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PREDICTION OF LIVE BODY WEIGHT FROM LINEAR BODY MEASUREMENTS OF WEST AFRICAN LONG-LEGGED AND WEST AFRICAN DWARF SHEEP IN NORTHERN GHANA

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ABSTRACT: *The knowledge of live weight of animals is so important in the livestock production and marketing practices that this study was undertaken to develop models for predicting the weight of sheep at market ages. Data comprising of the weight and linear body measurements were collected on the West African Long-Legged (WALL) and the West African Dwarf (WAD) sheep from Pong-Tamale and subjected to regression analyses. The results revealed that heart girth was the best predictor of liveweight, with prediction accuracies of 92.36% for two years old WALL sheep and 81.20% for one year old WAD sheep, while wither height was the second most important trait in liveweight prediction, in simple linear models. The quadratic models of the single-trait models also had heart girth as the best predictor of liveweight, recording 92.92% accuracy for one year old WALL sheep. Only two traits were mostly required for weight estimation in the multiple-trait models, and the best model was obtained from two years old WALL where heart girth and body length accounted for about 95.53% in prediction accuracy. The multiple-trait quadratic models were generally better in liveweight prediction compared to the respective linear models. Clearly, weight estimation was more accurate among the WALL than the WAD sheep, and also among the younger sheep regardless of the breed. The variations in the models suggest that breed and age of sheep had influence on the type of models required to predict their live body weight.*

ORIGINAL ARTICLE

Key words: *Estimation, Linear models, Livestock, Liveweight, Multiple regression, Quadratic model*

INTRODUCTION

The knowledge of weight estimation in sheep is paramount in sheep production as it is useful in the control and management of the herd during the entire rearing process. It has been used in administering medications, nutritional rationing and marketing of sheep. The prices of animals depend mainly on body weight. In Ghana, only the few large-scale livestock farms have proper weighing scales or bridges and market their animals based on weight. Within the rural communities, proper weighing scales or bridges are neither available nor affordable, but even if they were, it would be inconveniencing and a huge task to carry and assembly them, each time to weigh animals especially during marketing. Middlemen and butchers therefore move around the villages buying animals from farmers whose pricing system is often based on visual appraisal, a practice which does not favour farmers.

Measurement of linear body parameters have been used to estimate necessary information (like weight and size) in sheep, while other information are estimated by observing certain parameters such as age estimation from the number and shape of teeth (incisors) (Hamito, 2009). Linear body measurements (LBM) can also be used to assess growth rate, feed utilization and carcass characteristics in farm animals (Brown et al., 1973). According to Essien and Adesope (2003), LBM are divided into two groups; these include skeletal and tissue measurements. Skeletal measurements include all the height and length measurements while tissue measurements include heart girth, chest depth, punch girth and width of hips.

Live weights and body measurements taken on live animals have been used expansively for a diversity of reasons both in experiments and in breeding and selection procedures (Cam et al., 2010a). The accuracy of functions used to predict live weight or growth characteristics from live animal measurements is of immense financial contribution to livestock production enterprises. When the producers and buyers of livestock are able to relate live animal measurements to growth characteristics, an optimum production and value-based trading systems will be realized from accurate predictions. This will ensure that livestock farmers are adequately rewarded

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rather than the middlemen and/or livestock product processors that tend to gain more profit in livestock production business, especially in the rural areas of developing countries (Afolayan et al., 2006; Safu et al., 2009).

A number of studies have been carried out on linear measurements in several African sheep breeds but little is known about the breeds available in Ghana. It is therefore important to study linear body measurements of local sheep breeds in Ghana, particularly the West African Long-Legged (WAD) also called Sahel and the West African Dwarf (WAD) also called Djallonke, because most traditional farmers lack weighing scale/bridge and adequate knowledge to understand its manipulation. Besides, little is known about works done with regards to the local breeds in Ghana. This study was therefore undertaken to develop models for predicting the weight of the Ghanaian local sheep at market ages.

MATERIALS AND METHODS

Management of experimental sheep

The sheep were managed semi-intensively, housed in properly constructed pens throughout the night and sometimes during the day when there was the need to restrict their movement. Feed and water were provided for the sheep *ad-libitum* throughout the year. Conventional disease and pests control regimes were practised.

Data collection

A total number of 293 sheep (WAD and WALL) were used for the study of which 74 were one year old, 58 were two years old and 161 were three years old and above. The ages of the one and two years old animals were determined from their birth records (birth date) while dentition was used for the three years old and above sheep as most of them had no birth records. The variables measured included, live body weight (LW), body length (BL), heart girth (HG), chest depth (CD), height at withers (HW), rump height (RH), neck girth (NG), pin-bone width (PBW), age and sex of each animal. The linear body dimensions were defined and measured according to Birteeb et al. (2012).

Statistical analysis

The data were grouped by breed and by age into six groups namely; Breed1-Age1 (one year old WALL), Breed1-Age2 (two years old WALL), Breed1-Age3 (three years old and above WALL), Breed2-Age1 (one year old WAD), Breed2-Age2 (two years old WAD) and Breed2-Age3 (three years old and above WAD) for regression analyses. Each group was tested for normality assumption using the Kolmogorov-Smirnov test. With the exception of Breed1-Age1 and Breed2-Age3, the LW of all other sheep groups were not normally distributed and so were log-transformed in order to stabilise the variance and avoid violating the normality assumption required for regression analysis. Hence predicted LW must be antilog-transformed to obtain live body weight (in kg) of sheep in the four groups. Each simple linear regression was run using PROC REG procedure. The selection of significant variables in the multiple linear regressions was achieved by the use of the SELECTION=STEPWISE option of PROC REG. All variables selected in the linear models were then included in the quadratic regression models, which were analysed using the PROC GLM procedure. The regression model for the i^{th} group of sheep in the simple linear regression is:

$$y_{ij} = \mu_i + \beta_i x_{ij} + \varepsilon_{ij} \;; \qquad \varepsilon_i \sim N(0,\sigma^2) \qquad \text{...... [1]}$$

Where y_{ij} = the weight of the j^{th} individual in the i^{th} group

μ_i = the average weight (intercept) of the i^{th} group

β_i = the regression coefficient for the i^{th} group

x_{ij} = the trait (HG, HW, RH or BL) value of the j^{th} individual in the i^{th} group

ε_{ij} = the error associated with the weight of the j^{th} individual in the i^{th} group

The quadratic form of model [1] is given by:

$$y_{ij} = \mu_i + \beta_{i1} x_{ij} + \beta_{i2} x_{ij}^2 + \varepsilon_{ij} \qquad \text{...... [2]}$$

For the multiple linear regression, the model is given by:

$$y_{ij} = \mu_i + \beta_{i1}(HG_{ij}) + \beta_{i2}(HW_{ij}) + \beta_{i3}(RH_{ij}) + \beta_{i4}(BL_{ij}) + \beta_{i5}(NG_{ij}) + \varepsilon_{ij} \qquad \text{...... [3]}$$

Given that out of the five (5) traits in equation [3] above, only x_1, x_2,..., x_k are the *k* (*k*<5) traits that are selected and retained through the stepwise regression procedure, then the quadratic regression model of these selected traits would be:

$$y_{ij} = \mu_i + \beta_{i1} x_{1ij} + \beta_{i2} x_{2ij} + \ldots + \beta_{ik} x_{kij} + \beta_{i(k+1)} x_{1ij}^2 + \beta_{i(k+2)} x_{2ij}^2 + \ldots + \beta_{i(k+k)} x_{kij}^2 + \varepsilon_{ij} \qquad \text{...... [4]}$$

RESULTS

Morphological traits

The effects of breed and age on the morphological traits are presented in Table 1. The breed significantly (P<0.05) affected all morphological traits as higher values were recorded for WALL sheep against smaller values for the WAD sheep. Similarly, mature animals had higher (P<0.05) mean values for all body measurements than

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young animals. The heart girth was the most varied trait whereas the pin-bone-width was the least varied among all the traits irrespective of the breed or the age.

Table 1 – Least square means (±S.E.) of liveweight (kg) and linear body traits (cm) of Ghanaian sheep as affected by breed and age

Parameters / Traits	Breed		Age	
	WAD	WALL	Young	Mature
Liveweight (LW)	21.69±0.48[b]	27.54±0.80[a]	16.39±0.70[b]	32.84±0.61[a]
Height at withers (HW)	56.98±0.39[b]	65.33±0.66[a]	56.18±0.57[b]	66.13±0.50[a]
Rump Height (RH)	55.83±0.49[b]	66.25±0.82[a]	56.24±0.72[b]	65.84±0.63[a]
Body Length (BL)	55.15±0.46[b]	60.12±0.77[a]	52.10±0.68[b]	63.18±0.59[a]
Heart girth (HG)	65.77±0.58[b]	71.67±0.97[a]	60.38±0.85[b]	77.07±0.75[a]
Neck Girth (NG)	37.15±0.39[b]	39.31±0.65[a]	32.45±0.57[b]	44.01±0.50[a]
Check Depth (CD)	25.26±0.24[b]	29.77±0.40[a]	24.12±0.35[b]	30.91±0.30[a]
Pin-Bone Width (PBW)	11.94±0.11[b]	12.99±0.19[a]	11.28±0.17[b]	13.65±0.15[a]

[a,b]Means within the same row having different superscripts differ significantly (*P* < 0.05) between the two breeds and ages. S.E. = standard error.

Liveweight prediction based on linear models

Using one trait as a regressor, the results revealed that the linear regression of LW on HG had the highest adjusted coefficient of determination, while the second most important trait for predicting LW was HW for Breed1-Age1 (Table 2). With HG as the regressor in predicting live weight of a one year old and two years old WALL sheep in this study, the respective models can be written from the tables as follows:

$$\widehat{LW} = 0.63(HG) - 21.966$$

$$\widehat{LW} = antilog\,(\widehat{lw}) = 0.218 + 0.016(HG) \qquad \text{......... [5]}$$

Where $\widehat{LW}$ = predicted live body weight of sheep

$\widehat{lw}$ = predicted live body weight (this value is in logarithms form).

With the exception of models of Breed1-Age1 (1 year old WALL) and Breed2-Age3 (3 years old or more WAD), the predicted LW of all other models (in Tables 2 and 3) must be antilog-transformed to obtain the predicted live weight (kg) because their LW's were log-transformed before used for the regression analysis.

The trend of importance of the traits in LW prediction among the two years old WALL sheep was very similar to that of the one year old WALL sheep, with HG being outstanding among other traits in estimation of LW. However, all the traits appeared to predict LW better in the two years old than the one year old and three years old and above WALL sheep (Table 2). Interestingly, BL assumed more importance in predicting LW than RH in the three or more years old WALL sheep.

The trend of importance of weight prediction using the linear body traits of WAD sheep was very similar to that of the WALL except that the amount of variations explained by the regressors were generally lower in the former (Table 3). Expectedly, HG was the best trait for predicting LW across all ages for the WAD breed of sheep. Clearly BL and RH are not good predictors of LW especially in the older (three years and above) WAD sheep in this study.

Table 2 – Regression of body weight on body traits in WALL sheep

Age (years)	Variable	Linear			Quadratic			
		α	b_1	R^2_{adj}	α	b_1	b_2	R^2_{adj}
1	HG	-21.966	0.630	86.03	62.306	-2.153	0.023	92.92
	HW	-43.518	1.035	68.78	219.655	-8.159	0.080	71.58
	RH	-41.075	0.977	66.56	295.416	-10.630	0.010	72.29
	BL	-25.075	0.797	53.20	168.299	-6.913	0.076	59.42
2	HG	0.218	0.016	92.36	0.633	0.005	2.3E-4	91.60
	HW	-0.010	0.022	82.23	2.500	-0.054	6.4E-4	81.81
	RH	0.058	0.020	80.43	0.634	0.003	1.2E-4	78.36
	BL	0.061	0.022	76.60	1.931	-0.038	4.7E-4	74.82
≥ 3	HG	0.469	0.013	84.61	0.982	0.001	1.2E-4	84.33
	HW	0.507	0.015	72.58	0.629	0.011	2.4E-5	71.73
	RH	1.041	0.007	49.04	1.657	-0.017	2.1E-4	72.35
	BL	0.633	0.014	61.99	2.924	-0.056	5.3E-4	64.88

[1]All models were highly significant at 0.01 level; [2] α = intercept of the model. [3] b_i = parameter estimate of the i^{th} variable.

[4] $pE-q = p\times10^{-q}$, where *p* and *q* are constants and *E* is exponent.

The results of the multiple linear regression of LW on the body traits are presented in Table 4. Through the stepwise regression procedure, the results indicated that only two traits were required to predict LW in all the sheep and across all ages, except in the one year old WAD where three traits (HG, HW and BL) were required (Table 4). It is

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interesting to note that HG was the single most important trait required alongside other traits for weight estimation in all the sheep samples in these study. Even though BL predicted LW abysmally when it was used as the only regressor (Tables 2 and 3), paradoxically it was retained alongside HG in most of the samples (Table 4). This implies that BL is important in weight prediction when used alongside HG than when used alone.

Table 3 – Regression of body weight on body traits in WAD sheep

Age (years)	Variable	Linear			Quadratic			
		α	b_1	R^2_{adj}	α	b_1	b_2	R^2_{adj}
1	HG	0.114	0.018	81.20	-1.242	0.064	-3.8E-4	83.66
	HW	-0.447	0.030	67.70	1.050	-0.026	5.2E-4	67.38
	RH	-0.372	0.029	66.86	1.186	-0.030	5.7E-4	66.63
	BL	0.024	0.022	60.58	-1.230	0.071	-4.7E-4	61.07
2	HG	0.465	0.013	63.38	1.751	-0.025	2.8E-4	64.11
	HW	0.175	0.020	47.50	0.524	0.008	1.0E-4	46.33
	RH	0.269	0.019	40.86	0.053	0.027	-6.7E-5	39.52
	BL	0.579	0.014	54.54	0.199	0.027	-1.2E-4	53.69
≥ 3	HG	-6.263	0.436	39.62	114.978	-3.298	0.029	49.82
	HW	-11.619	0.596	35.22	22.948	-0.616	0.011	34.96
	RH	-10.465	0.587	34.86	25.512	-0.697	0.011	34.66
	BL	-3.178	0.460	25.34	-50.055	2.123	-0.015	25.37

[1]All models were highly significant at 0.01 level. [2]α = intercept of the model. [3]b_i = parameter estimate of the i^{th} variable. [4]$pE-q = p \times 10^{-q}$, where *p* and *q* are constants and *E* is exponent.

The combination of HG and BL ensured a better estimation of live weight among the two years old WALL sheep than any other group. NG together with HG was quite important in predicting LW in the one year old WALL sheep, while RH was an important trait for predicting LW in the oldest (3 years old and above) WALL sheep where it was retained together with HG .

Liveweight prediction based on quadratic models

The results of the quadratic regressions of the traits (associated with the linear models) are presented in Tables 2, 3 and 4. The quadratic models for predicting the weight of a yearling WALL sheep using HG (Table 2) and HG and NG (Table 4) are given respectively by:

$$\widehat{LW} = 62.306 - 2.153(HG) + 0.023(HG^2) \quad \text{...... [6]}$$

$$\widehat{LW} = 18.691 - 3.573(HG) + 5.424(NG) + 0.035(HG^2) - 0.087(NG^2) \quad \text{...... [7]}$$

Notably the parameter estimates (b_i) of the quadratic terms of the models whose LW were log-transformed were quite negligible and had to be given in standard form. The R^2_{adj} values associated with the quadratic models of the yearling WALL sheep were generally higher than those associated with the linear models (Tables 2 and 4). Nevertheless, weight estimations by linear models were quite better than those from quadratic models for the two years old WALL sheep. A remarkable observation among the three years and above WALL sheep was the good performance of the quadratic model of RH compared to its linear model in LW prediction (Table 2). Within each age group of the WAD sheep, the HW and RH accounted for almost the same variation in their linear and quadratic models (Table 3). In the use of one trait, the best quadratic model for the WAD sheep was obtained from the use of HG (Table 3) while the best quadratic model from the multiple traits was obtained using HG, HW and BL as regressors (Table 4). For the yearlings of both breeds, most of the quadratic models predicted liveweight better than their corresponding linear models. In general, liveweight estimations were better in WALL sheep than in WAD sheep, even though the combination of traits in the equations differed between the two breeds across all ages.

DISCUSSION

Variations within and among animal genotypes is fundamental to breed characterisation and adaptation to particular ecological zones all over the world. Nonetheless, any variation within or among any species is best and easily evidenced in the morphological characteristics of members of the species. In this study, the differences observed in the linear body dimensions due to breed and age were equally reported by Benyi (1997), Olatunji-Akioye and Adeyemo (2009) and Birteeb et al. (2012). The superiority of matured animals over young ones have been attributed to the effects of age as an important factor influencing body conformation (Birteeb et al., 2012). The Sahelian breed of this study was very similar in body size to the Yankasa breed in Nigeria (Afolayan et al., 2006). However, the two breeds under this study were clearly far smaller when compared to the Zulu sheep from South Africa (Kunene et al., 2007).

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Table 4 – Multiple regression of body weight on body traits of sheep

Age	Breed	Model	Variables	Parameter estimates							R^2_{adj}
				α	b_1	b_2	b_3	b_4	b_5	b_6	
1	WALL	Linear	HG+NG	-25.242	0.417	0.516	-	-	-	-	89.21
		Quadratic	$HG+NG+HG^2+NG^2$	18.691	-3.573	5.424	0.035	-0.087	-	-	93.72
	WAD	Linear	HG+HW+BL	-0.214	0.012	0.007	0.006	-	-	-	85.28
		Quadratic	$HG+BL+HW+HG^2+BL^2+HW^2$	1.079	0.064	0.015	-0.107	-4.3E-4	-8.3E-5	1.1E-3	87.32
2	WALL	Linear	HG+BL	-59.979	0.702	0.576	-	-	-	-	95.53
		Quadratic	$HG+BL+HG^2+BL^2$	-23.938	1.631	-1.684	-0.007	0.019	-	-	94.39
	WAD	Linear	HG+BL	0.337	0.009	0.007	-	-	-	-	72.11
		Quadratic	$HG+BL+HG^2+BL^2$	1.056	-0.043	0.044	3.8E-4	-3.3E-4	-	-	73.92
≥ 3	WALL	Linear	HG+RH	0.480	0.011	0.002	-	-	-	-	86.72
		Quadratic	$HG+RH+HG^2+RH^2$	1.111	-0.003	-3.0E-5	8.1E-5	2.1E-5	-	-	86.36
	WAD	Linear	HG+BL	-19.994	0.368	0.329	-	-	-	-	51.64
		Quadratic	$HG+BL+HG^2+BL^2$	33.502	-2.593	1.891	0.023	-0.014	-	-	57.37

[1]All models were highly significant at 0.01 level. [2] α = intercept of the model. [3] b_i = parameter estimate of the *i*th variable. [4] $pE-q = p\times10^{-q}$, where *p* and *q* are constants and *E* is exponent.

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The live body weight (LW) of sheep is the single most important growth and economic trait that most stockmen and processors of sheep products pay keen attention to. Even though the use of conventional weighing scales is the best way of determining LW of an animal, LW estimation from linear body measurements is gaining grounds of late (Afolayan et al., 2006; Kunene et al., 2007; Hamito, 2009). In this study HG was the most important trait in predicting live body weight of sheep with higher accuracies in simple linear regressions irrespective of the breed or age of the sheep. With HG as a predictor, the R^2_{adj} values for all sets of WALL sheep herein were higher than the R^2 values of 39%, 78% and 80% respectively, reported for three populations of commercial sheep in Nigeria by Olatunji-Akioye and Adeyemo (2009). About 88% accuracy of predicting live body weight from HG was reported in Yankasa sheep of Nigeria (Afolayan et al., 2006). In an earlier study of two breeds of goats in Ghana, Benyi (1997) reported LW prediction accuracy of 90.40% and 92.01% from HG which was comparable to the performance of HG in this study even though Benyi's work was on a different genus (*Capra*).

From the R^2_{adj} values, it is clear that live body weight could be predicted from the other traits (HW, RH and BL) with a reasonable accuracy in the sheep under the present study, except in the oldest class (3 years and above) WAD sheep, where the predictive abilities of all the traits were awfully low. These low prediction accuracies were only comparable to the 39% obtained for commercial sheep (Olatunji-Akioye and Adeyemo, 2009) but far lower than those reported for animals from on-farm or on-station by Benyi (1997), Adeyinka and Mohammed (2006) and Afolayan et al. (2006). It implied that all the traits were not good predictors of live body weight of WAD sheep that were over two years old. Kunene et al. (2007) and Olatunji-Akioye and Adeyemo (2009) attributed the lower predictability of live body weight from linear body dimensions of sheep to wider variations in the actual (observed) live weight caused by differences in environmental conditions. However, the sheep in the present study were all housed and reared under the same environmental conditions. It is therefore conceivable that an unidentified underlying factor may be implicated.

The palpable significance of HG was particularly illustrated in the multiple linear regressions, where it was required alongside another trait, especially BL, to predict LW in all the samples of sheep. The two traits (HG and BL) are a representation of body volume index of the animal (Baffour-Awuah et al., 1999), and can be seen to be indispensable in liveweight prediction of sheep. This finding is in agreement with other researches where heart girth was found to be the most important and single variable for predicting body weight (Benyi, 1997; Afolayan et al., 2006; Olatunji-Akioye and Adeyemo, 2009). For the one year old WAD sheep, the selected weight predicting traits represent the main body dimensions, which suggest that the entire body conformation of a one year old WAD is required for attainment of higher accuracy in LW prediction. Adeyinka and Mohammed (2006) suggested that the addition of other linear measurements (like height at withers and body length) to heart girth could improve the predictability of the resultant equations. Such a suggestion was supported by the findings of the present study since the multiple (two or three traits) linear models predicted live body weight of sheep better than most of the simple (one trait) linear models. However, a further addition of traits to a model in this study did not suggest further and better improvement in live body weight predictability because the prediction accuracy from the only three-trait (HG, HW and BL) model for one year old WAD sheep was not much better than that obtained from the use of only HG in a simple linear model for the same group of animals.

In this study, the number and particular type of traits required in a model depended on the breed and age of the sheep population, which was in line with the findings of most researchers (Benyi, 1997; Thiruvenkadan, 2005; Kunene et al., 2007; Hamito, 2009) who suggested the development of separate models for different breeds, different sexes and different ages of livestock. The existence of seasonal variations between body weight and body measurements of small ruminants even led to the development of different weight prediction equations for the same set of animals at different seasons (Bassano et al., 2001; Adeyinka and Mohammed, 2006). The present study also revealed that liveweight prediction was generally more accurate among two years old WALL sheep, and one year old WAD sheep in the two breeds. The use of these linear models suggested that the best time to sell sheep on the bases of their liveweight is when they are just attaining maturity weight, especially at one year old for WAD, and two years old for WALL sheep because their liveweight could best be predicted during these ages respectively. Unless weighing scales are available, it may not be economical to keep and raise sheep beyond two years because the liveweight predictability of such older sheep is quite low and livestock producers, majority of whom are rural folk, may not be able to price their stock appropriately, besides incurring more cost to feed and manage the animals up to that age.

The predictive accuracies of the quadratic models in the one year old WALL were higher than those of the linear models, with the heart girth being the best predictor. The performance of HG as a predictor for the entire WALL and the one year old WAD sheep in this study were higher than 73% for billy goats but quite lower than 99% for nanny goats reported by Adeyinka and Mohammed (2006). Such variations may arise partly from the differences in the genus of the animals, but also from the seasonal variations in the weights of animals since the animals and data gathering periods may vary from one study to another. In an earlier study, Adeyinka and Mohammed (2006) observed that season affected liveweight and hence the accuracy of its prediction from linear body measurements.

The results suggested that among the two years old WALL sheep, liveweight prediction is easier and better done with the use of linear models than quadratic models irrespective of the linear body measurement (trait) used as the regressor. It is noteworthy that the choice of the model type (linear or quadratic) based on the accuracy of

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liveweight prediction, is affected by the particular sheep population involved and the type of body traits used as the predictor variable(s). The superiority of a quadratic model was palpable in the three years old and above WALL sheep where the accuracy of liveweight prediction from RH was explicitly better in a quadratic model than in a linear model. In multiple regressions of the traits most of the quadratic models had higher predictive accuracies than the respective linear models, implying that when more than one linear body trait are used as the regressors, weight of sheep is better estimated with nonlinear models (Kum et al., 2010).

This confirmed the report of Benyi (1997) that geometric models were better than linear models in liveweight prediction. All the predictive accuracies obtained in the present study were lower than 98% and 99% reported for WAD and Sahel x WAD breeds of goat in southern Ghana (Benyi, 1997). HG and HW each predicted liveweight better in the younger WALL sheep under this study as compared to their respective performance of 89% and 71% obtained in Yankasa sheep of Nigeria (Afolayan et al., 2006). It cannot be said that either one of the model types (linear or quadratic) is completely superior to the other in prediction of live body weight of sheep across all breeds and ages under the current study. This is because model performance seems to be influenced by the age and the particular body trait(s) of the animal. Nevertheless the best prediction linear and quadratic models were obtained from the two years old WALL sheep using HG and BL as the regressors.

CONCLUSION

Among the linear body measurement traits, heart girth was the best predictor of liveweight irrespective of the breed or age of the sheep in this study. In multiple linear regressions, the two main traits required to predict liveweight accurately were heart girth and body length. This study also revealed that in each breed, weight estimation was better in the growing (1 – 2 years) sheep groups than the matured ones (3 years and above). The best liveweight prediction model was a linear model for the two years old WALL sheep, and liveweight predictability accuracies were generally better for the WALL than the WAD sheep.

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