PREDICTIONS OF BODY WEIGHTS OF BALAMI, UDA AND YANKASA SHEEP USING LINEAR BODY MEASUREMENTS

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Abstract

Three breeds of sheep (Balami, Uda and Yankasa) were bred at the Sheep Project Unit of Small Ruminant Research Programme (SRRP) of National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika-Zaria to produce pure breed lambs which were used to generate prediction equations for body weight of lambs at birth, 90, 180 and 360 days of age using body linear measurements of lambs {neck length (NL), back length (BL), height at wither (HW), chest girth (CG), loin girth (LG) and leg length (LL)}. The data obtained were subjected to PROC REG procedure of SAS with stepwise selection. Prediction equations for the association between body weight and linear body measurements were generated. The results showed that loin girth accounted for almost 100% of the variability at the 90-day weights of Balami (both male and female) and Uda males. Height at wither featured prominently in the equations for the prediction of the weight of lambs at 90-day for the overall population, YK X YK, female YK X YK, UD X UD and female UD X UD. The respective R^2 for these equations that featured height at wither were 0.177, 0.152, 0.737, 0.993 and 0.502. Back length accounted for most of the variability of the 360-day weight of female Uda (62.28%) and the overall population (55.39%). All the prediction equations for 180 and 360-day (yearling) weight of Balami, Uda and Yankasa sheep had high R^2 values (0.692-0.954). Height at wither, chest and loin girth featured more prominently in explaining the variations of body weight of lambs of Balami, Uda and Yankasa at birth, 90, 180 and 360 days. Weighing charts and bands should be produced on the basis of prediction equations that have high coefficients of determination (R^2).

Key Words: Sheep; prediction equations; body weight; linear body measurements; Nigeria

Introduction

Linear body measurements have been used in animals to estimate body weight (Topal and Macit, 2004; Yakubu *et al.*, 2005; Afolayan *et al.*, 2006) and price of sheep in open markets (Iyiola-Tunji *et al.*, 2011). Some authors (Monsi, 1992; Okon *et al.*, 1997; Chineke, 1996; Akpa, 2000; Ozoje and Mgbere, 2002) had used linear body measurements to examine relationships among economic characteristics, reproductive performance and to study the interactions between heredity and the environment in several animals. This method of evaluating livestock is especially important in rural communities where weighing scales may not be available (Sowande and Sobola, 2008; Yakubu, 2010). Some of the body linear measurements studied by various authors (Salah *et al.*, 1965; Tegbe and Olorunju, 1986; Otoikhian *et al.*, 2008; Osaiyuwu *et al.*, 2010; Semakula *et al.*, 2010; Yakubu, 2010) in livestock were neck length, back length, height at wither, loin girth, chest girth, leg length, *et cetera*. Ozoje and Mgbere (2002) reported on the use of skeletal dimensions such as shoulder width, heart girth and height at withers as good indicators of live weight and condition score. Heart girth that reflected the physiological status of animals had also been considered as the best indicator of live weight and condition score of pigs (Tegbe and Olorunju, 1986). Chineke (2005) asserted that simple linear measurements can be used to reliably predict body weight.

Linear body measurements together with live body weight were influenced significantly by breed, age and sex of the animal (Semakula *et al.*, 2010). Information on linear body measurements of sheep breed found predominantly in Northern Nigeria (especially Balami and Uda) is scarce. However, some authors (Chineke, 1996; Yakubu *et al.*, 2005; Afolayan *et al.*, 2006; Sowande and Sobola, 2008; Akpa *et al.*, 2010) had studied the relationship between linear body measurements and live weight of West African Dwarf and Yankasa sheep in Nigeria. Yakubu (2010) obtained positive relationships between body linear measurements and body weight of Yankasa sheep and concluded that the association may be used as a selection criterion since positive correlations of traits suggest that the traits are under the same gene action (pleiotropy/linkage). This study was therefore aimed at generating some prediction equations for body weight of Balami, Uda and Yankasa sheep using linear body measurements.

Materials and Methods

This study was conducted at the Sheep Project Unit of Small Ruminant Research Programme (SRRP) of National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika-Zaria. The institute is located in Northern Guinea Savannah zone of Nigeria on latitude 11°12´16.78´´N and longitude 7°33´39.18´´E with an elevation of 691 metres above sea level.

Three breeds of sheep (Balami, Uda and Yankasa) that are found predominantly in Northern Nigeria were bred to produce pure breed lambs which were used for the study. The ewes that were selected for the study were between two and three years old based on the recommendation of Taiwo *et al*. (1982). The breeding pattern and the resulting lambs are as shown in Table 1. Ewes gave birth in approximately 5 months after each mating. All the lambs were ear-tagged soon after birth.

Table 1: Breeding Pattern and the Resulting Number of Lambs

Sire Breed	Dam Breed	Lamb Genotype	Number of lambs: At birth	90-day	180-day	360-day
Yankasa	Ya nkasa	YK X YK	110	93	65	25
Uda	Uda	UD X UD	18	16	11	6
Balami	Balami	BL X BL	3	3	3	1
		Overall	131	112	79	32

Records taken included lamb's sire and dam, date of mating, date of birth, lamb's sex, type of birth, weight at birth, 90-day weight (weaning weight), 180-day and 360-day weight (yearling weight). Linear body measurements of lambs were also taken at birth, 90, 180 and 360 days. The linear body measurements considered at birth, 90, 180 and 360 days were neck length, back length, height at wither, loin girth, chest girth and leg length.

Body weights were recorded in kilogramme using Salter® weighing scale. Data that were not collected at the desired date were adjusted using the following formula:

$$\text{Body weight at specific age} = \left(\frac{X_{ik} - X_{ij}}{Y_k - Y_j}\right) * (Y_L - Y_j) + X_{ij}$$

Assumptions made were:

$j, k, L \neq 0$; $j, k, L > 1$; $k > j$; $L > j$ and $k \neq L$ (Source: Iyiola-Tunji, 2012)

Where:

X_{ik} = parameter measurement (growth trait or linear body measurements) after the desired date;

X_{ij} = value of the parameter measured (growth trait or linear body measurements) before the desired date;

Y_k = Date of record;

Y_j = Date of the previous record; and

Y_L = Age of animal on the day of record.

Body linear measurements were recorded in centimetre using a measuring tape. The description of each of the linear body measurements are shown in Plate I. Descriptions of body measurements taken are as stated below:

Neck length: The distance between the last atlas bones to the last cervical vertebra.

Back length: The distance from the last cervical vertebra anteriorly, the entire thoracic vertebra, sacral vertebra to sacrococcygeal vertebra joints at the hip of the animal.

Height at withers: Measured from the tip of the scapula at the cervicothoracic joint to the tip of the hoof.

Loin girth: Is the measure of the circumference at the loin, in a position anterior to the hind leg.

Chest girth: This was measured as the circumference posterior to the forelegs at right angles to the body axis.

Leg length: Leg length was measured from the hip of elbow joint to the tip of the hoof.

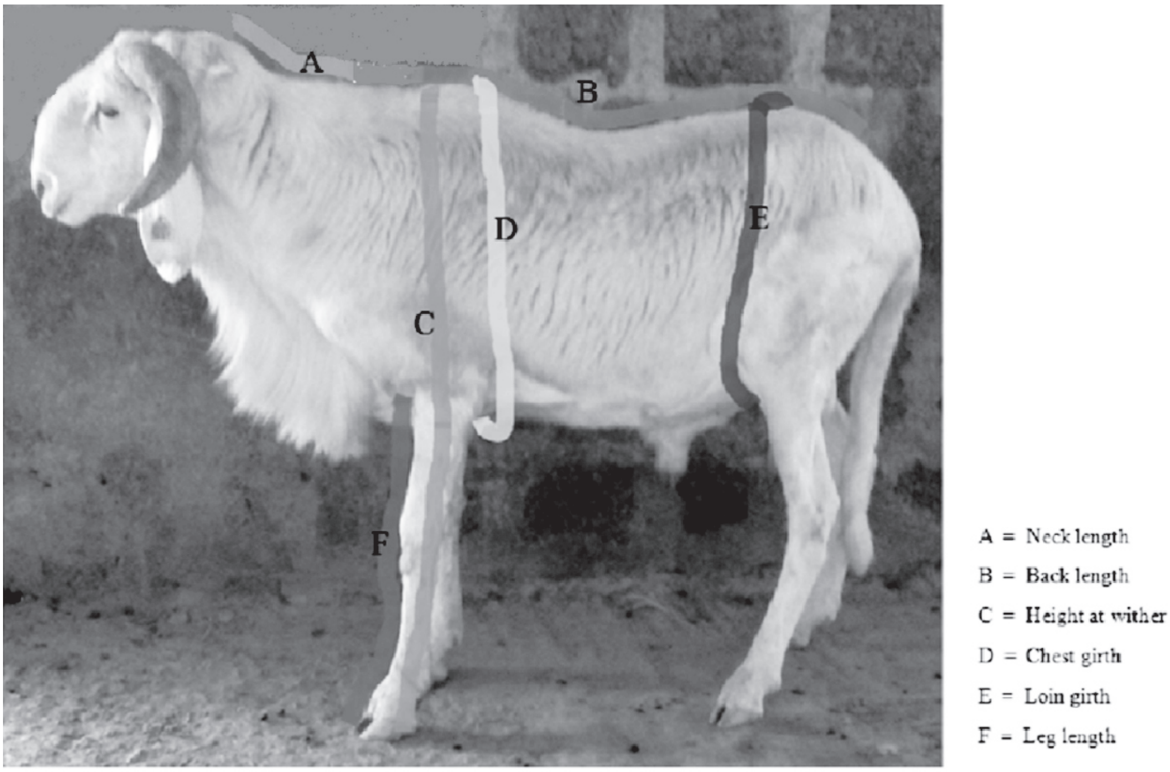

Plate : Linear body measurements
(Source: Iyiola-Tunji, 2012)

Stepwise regression procedure of SAS (SAS, 2003) was used to generate prediction equations for the association between body weight at various ages and linear body measurements.

Results and Discussion

Results

Tables 2 - 5 showed the prediction equations for body weights of lambs generated from linear body measurements of Balami, Uda and Yankasa lambs at birth, 90, 180 and 360 days, respectively.

a. Birth weight

Table 2 showed the prediction equations for birth weight of Balami, Uda and Yankasa sheep Loin girth (R^2 = 0.129) and chest girth (R^2 = 0.015) of lambs were the only linear body measurements that contributed to the prediction equation for birth weight of the overall population. Loin girth accounted for about 56% variability of birth weight of UD X UD female lambs. Neck length (35.67%) and loin girth (13.01%) were the most important linear body measurements for the variability of birth weight of UD X UD lambs of either sex. Table 2 also showed that the coefficient of determination (R^2) of the prediction equations for birth weight of most of the classes of lambs considered were low, except for BL X BL where chest girth featured prominently in explaining almost all the variations (99.8%) of birth weight.

Table 2: Prediction equations for birth weight of Balami, Uda and Yankasa sheep

Class of lambs	Prediction equation	Partial contributions of predictors	R^2
Overall	Y = 0.754 + 0.037LG + 0.02CG	LG (0.129), CG (0.0152)	0.144
YK X YK	Y = 1.025 + 0.021LG + 0.029CG	LG (0.0641), CG (0.0271)	0.091
UD X UD	Y = 2.081 - 0.131NL + 0.074LG	NL (0.357), LG (0.130)	0.487
BL X BL	Y = 38.350 - 0.975CG	CG (0.998)	0.998
YK X YK (males)	Y = 2.076 - 0.073HW + 0.065LG + 0.042CG	HW (0.0642), LG (0.0406), CG (0.0676)	0.172
YK X YK (females)	Y = 0.820 + 0.055CG	CG (0.0775)	0.078
UD X UD (female)	Y = 0.022 + 0.081LG	LG (0.5631)	0.563

Y = birth weight; BL = Back length; Chest Girth; HW = Height at wither; LG = Loin girth; LL = Leg Length; Neck Length. Group of lambs irrespective of sex. Values in parenthesis are the partial coefficient of determination (partial R^2) contribution of their respective preceding predictors.

b. 90-day weight

Table 3 showed prediction equations for 90-day body weight of Balami, Uda and Yankasa sheep. Loin girth explained about 100% of the variability of the 90-day weight of BL X BL (both male and female) and UD X UD males. Height at wither accounted for 67.52% and 50.16% of the 90-day weight of UD X UD (both male and female) and UD X UD females, respectively. The prediction equations for BL X BL, male UD X UD, female YK X YK and UD X UD (both male and female) had high R^2; corresponding to 0.997, 0.993, 0.737 and 0.675, respectively. Leg length (LL) of Balami lambs was the feature that explained almost all the variations of 90 days weight of the lambs.

Table 3: Prediction equations for 90-day body weight of sheep of Northern Nigeria

Class of lambs	Prediction equation	Partial contributions of predictors	R^2
Overall	Y = -9.373 + 0.291NL + 0.140HW + 0.102LG	NL (0.1276), HW (0.0356), LG (0.0141)	0.177
YK X YK	Y = -13.345 + 0.447BL + 0.183HW	BL (0.1207), HW (0.0308)	0.152
UD X UD	Y = -12.450 + 0.399HW	HW (0.6752)	0.675
BL X BL	Y = -4.985 + 0.290LG	LG (0.9971)	0.997
YK X YK (males)	Y = -9.275 + 0.379LG	LG (0.0953)	0.095
YK X YK (females)	Y = -15.774 + 0.240BL - 0.138HW + 0.129CG + 0.525LL	BL (0.6346), HW (0.0683), CG (0.0153), LL (0.0192)	0.737
UD X UD (male)	Y = -21.461 + 0.589LG	LG (0.9928)	0.993
UD X UD (female)	Y = -8.105 + 0.313HW	HW (0.5016)	0.502

Y = birth weight; BL = Back length; Chest Girth; HW = Height at wither; LG = Loin girth; LL = Leg Length; Neck Length. Group of lambs irrespective of sex. Values in parenthesis are the partial coefficient of determination (partial R^2) contribution of their respective preceding predictors.

c. 180-day weight

Table 4 shows the prediction equations for 180-day body weight of sheep of Northern Nigeria. Height at wither featured prominently in the equations for the overall population, YK X YK, male YK X YK and female UD X UD. However, leg length accounted for 76.14% of the variability of the 180-day weight of UD X UD (in both sexes). The R^2 of all the equations generated for prediction of 180-day weight in this study was high.

Table 4: Prediction equations for 180-day body weight of sheep of Northern Nigeria

Class of lambs	Prediction equation	Partial contributions of predictors	R^2
Overall	Y = -22.159 + 0.326HW + 0.151CG + 0.152NL + 0.078LG	HW (0.6815), CG (0.0441), NL (0.0145), LG (0.0061)	0.746
YK X YK	Y = -20.209 + 0.368HW + 0.204LG	HW (0.6402), LG (0.0675)	0.708
UD X UD	Y = -18.965 + 0.829LL	LL (0.7614)	0.761
YK X YK (males)	Y = -27.279 + 0.433HW + 0.300BL + 0.158LL	HW (0.7543), BL (0.0321), LL (0.0156)	0.802
YK X YK (females)	Y = -16.429 + 0.145CG + 0.154LG + 0.294NL	CG (0.6116), LG (0.0433), NL (0.0367)	0.692
UD X UD (female)	Y = -19.150 + 0.544HW	HW (0.8013)	0.801

Y = birth weight; BL = Back length; Chest Girth; HW = Height at wither; LG = Loin girth; LL = Leg Length; Neck Length. Group of lambs irrespective of sex. Values in parenthesis are the partial coefficient of determination (partial R^2) contribution of their respective preceding predictors.

d. 360-day weight

Table 5 shows prediction equations at the 360-day weight of sheep of Northern Nigeria. Back length accounted for most of the variability of the 360-day weight of female UD X UD (62.28%) and the overall population (55.39%). Height at wither accounted for most of the variability of the 360-day weight of male YK X YK (78.22%) and the entire YK X YK (71.50%). Chest girth was mostly responsible for the variability of the 360-day weight of female YK X YK (78.07%). All the prediction equations for 360-day (yearling) weight of sheep of Northern Nigeria had high R^2 values (0.766-0.954).

Table 5: Prediction equations for 360-Day body weight of sheep of Northern Nigeria

Class of lambs	Prediction equation	Partial contributions of predictors	R^2
Overall	Y = -27.571 + 0.362BL + 0.198HW + 0.348NL + 0.154CG	BL (0.5539), HW (0.1350), NL (0.0581), CG (0.0186)	0.766
YK X YK	Y = -27.282 + 0.275HW + 0.380NL + 0.263CG	HW (0.7150), NL (0.1111), CG (0.0472)	0.873
YK X YK (males)	Y = -25.969 + 0.437HW + 0.536NL	HW (0.7822), NL (0.1718)	0.954
YK X YK (females)	Y = -26.305 + 0.505CG + 0.197HW	CG (0.7807), HW (0.0446)	0.825
UD X UD (female)	Y = 27.301 + 1.219BL - 1.955NL	BL (0.6228), NL (0.3093)	0.932

Y = birth weight; BL = Back length; Chest Girth; HW = Height at wither; LG = Loin girth; LL = Leg Length; Neck Length. Group of lambs irrespective of sex. Values in parenthesis are the partial coefficient of determination (partial R^2) contribution of their respective preceding predictors.

Discussion

The accuracy of functions used to predict live weight or growth characteristics from a live animal using linear body measurements is of immense financial contribution to livestock production enterprises (Afolayan *et al*., 2006). Some of the circumstances that causes fluctuations in weight of sheep include management system, pregnancy, gut fill and lactation. The linear body measurements are mostly not affected by these circumstances and physiological states of the animal. Cam *et al*. (2010) reported that animals have a balanced relationship between body weights and linear body measurements. This reason had also been put forward to substantiate the usage of linear body measurements in generating prediction equations for estimating live body weight of sheep (Iyiola-Tunji, 2012).

The prediction equations for birth weight and subsequent body weights at 90, 180 and 360 days obtained for different groups of lambs in this study indicated that the first significant variables (obtained through multiple regression analysis using stepwise selection) explained higher proportions of body weight than the second or third variables as the case applied. The R^2 is a measure of goodness-of-fit of regression equation (Cornell and Berger, 1987). The low R^2 obtained for the prediction equations for most of the groups in relation to birth weight were low. This is an indication that the total variations of birth weight were lowly explained by the respective predictors. This pattern of results could be as a results of measurement errors. Birth weight is an important trait and is relate d to survival and growth performance. Some attendant errors in measuring birth weight of lambs could be as a result of inability to absolutely restrain the animals while conducting the weighing.

However, the R^2 for prediction equations at subsequent age (90, 180 and 360 days) of lambs in this study were mostly high, indicating the reliability of the generated prediction equations. The prediction equations generated in this study incorporating different predictors agree with Yakubu (2010) who stated that morphometric characters of sheep are genetically controlled and unique to each breed of sheep. Baffour-Awuah *et al*. (2000) had suggested that predictors that consider the volume of an animal in terms of circumference and body length tend to give a better accuracy of prediction of live weight of animals. Semakula *et al*. (2010) affirmed that linear body measurements together with live body weights were influenced significantly by breed, age and sex of the animal. The prediction equations for Balami, Uda and Yankasa sheep were generated with intense consideration of the foregoing facts (Baffour-Awuah *et al*., 2000; Afolayan *et al*., 2006; Semakula *et al*., 2010; and Akpa *et al*., 2010).

Height at wither featured prominently in the equations for the overall population, YK X YK, male YK X YK and female UD X UD. This is in agreement with Khan *et al*. (2006) who had reported a very high phenotypic correlation (0.746) between body weights of goats found in Peshawar, Pakistan and height at wither at age 4 to 12 months. Shirzeyli *et al*. (2013) stated that the most appropriate parameters to predict the body weight in the established regression equations were heart girth and body length. Tadesse *et al*., (2012) also explained that there was highest estimation precisions in goats when both chest girth (heart girth) and body length were considered in equations simultaneously. Thiruvenkadan (2005) obtained the greatest variation of body weight been accounted for by combination of height at withers, chest girth and body length than individually of all the age groups in both sexes. Shirzeyli *et al*. (2013) obtained the highest R^2 for four breeds of Iranian sheep when all the body measurements were included in the regression equations. They suggested that weight could be estimated more accurately by combination of two or more measurements than by girth or length. This observation was similar to the patterns obtained in this study. In all the prediction equations with more than one predictor, the addition of one or more

Conclusion and Recommendation

Height at wither, chest and loin girth featured more prominently in explaining the variations of body weight of lambs of Balami, Uda and Yankasa at birth, 90, 180 and 360 days. Weighing charts and bands should be produced on the basis of prediction equations that have high coefficients of determination (R^2).

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