 1978) and in three West African breeds of cattle (Buvanemdran *et al.* 1980).

After birth, the relationships that existed between BWT and LBM at subsequent ages were generally negative, non-significant in most cases and followed no distinct pattern (Table 2). The negative and significant correlation coefficients observed between BWT and some LBM at 12, 18 and 24 months of age in N'Dama herd at Fashola, imply that an increase in these body dimensions in N'Dama cattle were not met with a corresponding increase in BWT at the respective ages. These observations may be related to the cyclic gain and loss in body weights associated with seasonal pattern of forage growth in tropical environment. In addition, feeds supplementation in the herd especially during dry season, may not have been adequate enough to offset possible loss in weight in the animals, due probably to poor finances on the ranch.

However, nutritional variation has been reported to influence the pattern of tissue growth and development in beef cattle (Ehoche *et al.* 1993; Mgbere, 1995). At 18 months of age, correlation between BWT and HTW and BWT and BLT were positive significant in N'Dama females, implying that an increase in HTW and BLT brought about a corresponding increase in BWT

at this age. The inconsistency in the direction of correlation between these traits agrees with those of Brown *et al.*, (1983), who reported varying magnitude and direction of correlation between body weight and linear body measurements at various ages in Hereford and Angus cattle. Similarly, Ibe and Ezekwe, (1994) noted that feeds restriction such as occurring during dry season may improve the shape of animals although it adversely affect body size. Such considerations therefore, indicate that the relationships between bodyweights and linear body measurements could be different during different periods of growth and development as noted in the present study. The growth curves presented by Mgbere (1995) for male and female N'Dama cattle in the humid tropics of Nigeria lend support to this assumption. At birth, BWT of N'Dama male calves could be significantly $P<0.001$) predicted ($R^2m = 36.5\%$) by HGT, STD, HTW and HDS. But in females, only three linear body measurements, namely; HTW, HDS and HGT significantly ($P<0.001$) contributed to the predictability of BWT at birth ($R^2m=28.4\%$). HGT was of greater importance as a predictor of body weights in N'Dama bulls at Fashola. This trait made the highest contribution of 25.1%, 20.7% and 39.8% to the variability in the body weights at birth, 12 and 24 months of age, respectively (Table 3). The implication of this is that a breeder or cattleman could have fairly good knowledge of body weight of N'Dama bulls by simply measuring their HGT at those ages.

The value of HGT measurement for the prediction of live weight in farm animals is well recognized in cattle (Buvanendran *et al.*, 1980; Mani, 1991; Ibe and Ezekwe (1994). Buvanendran *et al.* (1980) observed that chest girth accounted for 86-96% of total variation in body weight in three West African breeds of cattle and therefore recommended the use of this body measurement alone to predict live-weight under field conditions. According to Jeffery and Berg

(1972), while heart and pounce girth at any age reflects body conditions, height at wither reflects body conditions, height at wither reflects the animal's skeletal size. Except at birth, where R^2m value of 28.4% was obtained, LBM were generally considered as poor predictors of BWT in N'Dama females. The low level of values obtained imply that other sources of variation unaccounted for in the present study, may be implicated. This observation may also be responsible for the poor level of association noted in females' data, between BWT and LBM (Table 2). Brown *et al.* (1983) documented similar results ($R^2m=0.3-13.8\%$) when regression models were used for predicting post-weaning measures of size and shape in young Angus and Hereford bulls under range conditions.

Conclusion

This study points out that growth involves increases in body weight and also changes in body shape. It is evident from this report that skeletal growth is much more regular than is growth in weight. The level of predictability of BWT by LBM in N'Dama cattle as defined by the model coefficients of determination were generally poor and could merely reflect conditions specific to the Fashola herd rather than a universal trend for N'Dama cattle. There may also be other contributing factors that have not been adequately allowed for in the population studied. The pattern of relationship noted in the present study, indicate that selection based on LBM of N'Dama cattle could result in differing BWT during various stages of the animals' growth and development. However, such measurements would aid in recognizing and describing at an early age, some of the complex relationships that contribute to adaptation of N'Dama cattle to humid tropical environments and its functional efficiency. The variations observed among the traits measured may be due to poor animal management and production

environment, which tended to affect the animal performance. The performance of the relationships presented here in term of R^2m values indicate that other sources of various needed to be examined. Further work to identify new variables and to study the functional form of the empirical relationships reported here is therefore recommended. A better prediction may be obtained from the use of more mechanistic models based on detailed description of the physical state of the animals. This will allow for up-date and applicability, following possible changes in breed size, age at breeding, calving age and other environmental and genetic shifts in the population.

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