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Body Weight Prediction Equations from Different Linear Measurements in the Short-Eared Somali Goat Populationof Eastern Ethiopia

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Abstract: This study was conducted on randomly selected whole-flocks of the short-eared Somali goat kept under extensive pastoral production systems around Dire Dawa, Eastern Ethiopia to obtain some prediction equation between live weight and various linear body measurements. Both male and female goats with five different dentition groups were included in this study. Live weight was regressed on the body measurements separately for males and females for each dentition class and for the pooled data by sex categories. All the parameters contributed significantly ($p<0.05$) to the model for the pooled data of female age groups depicting an R^2-value of 85%. In the males using the pooled data for all dentition groups (0-4PPI), four parameters (chest girth, body length, body condition and pelvic width) contributed significantly ($p<0.05$) to the model giving an R^2-value of 91%. However, chest girth was the only regressor that consistently significantly ($p<0.01$) contributed to the regression models across all age and sex groups.

Key words: Short-eared Somali goat, body weight, linear measurements, chest model, Syria

INTRODUCTION

In many developing countries where small holder and extensive pastoral livestock production systems are predominant, live animal marketing is based on physical appraisal. However, as in the case of Ethiopia as the contribution of the Pastoral and Small Holder Production Systems live animal and meat export sector increases this poses a problem. Lack of common interface is an evident problem between the Traditional Physical Appraisal Marketing System of the pastoralist and small holder livestock producers and the Body Weight-Based Marketing System of exporters and large scale abattoirs. Lack of the required weighing equipment at the traditional markets causes big difficulties. In order to overcome these difficulties some linear measurements especially in the case of large animals are used to estimate body weight (Gul *et al*., 2005). Using this kind of estimation could also be applicable in goat production and marketing if the linear relationship of body weight and the liner measurements are investigated with regression equations. Prediction equations have been developed for goat breeds elsewhere in the tropics using various linear measurements (Pradhan, 1982; Gul *et al*., 2005). As linear body traits and body weight are influenced by breed and environmental factors, development of breed specific prediction equations is crucial for prediction of live body weight from linear measurements with reasonable accuracy.

The aim of this study is developing regression equation between live weight and linear body measurements in the short-eared Somali breed population around Dire Dawa, Ethiopia.

MATERIALS AND METHODS

The study area: This study was carried out in the rural peasant associations around dire dawalocated between 9°27'-9°49' North latitude and 41°38'-42°19' East longitude in the Eastern part of Ethiopia (DDAC, 2002). The North Eastern part of dire dawa is relatively sparsely populated lowland exhibiting pastoral and Agro-Pastoral System and the Southeastern part of the administration comprises of the escarpment with Mixed Farming System (DDAC, 2004). The study sites include Jeldesa, Goladeg and Mudianeno peasant associations found in the North-Eastern and North-Western parts of the Dire Dawa administrative council. Goat and camel are the dominant livestock species in the study sites kept under pastoral and Agro-Pastoral Production Systems. In the study sites, the short-eared Somali goat breed is preferred and predominantly kept by the Issa pastoralists.

Sampling procedures: In this study, linear and body weight measurements were taken from randomly selected whole flocks including kids within villages at each peasant association until the target total number of animals was achieved. The age of animals was estimated

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from dentition to support the age information provided by owners. Summarized details of the sample size are shown in Table 1.

Data collection: Quantitative measurements of linear traits (cm) and body weight (kg) were taken on sample goats using standard plastic tapes and a 100 kg portable balance, respectively (Table 2). Linear measurements included body length, chest girth, height at wither, chest width and pelvic width. Apart from these, scrotal circumference and scrotal length were measured exclusively on the male population. Body condition score was assessed subjectively and scored using a 5 point scale (1 = very thin, 2 = thin, 3 = average, 4 = fat and 5 = very fat/obese) for both sexes. The score of an animal was done by feeling the back bone with the thumb and the end of the short ribs with finger tips immediately behind the last ribs.

Data analysis: The stepwise REG procedures of SAS (2003) were used order to predict body weight from linear measurements where other body measurements were added, one at a time to chest girth. Live weight was regressed on the body measurements separately for males and females for each dentition class and for the pooled data by sex categories. Stepwise multiple regressions were carried out in estimation of body weight from body measurements in female and male goats, six and eight body measurements were used, respectively. Body length, chest girth, wither height, chest width, pelvic width and body condition were the independent parameters or regressors for female goats. In addition to these variables, scrotal circumference and scrotal length were added for the male population. Due to inadequate sample size of males in each dentition classes, regression was applied only on the pooled data (0-4PPI). The choice of the best fitted regression model was assessed using coefficient of determination (R^2):

Multiple Linear Regression Model for females:

$$Y_j = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + e_j$$

Where:

Y_j = The dependent variable body weight
β_0 = The intercept
X_1-X_6 = The independent variables; body length, chest girth, height at wither, chest width pelvic width and body condition score, respectively
β_1-β_6 = The regression coefficients of the variables X_1, X_2, X_3, X_4, X_5 and X_6, respectively
e_j = The residual error

Multiple Linear Regression Model for males:

$$Y_j = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + e_j$$

Where:

Y_j = The dependent variable body weight
β_0 = The intercept
X_1-X_8 = The independent variables body length, chest girth, height at wither, chest width, pelvic width, scrotal circumference, scrotal length and body condition score, respectively
β_1-β_8 = The regression coefficients of the variables X_1, X_2, X_3, X_4, X_5, X_6, X_7 and X_8, respectively
e_j = The residual error

Table 1: Summary of total number of samples by PA

		No. of animals used for body weight and linear measurements						
		Female					Male	
PA	No. of villages	0PPI	1PPI	2PPI	3PPI	4PPI	0-4PPI	Individuals interviewed
Jeldesa	3	18	24	45	118	42	63	38
Mudianeno	2	18	16	50	106	51	67	48
Goladeg	2	31	25	31	63	83	38	40
Total	7	67	65	126	287	176	168	126

PPI = Pairs of Permanent Incisors; PA = Peasant Association

Table 2: Linear traits measured on each sample animal

Parameters	Units	Descriptions
Body weight	kg	Taken early in the morning using 100 kg spring balance
Body length	cm	The horizontal distance from the point of shoulder to the pin bone to the nearest centimeter
Chest girth	cm	The height from the bottom of the front foot to the highest point of the shoulder between the withers to the nearest centimeter
Height at wither	cm	The distance around the animal measured directly behind the front leg to the nearest centimeter
Chest width	cm	The width of the chest between the briskets to the nearest centimeter
Pelvic width	cm	The distance between the pelvic bones, across dorsum to the nearest centimeter
Scrotal circumference	cm	The circumference of the testis at the widest part to the nearest centimeter
Scrotal length	cm	The length of the scrotum in centimeters from the base to the tip of its tail

kg = Kilograms; cm = centimeters

RESULTS AND DISCUSSION

Table 3 shows the regression output and coefficient of determination for the sample population at different dentition and sex categories. In the prediction of body weight in females, the multiple stepwise regressions found only three parameters to be significant ($p<0.05$) for dentition groups two (chest girth, body length and withers height) and four (chest girth, body condition and body length) with R^2-values of 82 and 61%, respectively. Five regressors (chest girth, body length, body condition, pelvic width and withers height) were found to have significant association ($p<0.05$) with body weight for the dentition group three giving an R^2-value of 47%. On the other hand, all the parameters contributed significantly ($p<0.05$) to the model for the pooled data of female age groups depicting an R^2-value of 85%. Significant contribution ($p<0.05$) of chest width was only observed in the models for dentition group two and the pooled data. Among the female age groups, regression of body weight in the dentition group three had the lowest R^2-value (47%) of all.

In the males using the pooled data for all dentition groups (0-4PPI), four parameters (chest girth, body length, body condition and pelvic width) contributed significantly ($p<0.05$) to the model giving an R^2-value of 91%. Scrotal circumference and length were not found to have significant association with body weight for the pooled data of the male goats despite the fact that various studies have shown strong correlation between scrotal parameters and body weight in male goats. Even though scrotal circumference increases with age, its growth increment is sluggish compared to increases in body weight (Mekasha, 2007). Earlier studies have demonstrated that scrotal circumference increases rapidly in young bulls, only gradually in mature bulls and can even decrease as bulls age (Coulter and Foote, 1977; Brito *et al*., 2002).

The R^2-values computed for the body measurements were generally higher for the males pooled data (91%) than any of the age groups including the pooled data for females. This may imply that body weight could be predicted with better accuracy for males than for their female counterparts. Similar inference was made by ZewduEdea (2008) for higher R^2-values computed for male Bonga and Horro sheep than their female counter parts.

Parameter estimates in Multiple Linear Regression Models also showed that subsequent inclusions of parameters on the chest girth kept the R^2-values improving although the change had a pattern of diminishing marginal rate. This suggests that body weight could be more accurately predicted by combinations of two or more measurements than chest girth alone. Other findings have also shown similar improvement in R^2-values with subsequent addition of more linear measurements (Gul *et al*., 2005; FikrteFirew, 2008; ZewduEdea, 2008). Despite better prediction of body weight from combinations of body measures having these

Table 3: Prediction equations at different sex and age groups

Dentition	Equations	Intercept	β_1	β_2	β_3	β_4	β_5	β_6	R^2	R^2-change
Female	CG	-15.75	0.53	-	-	-	-	-	0.690	0.000
1PPI	CG+BL	-16.84	0.39	0.18	-	-	-	-	0.750	0.050
	CG+BL+PW	-15.99	0.34	0.16	0.31	-	-	-	0.780	0.020
	CG+BL+PW+CW	-16.61	0.29	0.14	0.39	0.38	-	-	0.790	0.010
2PPI	CG	-25.95	0.72	-	-	-	-	-	0.700	0.000
	CG+BL	-28.38	0.55	0.24	-	-	-	-	0.810	0.100
	CG+BL+WH	-31.78	0.49	0.20	0.16	-	-	-	0.820	0.013
3PPI	CG	-4.24	0.39	-	-	-	-	-	0.270	-
	CG+BL	-13.80	0.32	0.25	-	-	-	-	0.370	0.090
	CG+BL+BC	-13.91	0.31	0.23	0.74	-	-	-	0.410	0.040
	CG+BL+BC+PW	-17.23	0.28	0.18	0.81	0.53	-	-	0.450	0.030
	CG+BL+BC+PW+WH	-21.66	0.24	0.15	0.89	0.45	0.16	-	0.470	0.020
4PPI	CG	-14.26	0.57	-	-	-	-	-	0.420	0.000
	CG+BC	-12.89	0.49	1.26	-	-	-	-	0.540	0.120
	CG+BC+BL	-22.20	0.42	1.14	0.23	-	-	-	0.610	0.070
0-4PPI	CG	-22.30	0.67		-	-	-	-	0.780	0.000
	CG+BL	-24.42	0.45	0.29	-	-	-	-	0.830	0.057
	CG+BL+WH	-27.44	0.39	0.24	0.15	-	-	-	0.840	0.007
	CG+BL+WH+BC	-24.34	0.36	0.22	0.14	0.37	-	-	0.840	0.003
	CG+BL+WH+BC+CW	-25.23	0.33	0.21	0.16	0.38	0.20	-	0.840	0.002
	CG+BL+WH+BC+CW+PW	-24.65	0.32	0.20	0.13	0.35	0.21	0.19	0.850	0.001
Male	CG	-25.70	0.72	-	-	-	-	-	0.840	0.000
0-4PPI	CG+BL	-27.84	0.43	0.39	-	-	-	-	0.900	0.060
	CG+BL+BC	-30.30	0.42	0.37	1.2	-	-	-	0.914	0.010
	CG+BL+BC+PW	-29.58	0.37	0.32	1.34	0.37	-	-	0.919	0.005

BL = Body Length; CG = Chest Girth; CW = Chest Width; WH = Wither Height; PW = Pelvic Width; BC = Body Condition score; 0PPI = 0 Pair of Permanent Incisors; 1PPI = 1 Pair of Permanent Incisors; 2PPI = 2 Pairs of Permanent Incisors; 3PPI = 3 Pairs of Permanent Incisors; 4PPI = 4 Pairs of Permanent Incisors variables to predict body weight poses a practical problem under field settings due to the higher labor and time needed for measurement. Measurement of traits also has cost implications and it will be unpractical to consider many traits under farmers/pastoralists conditions. Thus, reduces the practical usefulness of using other measurements in conjunction with heart girth to predict body weight (Berge, 1977). Under such conditions, the most practical prediction accuracy may be obtained through the use of chest girth alone.

CONCLUSION

This study has shown that some linear body measurements can predict body weight with reasonable accuracy in male and female goats of the short-eared Somali breed. Parameter estimates in Multiple Linear Regression Models showed that the more parameters are included in the modelthe better R^2-values generated. However, the consistency in which chest girth alone significantly contributed to the regression models across all age and sex groups demonstrates that use of chest girth measurement alone can predicting body weight with reasonable accuracy while avoiding the complexity of measuring several linear traits in the case of short-eared Somali breed.

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