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Relationship between Linear Body Measurement and Live Body Weight in West African Dwarf Goats in Obio Akpa

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ABSTRACT
A study was conducted to determine the phenotypic relationship between linear body measurements, Heart girth (HG), Body depth (BD), Rump height (RH), Height at wither (HAW), Body length (BL) and body weight (BWT); and to predict body weight from linear body measurements using two hundred and ninety four West African Dwarf (WAD) goats (250 females and 44 males) in four age groups varied between 6-12 months (0PPI-wihout pair of permanent incisors), 1-1.5 year (1PPI), 1.5-2 year (2PPI), and 2.5 – 3 years (3PPI). The data obtained from this study were analyzed using linear and multiple regressions. Results showed that the mean live body weight of female WAD goats in the four age category were 9.563 ± 4.844, 12.628 ± 4.958, 21.077 ± 6.558 and 23.885± 3.652 kg, respectively while males of age group (0PPI) and (PP1) recorded 6.963±1.43 and 12.235 ± 4.815kg respectfully. There were significant correlation (P<0.001) between body weight and measured linear measurements, HG (r = 0.681), BD (r = 0.669), RH (r = 0.607), HAW(r = 0.571), BL (r = 0.634), in the pooled group irrespective of sex or age. Simple linear regression analysis showed that body weights could be predicted accurately from heart girth at different ages studied; multiple regression showed high accuracy when more variables were included in the prediction equations (R^2 = 0.803, 0.694 and 0.710 for male, female and male/female groups respectively in the pooled age group). This indicated that there was high correlation between linear body measurements and live body weight which could be used as selection criteria in improving meat production in WAD goat. The highest R^2 was obtained when all the body measurements were included in the regression equations; this suggests that live body weight could be estimated more accurately by combination of two or more linear measurements.
Key words: WAD goat, body weight, linear body measurements, relationship

Introduction
The main purposes of animal breeding practices are to improve traits of economics values; body weight being an important economic trait in the selection of animals demands an accurate estimation to enhance livestock breeding and production. Furthermore, knowledge of animal live weight is an important tool for farmers in making decisions, such as estimation of market prices for live animals, determining correct dosages in drug administration, determining animal's feed requirements for growth, maintenance, and production (Mahieu *et al*., 2011;Tsegaye *et al*., 2013; Chitra *et al*., 2012). The conventional method of estimating live weight is the use of weighing balance (Shirzeyli *et al*., 2013). However, in the rural communities under field condition where the goats are kept for commercial purposes, these scales are not in use partly due to cost, labour and technicality involved in the use of weighing scales. This has led to difficulty in live animal marketing in relation to price setting. Nevertheless, there is need to estimate live weight of animals especially goats from simple and easily measurable morphological traits such as linear body measurements (Olatunji-akioye and adeyemo, 2009). Pesmen and Yardimci, (2008) indicated that different models might be needed to predict body weight in different environmental conditions, breed, age and gender. The use of linear body measurements in estimating live weight in goats have been reported by several authors (Fajemilehin and Salako, 2008; Adeyinka and Mohammed, 2006; Nsoso *et al*., 2004; Islam *et al*., 1991). Most of these reports are however limited to research institutes without major effect on the goat based population. Therefore, the aim of this study was to establish regression equation models that could be potentially used to predict body weight in West African dwarf goats under field conditions.

Materials and Methods
Study Location

The study was carried out in Obio Akpa community in Oruk Anam LGA of Akwa Ibom State, South-South Nigeria. Obio Akpa is located between latitudes $5^0 17^1$N and $5^0 27^1$N and between longitudes $7^0 27^1$N and $7^0 58^1$E with an annual rainfall ranging from 3500mm – 5000mm and average monthly temperature of 25^0C, and relative humidity between 60-90%. It is in the tropical rainforest zone of Nigeria. The people in the study areas depend on livestock and crop production, (Wikipedia, 2016).

Data collection methods

A total of two hundred and ninety four (294) WAD Goats comprising two hundred and fifty (250) females and forty-four (44) males in four (4) age groups as 0PPI, 1PPI, 2PPI and 3PPI; which was equivalent to 6-12 months, 1-1.5 year, 1.5-2 year and 2.5 – 3 years, respectively were examined for their body weight and linear body measurements, The age was estimated based on the pair of permanent incisor (PPI) as describe by Devendra and Mcleroy (1982). Linear body measurements studied included, heart girth (HG), Body depth (BD), Rump height (RH), Height at wither (HAW) and Body length (BL). All measurements were done early in the morning before the animals were released for grazing. All animals were under semi-intensive system of management. The animals were measured in their standing position under field conditions using flexible tape in centimeters, as previously described for goats (Hassan and Ciroma, 1991and Khan *et al*., 2006). Body weight was measured using a measuring scale in kg, Heart girth (circumference of the chest), Body Depth (circumference of the region immediately after the hind leg towards the abdomen), Rump height (distance from the ground to the rump), Height at Withers (distance from the ground to the withers) and Body Length (distance from the occipital protuberance to the base of the tail), all in centimeters.

***Statistical Analysis*:** The data obtained were analyzed using the Statistical Package for the Social Sciences (SPSS) version 20.0. Correlations (Pearson's correlation coefficients) between body weight and different body measurements were computed within each sex and age group. Regression analysis was employed to predict live weight from body measurements. The choice of the best fitted regression model was selected using coefficient of determination (R^2) and Mean standard error (MSE). The multiple regression models were followed to estimate body weight from body measurements for male and females in separate analyses. The full regression model of the measurements (all the five linear body measurements) was defined as:

$Y = \beta_0 + b_1\beta_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5$

Where, Y = dependent variable (body weight), β_o = intercept, β's = regression coefficients, X's = independent variables (HG, BD, RH, HAW and BL).

RESULTS AND DISCUSSION

BODY WEIGHT AND LINEAR BODY MEASUREMENT IN WEST AFRICAN DWARF GOATS

Table 1 indicates the live body weight and linear body measurement for WAD goats. The mean body weight of female West African Dwarf goats in the four age categories (0PP1 1PP1, 2PP1 and 3PP1) were noted as 9.563± 4.844, 12.628 ± 4. 958, 21.077 ± 6.558 and 23. 885 ± 3.652kg respectively, while the male of the first and second age groups (0PPI and 1PPI) recorded 6.963 ± 1.143 and 12.235 ± 4.815 respectively. With regard to the linear body measurements of West African dwarf goats, the results showed that the female mean heart girth (18.029 ± 4.174, 21.840 ± 1.756, 25.070 ± 2.594 and 26.048 ± 2.227cm), body depth (19.940 ± 5.630, 24.977± 2.276, 29.148 ± 3.593 and 30.834 ± 2.939cm); rump height (15.665 ± 3.201,18.208 ± 1.790, 20.136 ± 1.894 and 20.271 ± 2.122 cm); height at wither (14.121 ± 2.720, 16.775 ± 1.751, 18.144 ± 1.768 and 18.065 ± 1.372 cm) and body length (18.132±4.540, 23.048 ± 2.004, 25.191± 2.404 and 26.362 ± 2.062 cm) in the respective age groups. Both the live weight and linear body measurements increased as age increases, indicating that the studied population were in good health conditions. Dereje and Aynalem, (2013) earlier stated that live body weight of goat increase as age increases till the first set of incisors and gradually the rate of increase reduces to maturity. Adeyinka and Mohammed (2006) reported lower mean body weight in female goats than males, which is at variance with the present study. This may be as a result of differences in breeds used. It was very difficult to get male goats older than one year under field condition, this was because few male goats are usually used for breeding purposes, and the rest are sold out when beyond one year of age. This makes it difficult to present the body measurements of male goat in all the age groups except the first and second age groups (0PP1 and 1PP1).

TABLE 1: mean ± SD for live body weight (kg) and linear body measurement (cm) for West African Dwarf goats.

	Sex	No. of obs	BWT	HG	BD	RH	HAW	BL
0PP1	F	55	9.563±4.844	18.029±4.174	19.940±5.630	15.663±3.201	14.121± 2.720	18.132± 4.540
	M	27	6.963±1.143	17.844±3.814	20.574±6.090	15.422±3.044	13.674±2.820	18.048±4.750
	M&F	82	8.707±4.509	17.968±4.367	20.148±5.762	17.968±4.367	13.974±2.751	18.104±4.586
1PP1	F	70	12.628±4.958	21.840±1.756	24.977±2.276	18.208±1.790	16.775±1.751	23.048±2.004
	M	17	12.235±4.815	22.923±2.608	25.235±1.961	18.294±2.077	15.676±2.228	22.558±2.668
	M&F	87	12.551±4.905	22.052±1.981	25.027±2.210	18.225±1.837	16.560±1.891	22.952±2.141
2PP1	F	90	21.077±6.558	25.070±2.594	29.148±3.593	20.136±1.894	18.144±1.768	25.191±2.404
3pp1	F	35	23.885±3.652	26.048±2.227	30.834±2.939	20.271±2.122	18.065±1.372	26.362±2.062
Pooled	F	250	16.464±7.733	22.540±3.521	26.190±5.418	18.632±2.863	16.865±2.509	23.202±4.093
	M	44	9.000±4.620	19.806±4.193	22.375±5.402	16.531±3.034	14.447±2.765	19.790±4.609
	M&F	294	15.346±7.814	22.131±3.751	25.619±5.576	18.317±2.980	16.503±2.687	22.691±4.341

Bwt =Body weight, RH=Rump Height, BD=Body Depth, HAW=Height at wither, HG=Heart Girth, BL=Body Length, M=Male, F=female, M/F=male and female, PP1=pair of permanent incisors
Pooled = combination of data irrespective of age

Table 2 shows the relationship between Body weight and linear body measurement in West African dwarf goats. The highest coefficient of correlation was obtained between BWT and HG in males (r = 0.748) when all ages were considered. This implies that better prediction of body weight could be obtained in male WAD goats than in females. This result is in line with the findings of Alemayehu and Tikabo (2010) who obtained a higher correlation between body weight and linear body measurements in male highland sheep than the females. In 0PP1 male group, there were very high and significant correlations between body weight and all linear body measurements studied. This suggests that selection of animals at this age group will lead to higher live body weight.

Table 2: Phenotypic correlation between Live Body Weight and Linear Body Measurement for West African Dwarf Goat.

	SEX	NO. OF OBSEVATION	BL	HAW	RH	HG	BD
0PP1	F	55	0.293	0.350*	0.305*	0.444**	0.419**
	M	27	0.705**	0.717**	0.724**	0.770**	0.585**
	M&F	82	0.374*	0.448**	0.390*	0.485**	0.418**
1PP1	F	70	0.278	0.471**	0.452**	0.485**	0.380*
	M	17	0.130	0.261	0.546**	0.696**	0.679**
	M&F	87	0.022	0.466**	0.155	0.590**	0.426**
2PP1	F	90	0.618**	0.307**	0.446**	0.618**	0.456**
3PP1	F	35	0.215	0.154	0.105	0.460**	0.194
Pooled	F	250	0.609**	0.518**	0.563**	0.679**	0.647**
	M	44	0.599**	0.609**	0.733**	0.748**	0.606**
	M&F	294	0.634**	0.571**	0.607**	0.681**	0.669**

**P<0.01; *P<0.05, Bwt =Body weight, RH=Rump Height, BD=Body Depth, HAW=Height at wither, HG=Heart Girth, BL=Body Length, M=Male, FM=female, M/F=male and female, PP1=pair of permanent incisors, Pooled = combination of data irrespective of age

Prediction of Body weight from Linear Body Measurement

The prediction equations to estimate body weight from linear measurements using regression analysis for females at different age groups is shown in Table 3. The results shows that in 0PPI, the equation with heart Girth alone was statistically significant ($p<0.001$ with R^2 value of 0.44 and MSE value of 19.195, which indicates that 44.4% of the variance in BWT was explained by the model. The R^2 values increased as the no of variables increased while the MSE values decreased with increased no of variables. When 1PPI age group was considered the same trend was observed.

In 2PPI age group, the regression analysis of how well HG predicts BWT was statistically significant with R^2 and MSE values of 0.618 and 26.877 respectively, indicating that 61.8% of the variance in BWT was explained by the model. As more variable were included the R^2 values also increased, when all the five variables were included in the equation, the R^2 and MSE values were 0.708 and 22.759 respectively indicating that 70.8% of the variance in BWT was explained by the model. The same trend was also observed in 3PPI age group.

Table 3: Body weight prediction equations for female West African dwarf Goat at different age groups

Age	Equation	βo	β1	β2	β3	β4	β5	R^2	MSE	P-val
0PPI	HG	0.268	0.516					0.444	19.195	0.001
	HG+BD	0.409	0.445	0.057				0.449	19.549	0.003
	HG+BD+RH	1.861	0.610	0.091	-0.327			0.461	19.578	0.006
	HG+BD+RH+HAW	1.425	0.596	0.070	-0.452	0.219		0.463	19.920	0.015
	HG+BD+RH+HAW+BL	0.698	0.894	0.202	-0.456	0.571	-0.672	0.526	18.712	0.006
1PPI	HG	-16.652	1.341					0.475	19.320	0.000
	HG+BD	-19.395	1.087	0.332				0.491	19.225	0.000
	HG+BD+RH	-13.970	1.342	0.428	-0.736			0.544	18.084	0.000
	HG+BD+RH+HAW	-12.665	1.325	0.530	-0.458	-0.510		0.560	17.904	0.000
	HG+BD+RH+HAW+BL	-13.019	1.325	0.534	-0.458	-0.526	0.023	0.560	18.182	0.000
2PPI	HG	-18.098	1.563					0.618	26.877	0.000
	HG+BD	-18.420	2.170	-0.511				0.635	26.273	0.000
	HG+BD+RH	-19.237	2.109	-0.504	0.107			0.635	26.556	0.000
	HG+BD+RH+HAW	-22.352	2.149	-0.490	-0.230	0.466		0.642	26.474	0.000
	HG+BD+RH+HAW+BL	-29.343	1.721	-0.578	-0.205	0.045	1.088	0.708	22.759	0.000
3PPI	HG	4.254	0.754					0.460	10.839	0.005
	HG+BD	5.826	0.871	-0.150				0.470	11.043	0.018
	HG+BD+RH	7.565	1.017	-0.100	-0.350			0.498	10.998	0.029
	HG+BD+RH+HAW	5.275	0.999	-0.090	-0.494	0.297		0.503	11.289	0.060
	HG+BD+RH+HAW+BL	0.734	0.959	-0.080	-0.561	0.311	0.242	0.519	11.422	0.089

RH=Rump Height, BD=Body Depth, HAW=Height at wither, HG=Heart Girth, BL=Body Length, PP1=pair of permanent incisors, βo=intercept, β1- β5=regression coefficients,R^2 =coefficient of determination, MSE= Mean square error

The result of linear body measurement as related to body weight in male West African dwarf goats is shown in Table 4. The results indicates that in the two age groups (0PPI and 1PPI), in which male animals were available for measurement, the regression analysis of how well linear body measurements predict BWT were statistically significant ($p<0.001$), with the highest R^2 value and least MSE obtained when all the five variables were included in the equation.

Table 4: Body weight prediction equations for male West African dwarf Goat at 0PPI and 1PPI age groups

Age	Equation	βo	β1	β2	β3	β4	β5	R^2	MSE	P-val
0PPI	HG	-3.483	0.585					0.710	5.093	0.000
	HG+BD	-3.622	0.477	0.101				0.725	5.082	0.000
	HG+BD+RH	-5.182	0.177	0.101	0.448			0.762	4.679	0.000
	HG+BD+RH+HAW	-4.999	0.220	-0.014	-0.287	0.932		0.790	4.694	0.000
	HG+BD+RH+HAW+BL	-4.569	0.113	-0.101	-0.323	0.950	0.199	0.795	4.507	0.000
1PPI	HG	-12.863	1.152							
	HG+BD	-17.850	0.812	0.500				0.498	18.516	0.000
	HG+BD+RH	-15.098	1.018	0.566	-0.491			0.521	18.165	0.000
	HG+BD+RH+HAW	-14.396	0.983	0.600	-0.401	-0.148		0.523	18.336	0.000
	HG+BD+RH+HAW+BL	-10.367	1.069	0.551	-0.347	-0.064	-0.308	0.537	18.186	0.000

RH=Rump Height, BD=Body Depth, HAW=Height at wither, HG=Heart Girth, BL=Body Length, PP1=pair of permanent incisors, βo=intercept, β1-β5= regression coefficients, R^2 =coefficient of determination, MSE= Mean square error

Table 5: Body weight prediction equations for male and female West African dwarf Goat irrespective of age.

Sex	Equation	βo	β1	β2	β3	β4	β5	R^2	MSE	P-val
F	HG	-15.583	1.422					0.647	34.881	0.000
	HG+BD	-13.127	0.532	0.672				0.690	31.554	0.000
	HG+BD+RH	-13.318	0.519	0.664	0.037			0.690	31.678	0.000
	HG+BD+RH+HAW	-12.883	0.562	0.662	0.165	-0.221		0.691	31.732	0.000
	HG+BD+RH+HAW+BL	-12.870	0.479	0.607	0.141	-0.338	0.246	0.694	31.614	0.000
M	HG	-6.989	0.807					0.733	10.123	0.000
	HG+BD	-7.432	0.690	0.124				0.739	10.155	0.000
	HG+BD+RH	-10.056	0.265	0.119	0.674			0.768	9.397	0.000
	HG+BD+RH+HAW	-9.789	0.205	0.158	0.895	-0.250		0.772	9.517	0.000
	HG+BD+RH+HAW+BL	-9.873	0.631	0.443	0.909	-0.376	-0.664	0.803	8.579	0.000
M&F	HG	-15.587	1.398					0.671	33.692	0.000
	HG+BD	-14.224	0.640	0.601				0.709	30.625	0.000
	HG+BD+RH	-15.101	0.555	0.567	0.198			0.710	30.621	0.000
	HG+BD+RH+HAW	-15.042	0.559	0.569	0.217	-0.033		0.720	30.725	0.000
	HG+BD+RH+HAW+BL	-15.017	0.516	0.541	0.207	-0.077	0.109	0.730	30.783	0.000

RH=Rump Height, BD=Body Depth, HAW=Height at wither, HG=Heart Girth, BL=Body Length, M=Male, F=female, M/F=male and female, PP1=pair of permanent incisors, βo=intercept, β1- β5=regression coefficients, R^2 =coefficient of determination, MSE= Mean square error

The prediction of body weight from interaction of age and sex as related to linear body measurements presented in Table 5 indicates that predictions were more accurate for males than females. This could be due to varying deposition of fat in the two sexes as earlier reported by Bassono *et al*.,(2001). Generally, it was observed that the higher the variables, the higher the coefficient of determination (R^2) and better prediction of body weight based on linear body measurements. This agrees with Topal *et al.,* (2003) who reported that either R^2 or MSE may be confidently applied to investigate the fitting state of simple and multiple regression models to actual data for estimation of body weight in livestock.

In all the age and sex groups, there was high correlation between BWT and HG even as the highest variation of body weight was accounted for by the combination of all the five variables (HG, BD, RH, HAW, & BL). This observation is in agreement with the work of Topal and Macit (2004), Tadesse and Gebremariam (2010), and Raja *et al*., (2013). Moreover, the highest R^2 obtained in the pooled age groups when all the body measurements were included in the regression equations suggest that body weight could be estimated more accurately by combination of two or more variables than HG alone. More so, the coefficient of determination R^2 was highest in the equations with pooled data (irrespective of age) compared to equations formed at different age groups (Table 5). Hence, the above equations may be used to predict the body weight of West African dwarf goats at different age groups.

Table 6: Comparison of measured and calculated live weight values for West African dwarf Goat

			Corresponding results based on regression equations for live weights (kg)				
Age	Sex	M–BWT(kg)	HG	HG+BD	HG+BD+RH	HG+BD+RH+HAW	HG+BD+RH+HAW+BL
0PPI	F	9.563	9.571	9.569	9.552	9.578	9.579
1PPI	F	12.628	12.635	12.637	12.628	12.617	12.384
2PPI	F	21.077	21.086	21.087	21.100	21.065	21.050
3PPI	F	23.885	23.894	23.889	23.878	23.874	23.873
0PPI	M	6.963	6.956	6.968	6.962	6.956	6.969
1PPI	M	12.235	13.544	13.380	13.538	13.623	13.742
Pooled	F	16.464	16.469	16.463	16.459	16.469	16.458
	M	9.000	8.994	9.009	8.995	8.989	9.434
	M&F	15.346	15.352	15.337	15.332	15.335	15.257

M-BWT = Measured Body weight, RH=Rump Height, BD=Body Depth, HAW=Height at wither, HG=Heart Girth, BL=Body Length, M=Male, F=female, M&F=male and female, PP1=pair of permanent incisors, Pooled = combination of data irrespective of age

The comparison of the actual body weight and predicted body weight from linear regression equations are demonstrated in Table 6. The actual and computed body weights were more or less similar which confirms the

fact that body weight can be predicted from linear body measurements with accuracy. The present study is in agreement with Tsegagy *et al*., (2013), Slippers *et al,*. (2000) and Myeni and Slippers 1997. The same authors indicated that there were no significant differences between actual body weight and body weight predicted with equations.

CONCLUSION

The body weight and linear body measurements were significantly correlated with each other. Body weight had higher correlation with HG than other body measurements (BD, RH, HAW and BL). In all investigated sex and age group, the highest R^2 was obtained when all the body measurements were included in the regression equations; this suggests that body weight could be estimated with more precision by combination of two or more linear body measurements.

Body weight can be predicted from body measurements with high accuracy to support improvement and husbandry practices of West Africa dwarf goats.

REFERENCES

Adeyinka, I. A. and Mohammed,I. D. (2006). Relationship of Live Weight and Linear Body Measurement in Two Breeds of Goats of Northern Nigeria. *Journal of Animal and Veterinary Advances* 5(11): 891-893.

Alemayehu T. and Tikabo G.(2010). Application of Linear Body Measurements for Live body Weight Estimation of Highland sheep in Tigray Region,North - Ethiopia. *Journal of the Drylands* (2): 203- 207.

Bassano, B., D. Bergero and A. Peracino, 2001. Accuracy of body weight prediction in Alpine Ibex (*Capra ibex*, L. 1758) using morphometry. *J. Anim. Phusiol. A. Anim. Nutr*., 87: 79-85.

Chitra, R., Rajendran, S., Prasanna, D., Kirubakaran, A. (2012). Prediction of body weight using appropriate regression model in adult female Malabari goat, *Vet World*, 5(7):409-411.

Dereje, T., B. Berhanu and H. Aynalem, (2013). Morphological Characterization of Indigenous Hararghe Highland Goat Breed in Their Native Environment,West Hararghe, Ethiopia, *American - Eurasian Journal of Scientific Research*, 8(2): 72-79.

Devandra C. and Mcleroy, G.B. (1982). Goat and sheep production in the tropics. Longman Scientific and Technical ELBS Edition, Longman, Singapore, pp. 20- 200

Fajemilehin, O. K. S. and Salako, A.E. (2008). Body measurement characteristics of the West African Dwarf (WAD) goat in deciduous forest zone of Southwestern Nigeria. *African Journal of Biotechnology* 7:2521-2526.

Hassan, A. and A. Ciroma, 1992. Body weight measurements relationship in Nigerian Red Sokoto goats. Proceedings of the First Biennial Conference of the African Small Ruminant Research Networks, December 10-14, 1992, ILRAD, Nairobi, Kenya, pp: 428-432.

Islam M. R., Saadullah M, Howlider A. R., Huq M. A. (1991). Estimation of live weight and dressed carcass weight from different body measurements in goats. *Indian Journal of Animal Sciences,*61:460-461.

Khan, H. F., Muhammad, R., Ahmad, G., Nawaz, G., Rahimullah and M. Zubair, (2006). Relationship of body weight with linear body measurements in goat. *Journal of Agriculture and Biology Sciences* 1:51-54.

Mahieu, M., Naves, M. and Arquet, R. (2011). Predicting the body mass of goats from body measurements. *Livestock Research for Rural Development.Volume 23, Article 192.* http://www.Irrd.org/Irrd23/9/mahi23192.htm**.**

Myeni, S.P. and Slippers, S.C. (1997). Estimation of body weight of Nguni goats from heart girth measurements. Proceedings of the Annual Symposium of the South African Society of Animal Scientists, Development of Animal Agriculture Branch, Mtunzini, RSA.

Nsoso, S. J., Mannathoko, G. G., Tadubana, T. T. and Malela, L. (2004). The effect of methods of castration on live weight dressed percentage and linear body measurements of indigenous Tswana goats raised under semi-intensive management in Southeast Botswana. *Livestock Research for Rural Development* Vol.16

Olatunji-akioye, A.O. and Adeyemo, O.K. (2009). Live weight and chest girth correlation in commercial sheep and goat herds in southwestern Nigeria. *International Journal of Morphology*. 27(1), 49-54.

Pesmen, G. and Yardimci M. (2008). Estimating the live weight using somebody measurements in Saanen goats. *Archiva Zootechnica,* 11(4): 30-40.

Shirzeyli, F. H., Lavvaf, A. and Asadi, A.(2013). Estimation of body weight from body measurements in four breeds of Iranian sheep. *Songklanakarin J. Sci. Technol*. 35(5):507-511.

Slippers, S. C., Letty B. A., De-Vilter J. R. (2000). Production of the body weight of Nguni goats. *South African Journal of Animal Science,* 30: 127-128.

Tadesse, A and Gebremariam, T. (2010). Application of Linear Body Measurements for Live Body Weight Estimation of Highland Sheep in Tigray Region, North-Ethiopia. *Journal of the Drylands* 3(2): 203-207.

Topal, M. and Macit, M. (2004). Prediction of body weight from body measurements in Morkaraman sheep. *J. Applied Anim. Res.,* 25: 97-100.

Topal, M., N. Yildiz, N. Esenbuga, V. Aksakal, M. Macit and M. Ozdemir, 2003. Determination of best fitted regression model for estimation of body weight in Awassi sheep. *J. Applied Anim. Res.,*23: 201-208.

Tsegaye, D., Belay, B. and Aynalem Haile, A. (2013). Linear Body Measurements as Predictor of Body Weight in Hararghe Highland Goats under Farmers Environment, Ethiopia. *Global Veterinaria* 11 (5): 649-656.

Wikipedia The free Encyclopedia *http*.s:// *en.wikipedia*.org/ wiki/ Akwa – Ibom.