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PREDICTION OF BODY WEIGHT FROM BODY MEASUREMENTS USING REGRESSION TREE (RT) METHOD FOR INDIGENOUS SHEEP BREEDS IN BALOCHISTAN, PAKISTAN

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ABSTRACT

The aim of this study is to estimate body weight from withers height, body length, and chest girth measurements by using Regression Tree (RT) Method. For this purpose, data were collected from 239 male sheep at yearling age (11-13 months) of five indigenous sheep breeds (Mengali (48), Balochi (48), Harnai (48), Beverigh (47) and Rakhshani (48)) reared in Balochistan, Pakistan. Bivariate relationships among body weight, withers height, body length, and chest girth measurements were calculated by using Pearson correlation coefficients. For RT method, body weight was used as a dependent variable, whereas withers height, body length, and chest girth measurements and breed were considered as independent variables. A highly significant correlation coefficient was detected between body weight and chest girth ($r=0.742$; $P<0.01$). Statistically significant correlation coefficients of body weight with withers height and body length were 0.419 ($P<0.01$) and 0.457 ($P<0.01$) respectively. In the current study, Regression Tree method illustrated that 72 % of variation in the body weight was explained by statistically significant variables; namely, withers height, body length, chest girth, and breed. Regression Tree method reflected the sheep with chest girth greater than 89 cm within all the sheep could produce the heaviest average body weight with 36.486 kg, and average body weight could increase with increasing chest girth, which was found considerably significant compared to others. Results on chest girth also supported previous reports in literature. It was concluded in the current study that Regression Tree Method could be efficient to predict body weight from withers height ($P<0.001$), body length ($P<0.001$), chest girth ($P<0.001$), and breed ($P<0.001$) at yearling sheep.

Key words: Body weight, Body measurement, Regression Tree Method, yearling sheep.

INTRODUCTION

Sheep meat production is indispensable to meet protein needs of people throughout the world. Most scientific studies in relation to growth, one of the critical characteristics in sheep production, have been conducted to increase meat production per sheep. Information on body weight with several body measurements is necessary not only to monitor the growth of the sheep but also to estimate genetic correlations between body weight and body measurements. Besides, genetic and non-genetic components for the growth parameters must be estimated for improving better selection strategies relating to growth and development of sheep**.** Body weight is measured not only to evaluate carcass yield (Afolayan *et al.,* 2006) and condition of the animal as a selection criterion but also to determine suitable medication dosage during health care and required feed amount of the animal (Kunene *et al.,* 2009).

Body measurements, an indicator of breed standards (Pesmen and Yardimci, 2008), provides great convenience for the prediction of body weight without weighbridges (Afolayan *et al.,* 2006; Adeyinka, and Mohammed, 2006; Yakubu, 2009). In recent years, there have been a great number of studies on the prediction of body weight from various body measurements taken at different growth periods of sheep (Afolayan *et al.,* 2006; Kunene *et al.,* 2009; Cam *et al.,* 2010a) and goat (Gül *et al.,* 2005; Khan *et al.,* 2006; Moaeen-ud-Din *et al.,* 2006; Rahman, 2007; Cam *et al.,*2010b). In these studies, Generally, Pearson correlation and regression coefficients have been used to determine the bivariate relationships between body weight and various body measurements. For analyzing multiple relationships among all traits, use of Multiple Regression Analysis (MRA) is the simple way to predict body weight using these body measurements. However, MRA produces biased estimates under some, especially multicollinearity problem etc. (Keskin *et al.,* 2007a, Keskin *et al.,* 2007b; Eyduran *et al.,* 2009; Eyduran *et al.,* 2010). However, use of Regression Tree method which is more advantageous compared to classic methods is scanty in animal science (Eyduran *et al.,* 2008; Mendes and Akkartal, 2009; Topal *et al.,* 2010). To date, it was therefore no available publication on using Regression Tree (RT) Method for body weight estimation from a variety of body measurements in sheep.

The aim of the present paper was to estimate body weight from body length, withers height and chest girth traits of five indigenous sheep breeds using Regression Tree (RT) method.

MATERIALS AND METHODS

The current study was carried out at Experimental Station at Centre for Advanced Studies in Vaccinology & Biotechnology (CASVAB), University of Balochistan, Quetta during August to December 2008. A total of 239 male sheep at approximately yearling age (11-13 months) of five indigenous sheep breeds (Mengali (48), Balochi (48), Harnai (48), Beverigh (47) and Rakhshani (48)) reared in Balochistan were provided. Animals were ear tagged and managed under identical conditions. A semi control feeding regime was applied i.e. wheat straw *ad libitum*, Green (Barseem) 3kg/day/head and commercial concentrate ration was offered @ 0.2, 0.3, 0.35, 0.4 and 0.5kg/day/head respectively. Animals were weighed/ measured at the start of trial and thereafter on monthly basis before morning feeding. In the current study, measurements such as live body weight, body length, withers height and chest girths (cm) were taken from all the sheep.

The animals were weighed by sheep weighing balance (±500 gms). The body measurements were taken through the sheep measuring scale (tape) (±1cm).

Statistical Analysis: Variable structure: Body weight, chest girth, body length, and withers height are continuous variables. Breed is a categorical (discrete) variable.

Pearson Correlation: Pearson correlation coefficient was used to determine degree of the linear relationship between two continuous variables.

Regression Tree Method: Regression Tree Method, a tree based model, determines the most appropriate cut-off values for independent variables significantly influencing target or dependent variable. The aim of Regression tree method is to form prediction rules in relation to a dependent variable on the basis of the values of independent variables (Hébert *et al.,* 2006). In the regression tree method, first node is called "root node", and homogenous subgroups, obtained by reducing variation in dependent variable based on independent variables, are called "terminal nodes" (Çamdeviren *et al.,* 2007). Regression tree method transforms continuous variables into categorical variables using appropriate cut-off values (Çamdeviren *et al.,* 2005).

In the current study, the influences of independent variables (withers height, body length, chest girth, and breed) on dependent variable (yearling body weight) were evaluated by using Regression tree method. For Regression Tree Method, F test was used as the significance test for a continuous dependent variable as in the current study (Hébert *et al.,* 2006).

In Regression tree method, the unexplained variation on body weight can be calculated with the equation: S_e^2 = Risk value / S_y^2. The explained variation on the weight is found as: the equation: S_x^2:1- S_e^2 as reported by Mendeş and Akkartal, (2009), All statistical analyses were performed through SPSS and MINITAB statistical package programs.

RESULTS AND DISCUSSION

Optimal regression tree which was drawn to monitor interactions among the examined variables is depicted in Figure 1. The independent variables such chest girth, withers height, body length and breed significantly influenced yearling body weight (P<0.001). As seen from Figure 1, the most effective variable on yearling body weight was determined to be chest girth variable (F=88.073; df=3, 235; P<0.001). In regression tree method, proportion of the unexplained variation (28%) was found as defined by Mendes and Akkartal (2009) with the following equation: S_e^2 = Risk value / S_y^2 where risk value was 4.5 and S_y^2 was variance of root node (4.008^2). However, proportion of the explained variation ($1\text{-}S_e^2$) for yearling body weight was 72%, which was explained by chest girth, withers height, body length and breed variables. This means that Regression Tree method could be sufficient to account for variation in the weight. Withers height had a significant effect on body weight of the yearling sheep with chest girth less than 71 cm (F=43.372; df=1, 65; P<0.001). Body length variable alone had a statistically significant influence on body weight of the yearling sheep with chest girth ranging from 71 to 81 cm (F=22.127; df= 2, 96; P<0.001). Statistically significant effect of only breed on body weight of the yearling sheep with chest girth ranging between 81 to 89 cm was detected (F=50.762; df=1, 36; P<0.001). Conversely, no significant variable on yearling body weight of the sheep with chest girth > 89 was observed.

Firstly, Node 0, root node of regression tree, was divided into four child nodes (Node 1, Node 2, Node 3, and Node 4) in terms of chest girth variable. Average body weight (S=standard deviation) of all sheep in Node 0 was 31.038 (4.008) kg. Numbers (%) of yearling body weight in Node 1 (a group of yearling sheep with chest girth ≤ 71 cm), Node 2 (a group of yearling sheep ranging in chest girth between 71 and 81 cm), Node 3 (a group of yearling sheep ranging in chest girth from 81 and 89 cm) and Node 4 (a group of yearling sheep with chest girth > 89) were 67 (28.0%), 99 (41.4%), 38 (15.9%), and 35(14.6%), respectively. Body weight averages (S) of the sheep in Node 1, Node 2, Node 3, and

Node 4 were 27.627 (S=2.405), 30.576 (S=2.829), 33.237(S=3.859), and 36.486 (S=1.560) kg, respectively. Among Nodes 1, 2, 3 and 4, only Node 4, a group of the sheep with chest girth greater than 89 cm, was the heaviest average body weight with 36.486 (S=1.560) kg, and heavier than the averages of Node 1, Node 2, and Node 3. These results illustrated that body weight of yearling sheep increased with increasing chest girth from ≤ 71 to >89 cm.

Secondly, Node 1, Node 2, Node 3 except for Node 4 was again divided into new child nodes. Node 1 was divided into new two child nodes (Node 5 and Node 6) depending on withers height variable. Numbers (%) of yearling sheep in Node 5 (a group of yearling sheep with withers height ≤ 58 cm and chest girth ≤ 71 cm) and Node 6 (a group of yearling sheep with withers height > 58 and chest girth ≤ 71) were 26 (10.9%) and 41 (17.2%). The body weight averages (S) for Node 5 and Node 6 were estimated as: 25.731 (S=2.127) and 28.829 (S=1.702) kg, respectively. This result revealed that average body weight of yearling sheep in Node 5 was lighter than the average in Node 6.

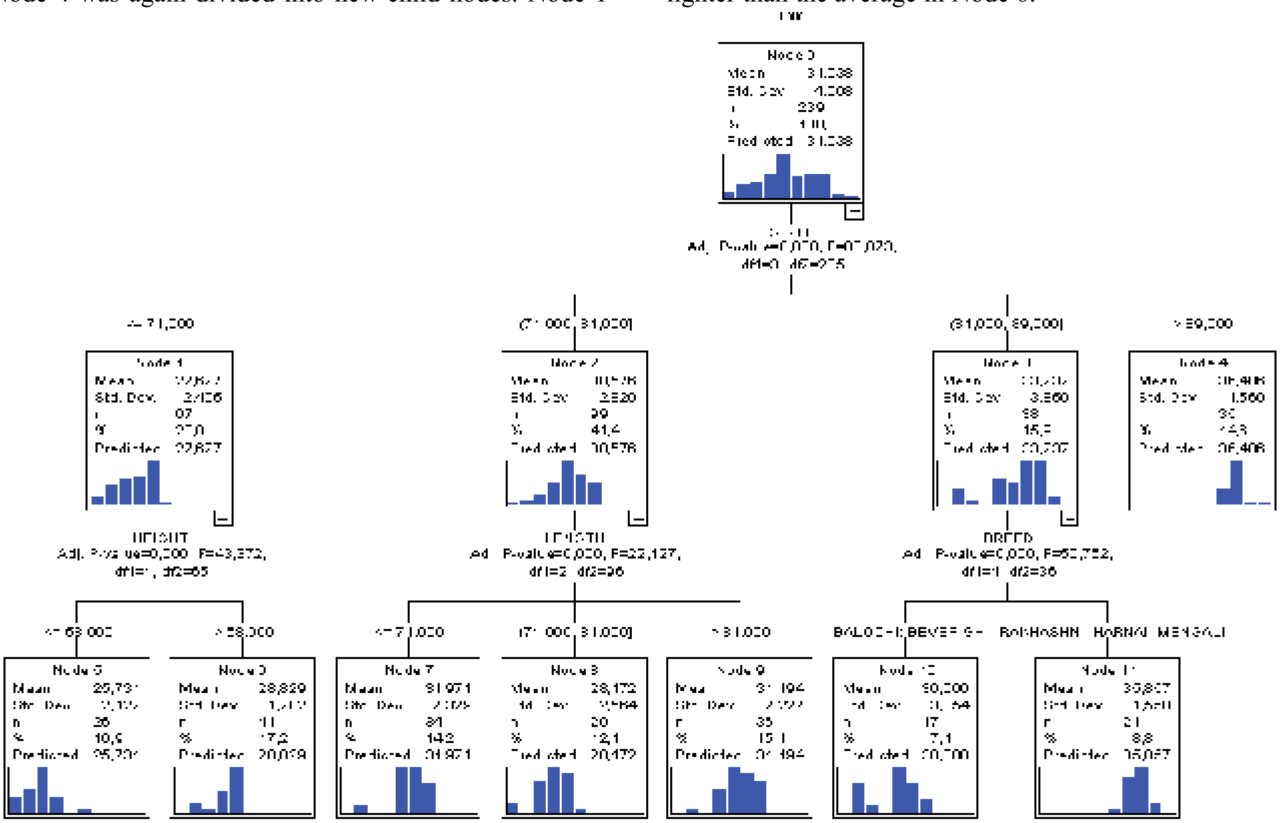

Figure 1: Regression Tree showing interactions among the examined variables

In the yearling 71 cm, average body weight of the yearling sheep with withers height greater than 58 cm was detected to heavier than the average of yearling sheep with withers height lower than 58 cm. Regression tree reflected that, average body weight increased from 25.731 to 28.829 kg when withers height was greater than 58 cm in the yearling sheep with chest girth less than 71 cm.

Thirdly, Node 2, a group of the yearling sheep with chest girth varying between 71 and 81 cm, was again divided into three new child nodes (Node 7, Node 8, and Node 9) based body length. Numbers (%) of the yearling sheep in Node 7 (a group of the sheep with body length ≤ 71 cm among the sheep with chest girth varying between 71 and 81 cm) , Node 8 (a group of the sheep with values ranging in both chest girth and body length between 71 and 81 cm), and Node 9 (a group of the sheep with body length > 81 cm among the sheep with chest girth between 71 and 81 cm) were 34(14.2%), 29(12.1%), 36(15.1%) respectively. Body weight averages (S) for corresponding nodes were found 31.971(S=2.329), 28.172(S=2.564), and 31.194 (S=2.227) kg, respectively.

Fourthly, Node 3 was divided into two child nodes, Node 10 and Node 11, with respect to breed. Numbers (%) of the sheep for Node 10 and Node 11 were 17(7.1%) and 21(8.8%), respectively. Body weight averages (S) for Node 10 and Node 11 were calculated as: 30.00(S=3.354) and 35.857(S=1.558) kg, respectively. Average body weight of Node 11, a group of Rakhshani, Harnai and Mengali sheep with chest girth ranging between 81 and 89 cm, was heavier than the average of

Node 10, a group of Balochi and Beverigh sheep with chest girth varying between 81 and 89 cm.

In Regression Tree method, chest girth was found to be the best predictor for explaining variation in the body weight at yearling age. This result was in agreement with those reported by several authors (Sarti *et al.,* 2003; Afolayan *et al.,* 2006; Olatunji-Akioye and Adeyemo, 2009).

There were statistically significant correlation coefficients between these traits. Body weight was strongly correlated with chest girth (r=0.744; P<0.01), and body weight increases with an increase in chest girth trait. Additionally, significant-positive correlation coefficients of body weight with withers height and body length were found as 0.419 (P<0.01) and 0.457 (P<0.01) respectively. A high correlation of 0.744 between body weight and chest girth was lower than the estimates reported by Sowande and Sobola (2008) (0.940) for West African dwarf sheep, Afolayan *et al.,* (2006) (0.94) for Yankasa sheep, and Topal and Macit, (2004) for Morkaraman sheep. The body weight showed very high positive correlation coefficients with withers height (0.808) and body length (0.784), respectively (Cam *et al.,* 2010b).

The differences in previous studies with the present study might be due to variation in ages and breeds of the studied animals, and managerial conditions in all studies. Comments of results obtained from the present study might be also different from the comments of earlier studies. That's why; regression tree method was firstly applied in the only the present study contrary to statistical methods of previous works for predicting body weight with variety body measurements. In other words, in recent years, many previous authors have used different statistical methods such as Pearson correlation, simple regression, multiple regression, non-linear regression, principle component regression, and factor scores in multiple regression analysis etc. As a result, Regression tree method provides substantial information for body weight estimation from linear body measurements

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