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BODY MEASUREMENTS AS BASIS OF ESTIMATION OF LIVE WEIGHT IN GROWING SAHIWAL CATTLE

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ABSTRACT
The present research was undertaken with an aim to derive prediction equation based on body measurements in different age groups of growing Sahiwal calves. Sahiwal cattle's which are divided into five age groups (0-6, 6-12, 12-18, 18-24 and 24-30 months) and mean values of various body parameter are as follow Body length (BL), Heart Girth (HG), Height at withers (HT), Head to shoulder length (HAW) and Chest depth (CD) (54.22 ± 2.47, 123.53 ± 5.83, 141.44 ± 3.80, 156.89 ± 3.52 and 199.48 ± 7.39kg), (69.91 ± 1.01, 94.70 ± 1.22, 100.51 ± 1.36, 102.32 ± 0.85 and 107.33 ± 1.87cm), (85.14 ± 1.61, 109.34 ± 2.19, 122.20 ± 1.74, 125.41 ± 0.94 and 132.20 ± 1.38cm), (77.44 ± 1.02, 97.75 ± 1.21, 101.88 ± 1.31, 103.26 ± 0.62 and 108.18 ± 1.10cm), (34.74 ± 0.46, 43.86 ± 0.85, 47.88 ± 0.74, 48.13 ± 0.70 and 52.03 ± 0.75)(31.90 ± 0.68,41.11 ± 0.96, 45.96 ± 0.96, 46.21 ± 1.12 and 50.06 ± 0.6cm), respectively. Best fitted BW Prediction model developed on the basis of multiple linear regression of two independent variables (HG and BL), three independent variables (BL, HG and HAW) and four independent variables (BL, HG, WAH and HS) were significant ($P < 0.05$) with R^2 values of 0.86, 0.86, and 0.87 respectively.

INTRODUCTION

India is rich in livestock resource values. A cattle is one of most famous and popular livestock animal in India. In India most of the cattle found in zebu type. Zebu cattle are carring different high values economic traits. The Sahiwal cattle are the most popular milch breed in India. Sahiwal cattle are well reported for ticks resistant, temperature endurance and high milk production ability under adverse situation. For Indian Sahiwal breed, the availability of data is poor. In our country most of farmer suffers problem of unavailability of animal weighing machine so use of body measurements estimation of body weight with body measurements as an substituted to weighing is commonly accepted. (Ulutas *et al.*, 2002). A study of linear measurements is important because most dairy lack a weighing machine and adequate knowledge to understand its manipulation. Simple linear measuring devices will be easy to handle and will assist in selecting animals to become the parents of the next generations (Essien and Adesope, 2003). Animal weighing devices are costly to purchase, heavy to transport and technical maintenance is needed which is often beyond the resources of livestock farmers (Abdelhdi and Babiker, 2009). On morphometric traits can be used in assessing growth rate, body weights, and feed utilization and carcass characteristics in farm animals (Brown *et al.*, 1973). Body weights (BW) shows one of the most important productive traits in Sahiwal cattle. BW is also good reveal of animal condition (Van Marle-Koster *et al.*, 2000).Van Marle-Koestzer *et al*. (2000).Periodical body weight of growing cattle is helpful in taking management decisions. Hence, the present study was designed to establish the relationship between body weight and body measurements and to develop the prediction equation for predicting the body weight on the basis of combined variables on body measurements. The body measurements used as selection criteria for growth traits in cattle. The correlation between different body measurements and body weights depend on many factors such as breed, age, managemental practices and fattening level of the animal. It was suggested that the best technique of weighing animals in absence of a weighbridge is to regress body weight on some readily assessable body measurements (Nesamvuni *et al.*, 2000). The paper deals with prediction of body weight of Sahiwal Cattle.

MATERIALS AND METHODS

Data related to this research were collected from 194 purebred growing male and female Sahiwal calves raised at Bull Mother Experimental Farm (BMEF) of the College of Veterinary Science & Animal Husbandry, Anjora, Durg and Government Cattle Breeding Farm (CBF), Anjora, Durg, Chhattisgarh. Durg is situated at an elevation of 317 meters above mean sea level at Latitude & Longitudes between 20°23' and 22°02' N & 80°46' and 81°58 E. There are three distinct seasons in the year based

on rain fall and temperature: Winter (November - February), hot and dry summer, and Rainy season. The duration of present investigation was from January 2015 to April 2015. These animals were also classified based on their age (months) into five different groups as (1) 0-6 months, (2) 6-12 months, (3) 12-18 months, (4) 18-24 months and (5) 24-36 months. The animals were raised on an semi intensive farming system. Routine feeding practice on the farm was continued and animals had the free access to fresh drinking water. Body weight (BW) and five individual variables i.e, body length (BL), heart girth (HG), height at withers (HAW)), head to shoulder length (HS) and chest depth (CD) were recorded for all selected animals. Measurements of animals were taken either at early morning or evening hours. Body weight (kg) was recorded by using electronic plateform scale which ranges (0-1000 kg). For the measurments of other body parameters especially designed large caliper was used. The heart girth measurement was taken using a tailor¼s measuring tape. The heart girth (HG) of cattle was measured from circumference of the thoracic cavity immediately behind the fore limbs and parallel to the body axis with the help of flexible measuring tape as described by Khan *et al*. (2006). Body length was measured from point of the shoulder to the point of the tuber ischii or pin bone of animal. From point of poll to shoulder Head to Shoulder length (HS) was measured. Height at weither (HAW) of cattle was measured as vertical distance from the point of withers to the floor measured with a stick-rule as described by Katongole *et al*. (2013). Chest Depth (CD) was measured from sternum area immediately caudal to the fore limbs to top of thoracic vertebra area.

Statistical analysis

To see the effect of body weights and body measurements, two way analysis of variance was conducted as per the method described by Snedecor and Cochran, 1994. The stepwise regression method was used to determine the best fitted regression equation in all groups of growing Sahiwal animals. Coefficients of determination values (R^2) were used to compare the efficiency of the best fitted regression equations. The All measurements were subjected to the correlation and regression procedures of SPSS (2001) using the model:

$$Y = \hat{a}_0 + \hat{a}_1 X_1 + \hat{a}_2 X_2 + \hat{a}_3 X_3 + \hat{a}_4 X_4 + \hat{a}_5 X_5$$

Where

Y = Dependent variable i.e. Body weight (kg)sxw

X_1 = Body length (cm)

X_2 = Heart girth (cm)

X_3 = Height at wither (cm)

X_4 = Head to shoulder length (cm)

X_5 = Chest depth (cm)

$\hat{a}_0$ = Intercept

$\hat{a}_1$, $\hat{a}_2$, $\hat{a}_3$, $\hat{a}_4$ and $\hat{a}_5$ are the partial regression coefficients of the independent variable X_1, X_2, X_3, X_4 and X_5 respectively.

RESULTS AND DISCUSSION

Descriptive statistics of body weight and body traits are shown in Table 1. In the present research, means for body measurements and body weights are shown Table 1 . The weights of animals were found range from 54.22kg to 199.48 kg. Result show that there is gradual increase in body weight and body measurements as animals are older in Sahiwal calves. In present research the growth in the body weight and body size along with age all the parameters were found increased. Parveen *et al*. (2009) had also reported the increase in body dimension of Sahiwal cattle. Stephens *et al*. (2007) have reported similar finding in crossbred cattle. Sushma *et al*. 2005 and Patel *et al*. (1990) has reported similar result in Ongole and Kankrej cattle, respectively.

Multiple linear regression of body weight on two independent variables

Multiple linear regression analysis based on two linear body parameters was used to design a body weight prediction model. In persent study reveals that was highly significant for the prediction of live weight. Based on multiple regression model, live weight changes with linear body measurements of heart girth and body length were predictable with R^2 values ranging out 0.82 to 0.88. The R^2 values showed that 82 to 88 percent of every one kilogram change in live weight was caused by combination of variables of heart girth and body length. According to this result, the body weight estimation of Sahiwal cattle using chest girth and body length as independent variables in multiple regression produced higher accuracies. Combination of two variables (BL and HG) was found to be best fitted for prediction of body weight for almost all age groups. Our result is more or less similar to Siddiqui *et al*., 2015, Sahu S. S. *et al*. (2016) and Milla et al. (2012), who found body BL and HG as more suitable parameters for body weight prediction with highest value of R^2.

Multiple linear regression of body weight on three independent variables

Most suited regression equation on the basis of three body parameters was performed in prediction equation table. Combination of BL, HG and HAW were found best fitted regression equation for all age groups with highest determination of coefficients (R^2) value. Findings of present study were supported by Siddiqui *et al*., 2015 and Sahu S. S.

Table 1: Means ± SE of physical variables in growing Sahiwal calves according to body weights groups

Variables	0-6 months	6-12 months	12-18 months	18-24 month	24-36 months
BW (kg)	54.22 ± 2.47	123.53 ± 5.83	141.44 ± 3.80	156.89 ± 3.52	199.48 ± 7.39
BL (cm)	69.91 ± 1.01	94.70 ± 1.22	100.51 ± 1.36	102.32 ± 0.85	107.33 ± 1.87
HG (cm)	85.14 ± 1.61	109.34 ± 2.19	122.20 ± 1.74	125.41 ± 0.94	132.20 ± 1.38
HAW (cm)	77.44 ± 1.02	97.75 ± 1.21	101.88 ± 1.31	103.26 ± 0.62	108.18 ± 1.10
HS (cm)	34.74 ± 0.46	43.86 ± 0.85	47.88 ± 0.74	48.13 ± 0.70	52.03 ± 0.75
CD (cm)	31.90 ± 0.68	41.11 ± 0.96	45.96 ± 0.96	46.21 ± 1.12	50.06 ± 0.69

Table 2: Regression equations and coefficient of determination for body weight prediction of Sahiwal calves of 0-36 months of age using linear body measurements

Age groups	Regression Equation	R^2
0-6 months	Y = -93.74 + 1.51BL + 0.49HG	0.82
	Y = -103.19 + 0.47BL + 0.47HG + 0.43HAW	0.84
	Y = -118.65 + 1.05BL + 0.32HG + 0.37HAW + 1.25HS	0.86
6-12 months	Y = -59.25 + -0.77BL + 2.34HG	0.88
	Y = -85.96 + -0.81BL + 2.19HG + 0.48HAW	0.89
	Y = -84.43 + -0.88BL + 2.10HG + 0.32HAW + 0.70HS	0.90
12-18 months	Y = -108.79 + 1.63HG + 0.49HAW	0.74
	Y = -114.02 + -0.23BL + 1.58HG + 0.37HAW	0.75
	Y = -114.03 + 0.23BL + 1.58HG + 0.37HAW + 0.00HS	0.75
18-24 months	Y = -236.32 + 2.67HG + 1.19HS	0.77
	Y = -309.94 + 0.62BL + 2.25HG + 1.20HAW	0.77
	Y = -267.14 + 0.72BL + 1.63HG + 0.63HAW + 1.74CD	0.82
24-36 months	Y = -460.39 + 1.38BL + 3.86HG	0.86
	Y = -450.01 + 1.49BL + 3.99HG + -0.35HAW	0.86
	Y = -431.47 + 1.65BL + 3.65HG + -1.05HAW + 1.63HS	0.87

et al. (2016) as they also reported that body length, heart girth and height at weither were more suitable parameters for estimation of body weight. In our study it was observed that below 12 months of age, R^2 value was around 60%. however accuracy of R^2 was increased over 8 years of age. Studies further indicated that generally body weights of more digits were predicted accurately as R^2 of models increased. Further in our study in Sahiwal cattle with augment in age, the precision of prediction of body weight increased which may be due to fact that growth is normal process by which animal body increased in external size in all directions at uniform rate. These finding were not supported by Paul *et al*. (2012), who found body length (BL), height at hip bone (HH) and abdominal girth (AG) as more suitable parameters in Nili-Ravi buffalo calves for body weight prediction with highest value of R^2.

Multiple linear regression of body weight on four independent variables

Prediction equation based on including all four body measurement parameters viz; BL, HG, WAH and HS was found to be a best for prediction of body weight for different age groups estimation with R^2 value of 0.86, 0.90, 0.75 and 0.82. Wilson *et al*. (1997) who performed the multiple linear regression and described that body length, heart girth, wither height is best for prediction of live body weight.

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