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RESEARCH ARTICLE

Estimation of Live Weight Using Different Body Measurements in Sahiwal Cattle

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ABSTRACT

The aim of the study was to predict the body weight using body measurements and to derive prediction equations for estimation of live weight by using the body measurements in Sahiwal cattle. Study was conducted at LES, Bahadurnagar, Okara, Pakistan. Three hundred and fifty animals of different ages were randomly selected. All the animals were weighed on a mechanical scale and their body measurements including body length (BL), heart girth (HG) and height at withers (WH) were recorded. Body condition scoring (BCS) was performed using 1 – 5 point scale with 0.25 intervals. The recorded data was analyzed to simple and multiple linear regression analysis. Highly significant positive correlation ($P<0.001$) of body weight was found with heart girth with correlation coefficient (r) was 0.983. Simple linear regression between BW and HG and multiple linear regression of BW on two independent variables (HG and BCS), three independent variables (BL, HG and BCS) and four independent variables (BL, HG, WH and BCS) were significant ($P<0.05$) with R^2 values of 0.967, 0.973, 0.973 and 0.974, respectively. Results indicated that farmers who lack measuring scales to regularly evaluate BW of their animals can use simple body measurements in order to monitor growth, determine feed requirements, to assess breeding age, to estimate marketing weight and cash value of their animals.

INTRODUCTION

Sahiwal cattle make a valuable contribution in economic sector of Pakistan. They are considered as a secure source of income, especially, for the poor in rural areas and landless farmers. These cattle serve as important source of protein (meat and milk) (Afzal and Naqvi, 2004). Cattle is considered as a prime source of income for millions of livestock holders. In our country all the indigenous cattle belong to zebu (humped type) cattle (*Bos indicus*). Fifteen breeds of cattle have been recognized in country constituting 43% of the total cattle population, out of which Sahiwal and Red Sindhi are well known internationally as dairy cattle breeds (Khan et al., 2008).

Sahiwal cattle are well reputed for ticks resistant, heat tolerant and high production ability under harsh environment. Most of the population is found mainly in Jhang, Muzaffargarh, Okara, Faisalabad, Sahiwal and Khanewal districts of Punjab. Average weight of adult male and female is 544 and 408 kg, respectively. Average age at maturity is 28 months, lactation length 283 days, lactation milk yield 1550 liters, service period 155 days, dry period 205 days, calving interval 440 days and gestation period 285 days (Afzal and Naqvi, 2004; Khan et al., 2008).

Estimation of live weight in cattle is an important issue mainly for the following reason. Though, weighing animals is too difficult to organize or not feasible in many cases (Coopman et al., 2009). Estimation of animal's live weight is essential to compute feeding requirement, breeding age, weight gain, marketing weight and cash value (Tariq et al., 2013). Animal weighing devices are costly to attain, heavy to transport and technical maintenance is needed which is often beyond the resources of livestock farmers (Abdelhadi

and Babiker, 2009). 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).

In addition to weight measurement, body measurements describe more wholly an individual or population as compared to the traditional methods of weighing and grading. For certain objectives body measurements of cattle are very useful such as prediction of carcass yield, growth rate, body conformation and condition (Nesamvuni et al., 2000).

This Study was planned to find the relationship of heart girth, body length, height at withers and body condition scores with the live weight and to develop prediction equations for live weight estimation in Sahiwal cattle using morphometric measurements.

MATERIALS AND METHODS

Three hundred and fifty Sahiwal cattle were selected randomly, maintained at Livestock Experimental Station, Bahadurnagar, Okara. These animals were kept under loose housing system. Routine feeding practice on the farm was continued and animals had the free access to fresh drinking water.

Morphometric measurements and body condition scoring

Three morphometric measurements (body length (BL), heart girth (HG) and height at withers (HW)), body weight and body condition scoring (BCS) were recorded for 350 selected Sahwial cattle. Body weight of animals was recorded early in the morning after overnight fasting on a mechanical scale (0- 1000 kg). Afterwards, morphometric measurements were taken in centimeters.

Average body length was recorded from the point of shoulder to the point of pin bone on each side, measured with a measuring tape. Heart girth was taken through a measuring tape drawn from a point slightly behind the shoulder blade, down the fore-ribs and under the body behind the elbow, all the way around as suggested by Pater (2007). Height at withers was measured when the animal standing on a level platform as distance from the surface of the soil/platform to the dorsal point of the withers, measured with a stick-rule accordingly as described by Katongole et al. (2013). Average of three consecutive readings was taken for more accuracy. Body condition scoring was performed (1-5 point scale with 0.25 point intervals) where 1 was severely under-conditioning or emaciated and 5 for severely over-conditioning (Edmonson et al., 1989).

Statistical analysis

The recorded data was subjected to statistical analysis to find the correlation coefficients and regression analysis as suggested by Steel et al. (1996). Taking the body weight as dependent variable and body length, heart girth, height at withers and body condition scores as independent variables correlation coefficients were determined and then simple and multiple linear regression analysis was performed for the pooled data using the Statistical Package for Social Sciences version 17.0 (SPSS Inc. 2007).

RESULTS AND DISCUSSION

Correlation of body weight with Morphometric measurements and body condition scoring

Correlation of body weight was determined with other variables including body length, heart girth, withers height and body condition scoring. Significantly resilient correlation of body weight was found with body length, heart girth and withers height however, important moderate correlation was found with body condition scoring. Values for correlation coefficients (r) and level of significance (P values) are given in table 1.

The body weight was highly correlated with heart girth in cattle as reported by Abdelhadi and Babiker (2009), Bagui and Valdez (2007) and Nesamvuni et al. (2000). Similarly results coincide regarding body weight (Tariq et al., 2013), however, differed in case of body condition scoring. Body condition scoring (BCS) exhibited the moderate positive significant correlation coefficient that was lower than that of other body measurement parameters. It may be due to higher variations in values of BCS at different ages and physiological status of animals.

Simple linear regression

Simple linear regression model was used to construct a prediction equation based on a single body measurement. Values of R^2 for BL, HG, WH and BCS were 0.938, 0.967. 0.923 and 0.365, respectively. Heart girth (HG) was found the best known body weight predictor with highest value of R^2 in this group and Body condition scoring (BCS) was lower (Table 2).

Findings of this study were supported by Kashoma et al. (2011) and Katongole et al. (2013). They described that R^2 value of heart girth were significantly higher and most suitable predictor for body weight estimation. The findings of present study revealed that single equation based on heart girth can be used to estimate body weight in whole population of cattle (Goe et al., 2001).

Table 1: Correlation of body weight with body length, heart girth, withers height and body condition

Variables	Correlation coefficient (r)	P value
BL	0.968**	0.000
HG	0.983**	0.000
WH	0.961**	0.000
BCS	0.604**	0.000

** = significant P<0.001, BL= Body length, HG= Heart girth, WH= Wither height, BCS= Body condition scoring.

Table 2: Simple linear regression of body weight (BW) on independent variables

Parameter	Regression Model	α Value	β Value	R^2
BL	BW= α + β (BL)	-289.513*±6.030	5.081*±0.070	0.938
HG	BW= α + β (HG)	-246.360*±3.920	3.457*±0.034	0.967
WH	BW= α + β (WH)	-440.526*±9.033	6.020*±0.093	0.923
BCS	BW= α + β (BCS)	-414.011*±38.972	192.663*±13.531	0.365

* = significant (P<0.05) BL= Body length, HG= Heart girth, WH= Wither height, BCS= Body condition scoring

Table 3: Multiple linear regression of body weight (BW) on two independent variables

Parameter	Regression Model	α Value	β_1 Value	β_2 Value	R^2
BL and HG	BW= α + β_1 (BL) + β_2 (HG)	-255.681*±4.706	0.825*±0.238	2.916*±0.160	0.968
BL and WH	BW= α + β_1 (BL) + β_2 (WH)	-346.460*±11.450	3.382*±0.302	2.080*±0.361	0.943
BL and BCS	BW= α + β_1 (BL) + β_2 (BCS)	-275.473*±12.428	5.155*±0.090	-7.093±5.492	0.938
HG and WH	BW= α + β_1 (HG) + β_2 (WH)	-235.740*±11.129	3.623*±0.167	-0.303±0.297	0.967
HG and BCS	BW= α + β_1 (HG) + β_2 (BCS)	-179.944*±8.515	3.698*±0.042	-32.572*±3.791	0.973
WH and BCS	BW= α + β_1 (WH) + β_2 (BCS)	-423.851*±13.547	6.150*±0.121	-10.179±6.175	0.923

* = significant P<0.05, BL= Body length, HG= Heart girth, WH= Wither height, BCS= Body condition scoring

Table 4: Multiple linear regression of body weight (BW) on three independent variables

Parameter	Regression Model	α Value	β_1 Value	β_2 Value	β_3 Value	R^2
BL, HG and WH	BW= α + β_1 (BL) + β_2 (HG) + β_3 (WH)	-227.808*±11.008	1.135*±0.261	3.205*±0.189	-0.896*±0.320	0.969
BL, HG and BCS	BW= α + β_1 (BL) + β_2 (HG) + β_3 (BCS)	-189.341*±9.106	0.603*±0.220	3.293*±0.153	-31.305*±3.785	0.973
HG, WH and BCS	BW= α + β_1 (HG) + β_2 (WH) + β_3 (BCS)	-163.536*±13.081	3.946*±0.156	-0.446±0.271	-32.952*±3.789	0.973
BL, WH and BCS	BW= α + β_1 (BL) + β_2 (WH) + β_3 (BCS)	-326.068*±14.474	3.404*±0.301	2.208*±0.363	-12.078*±5.295	0.944

* = significant P<0.05, BL= Body length, HG= Heart girth, WH= Wither height, BCS= Body condition scoring

Table 5: Multiple linear regression of body weight (BW) on four independent variables

Parameter	Regression Model	α Value	β_1 Value	β_2 Value	β_3 Value	β_4 Value	R^2
BL, HG, WH and BCS	BW= α + β_1 (BL) + β_2 (HG) + β_3 (WH) + β_4 (BCS)	-160.455*± 12.857	0.920*± 0.239	3.592*± 0.179	-0.920*± 0.293	-31.423*± 3.738	0.974

* = significant P<0.05, BL= Body length, HG= Heart girth, WH= Wither height, BCS= Body condition scoring

Multiple linear regression of body weight on two independent variables

Multiple linear regression analysis based on two body measurement parameters was performed to design a body weight prediction model. Combination of HG and BCS was found best suited model with highest R^2 value of 0.973 followed by combinations of BL and HG; and HG and WH with R^2 values of 0.968 and 0.967, respectively, for body weight prediction (Table 3).

Results of this study were in agreement with Enevoldsen and Kristensen, (1997) who reported that BCS with other body measurements provided the highest coefficient of determination (R^2). Results of research findings by Nesamvuni et al. (2000) also coincide with present study. It was reported that wither height and heart girth were more appropriate predictor for body weight in Nguni type cattle. These findings were not supported by Milla et al. (2012), who found body length and heart girth as more suitable parameters in Nilotic cattle for body weight prediction with highest value of R^2.

Multiple linear regression of body weight on three independent variables

Data was subjected to multiple linear regression analysis to design a body weight prediction model based on three body measurement parameters. Combination of BL, HG and BCS as well as HG, WH and BCS were found best suited model with highest R^2 value of 0.973 followed by combinations of BL, HG and WH with R^2 values of 0.969 for body weight prediction in this group (Table 4).

Findings of present study were supported by Katongole et al. (2013). In this study HG, WH and BCS were reported as variables with highest value of R^2 for prediction of body weight. Research findings of Yan et al. (2009) were also in accordance with present study who found that HG, BL and BCS were more appropriate parameters for prediction of body weight.

Multiple linear regression of body weight on four independent variables

Multiple linear regression analysis based on four body measurement parameters was performed to design a body weight prediction model. Regression model including all four body measurement parameters viz. BL, HG, WH and BCS was found to be a good prediction model for body weight estimation in this group of study with R^2 value of 0.974 (Table 5).

Findings of the research were deemed reliable to predict the body weight using BL, HG, WH and BCS. Research findings of Wilson et al. (1997) supported the present study who performed the multiple linear regression and described that body length, heart girth, wither height

and hip width were more suitable parameters for prediction of body weight.

Conclusion

In situation when weighing animals is not feasible or difficult to organize due to unavailability of weighing scale, it is recommended to predict the live weight using regression analysis with single or multiple independent variables that combines heart girth, body length, withers height and body condition scoring. Heart girth as sole body measurement while heart girth, body length, withers height and body condition scoring in combination could be used for prediction of body weight using simple and multiple linear regression equations in Sahiwal cattle.

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