PREDICTION OF LIVEWEIGHT OF HOLSTEIN AND BROWN SWISS CATTLE GROWN IN AN 12 MONTH INTENSIVE BEEF PRODUCTION SYSTEM BY USING REAL-TIME BODY MEASUREMENTS

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Abstract

In this study, it was aimed to evaluate the use of some morphometric body measurements to predict liveweight of Holstein and Brown Swiss cattle grown in a 12-month Intensive beef production system. Associations between liveweight (LW) and some body measurements such as heart girth (HG), wither height (WH), body length (BL), body depth (BD), hip width (HW), hip height (HH) and pin bone length (PL) were examined for prediction ability, using the data with 1068 observations for each traits.

The linear, quadratic and cubic regression models were performed to predict LW for both breeds and since there were no statistically significant differences in body measurements between breeds. The data of these breeds were combined and found that BL and HG would be the best possible traits in predicting LW (R^2=95.8% and 95.7% respectively) among the other measurements. All type of regressions showed that addition of quadratic and cubic terms contributed little benefit in predicting LW. Therefore, all linear terms of all body measurements were considered for analysis and they were significant and R^2 values for other body measurements WH, HW, BD, HH and PL were approximately 93.2, 79.9, 87.1, 90.9 and 79.2% respectively.

It can be concluded that in management situations where LW cannot be measured it can be predicted accurately by measuring BL and HG alone or both HG and even WH and different models may be needed to predict LW in different feeding and environmental conditions and breeds.

Key words: Prediction, Liveweight, Body measurements, Brown Swiss and Holstein cattle, Feedlot

INTRODUCTION

Especially in developing countries, small scale farming is characterised by poor resources and investments. The decisions on agricultural activities are primarily depended on trials and errors at small farming level.

Body measurements of beef cattle are used for several purposes, especially since ration preparations are based on animal's live weight and very important for prediction of body weight, including growth rate, body condition and conformation [10], [3].

Generally, marketing of animals between farmers is based on visual assessment in especially developing countries. Most of the veterinary medicines are prescribed on the basis of live weight criteria. However, prescriptions and dose of drug estimation is mostly performed by approximate estimations. The use of live weight criteria in ration formulation, drug estimation, body condition score and marketing requires sophisticated facilities which are expensive and hardly affordable to many small-scale farmers.

As long as scientists appreciate the importance of accurate prediction of animal's liveweight, on managerial decisions a simple and reasonable technique should be considered. Several studies have indicated that there is a relationship between some body measurements and body weight [7], [6]. It is also important to know the liveweight of a cattle for a number of reasons, related to breeding especially for selection, feeding and health care (treatment doses of antibiotics, anthelmintics and so forth).

The results of the most studies have recognised that the accuracy of estimating

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body weight from heart girth or other body traits may be affected by breed, type, age, size and condition of the animal [4] and also by different environmental conditions [2].

Therefore, the objective of this study was to gain further information about the relationship between body weight and some body measurements of different breeds such as Brown Swiss and Holstein cattle such as heart girth, body length, wither height, hip width chest depth, pin bone length and hip height and also to determine the value of using more than one body measurement as a single variable entry to the model to predict body weight and to validate the potential of this method as a means of predicting body weight under small scale farming conditions.

MATERIALS AND METHODS

Animals

The animals used in this study were comprised of 40 Brown Swiss and Holstein cattle in total, divided into two groups on the basis of weight. The average weight was 132 and 158 kg for Brown Swiss and Holstein groups respectively. Various measurements were collected from the animals experimented on Suleyman Demirel University research farm. Data were collected from December 2011 and lasted for 12 months. A total of 1068 observations were used for each trait measured. The animals were weighed using a mobile weighing bridge once a month. Body weights were recorded to the nearest kilogram (kg). All measurements were taken by the same individuals throughout the experimental period. The animals were fed ad- libitum and feed intake levels were provided such that feed always available in the feed bunks.

Body Measurements

Body measurements were taken while animals were standing in a crush before weighing. A plastic tape marked in centimetres (cm) was used for the measurement of most body traits except wither height, which was measured by measuring stick (Hauptner, Germany).

1-Heart Girth (HG)- was measured as the minimal circumference around the body immediately behind the front shoulder,

2-Wither Height (WH)- was the distance from the ground beneath the animal to the top of the withers directly above the centre of the shoulder,

3-Body Length (BL)- was the distance from the point of the shoulders to the ischium; in other words, from the sternum (manubrium) to the aitchbone (tuber ischiadicum),

4-Hip Width (HW)- was the widest point at the centre of the stifle,

5-Body Depth (BD)- from sternum area immediately caudal to the forelimbs to top of the thoracic vertebra.

6-Pin Bone Length (PL)- was the distance between two pin bones at the back

7-Hip Height (HH)- was the distance from the ground beneath the animal rear legs to the top of the vertebra.

Body weight was measured in kilograms and the body measurements in centimetres.

Statistical Procedure

The best prediction equations for body weight from other traits as independent variables, including HG, BL, WH, HW, BD, HH, PL, were determined. Descriptive statistics on a monthly basis and regression analysis of LW on each of the independent variables was performed using the General Linear Models procedure of MINITAB, 16 Inc. [5].

Correlation coefficients were also obtained between parameters. Polynomial regression analysis of body weight on heart girth, wither height, body length, hip width and chest depth was performed.

Linear, quadratic and cubic effects of independent variables on LW were included in the following model:

$$y_i = b_0+b_1X_i+b_2X_i^2+b_3X_i^3+e_i$$

Where

y_i= LW observation of an i th animal,

b_0= intercept, b_1, b_2, b_3= corresponding linear, quadratic and cubic regression coefficients I,

X_i = body measurement (HG, BL, WH, HW, BD, PL, HH) and

e_i = residual error term

Several different regression analyses were conducted;

1- All seven body measurements, expressed as linear functions, were combined in LW prediction equation

2- Each body measurement was included separately in regression analysis as linear, quadratic and cubic expressions to predict LW; and

3- The linear regression of each other measurement was then also added to the model as described previously.

RESULTS AND DISCUSSION

There were no statistically significant differences in body measurements between breeds (P >0.05). The data of these breeds were combined for all statistical analysis.

Descriptive statistics of body weight and body traits on a monthly basis are shown in Table 1.

The average values for LW increased throughout the experimental period from 144.7 kg to 507.8 kg with 363.1 kg difference. The corresponding ranges for HW, BL, HG, WH, BD, HH and PL were 28 cm to 41.3 cm with 13.3 cm difference, 102.3 cm to 151.4 cm with 49.1 cm difference, 117.8 cm to 183.5 cm with 65.7 cm difference, 98.7 cm to 133.4 cm with 34.7 cm difference and 50.1 cm to 69.8 cm with 19.7 cm difference, 105.2 cm to 137.7 cm with 32.5 cm difference, 21 cm to 28 cm with 7 cm difference, respectively.

Regressions of animal body weight on various body measurements using individual observations are shown in Table 2. As Table 2 shows models with one variable together with determination coefficients it was found that BL and HG would be the best possible traits in predicting LW (R^2=95.8% and 95.7% respectively) among the other measurements.

Table 1 Descriptive statistics of body weight and body traits by weighing times on 1.-12. month intervals

Weighing Time (month)	LW (kg)	HG (cm)	WH (cm)	HH (cm)	HW (cm)	BL (cm)	BD (cm)	PL (cm)
1.	144.7	117.8	98.7	105.2	28	102.3	50.1	21.2
12.	507.8	183.5	133.4	137.7	41.3	151.4	69.8	28.2
Difference	363.1	65.7	34.7	32.5	13.3	49.1	19.7	7

Table 2 Prediction equations of body weight and the linear effects of other body traits

MODELS WITH ONE VARIABLE	R^2 %
LW = - 445 + 4,99 HG	95,7
LW = - 786 + 9,29 WH	93,2
LW = - 550 + 6,68 BL	95,8
LW = - 373 + 18,6 HW	79,9
LW = - 606 + 14,8 BD	87,1
LW = - 236 + 20,9 PL	79,2
LW = - 855 + 9,55 HH	90,9

It was observed that in every steps of regression inclusion of BL and HG in the equation increased R^2 greatly. It was also found that when all variables were included in the regression PL, HW and BD were not significant while the rest gave significant slope values. The table containing the equations with all combinations of all body traits was cumbersome therefore it was not shown in the paper. However, The highest The R^2 values were obtained from the equation contained all body traits (R^2=97.5%) and the equation that included all body measurements except WH, HW and BD (R^2=97,5%) and those equations that included HG, BL and HH (R^2=97.4.0%), HG and BL (R^2 =97.1%) and only BL (R^2=95.8%). These results were in line with the findings of Tuzemen et al. [8], Ulutas et al. [9] and Bozkurt [1] who reported high R^2 value from the equation including all body traits. Bozkurt [1] found that when considering individual equations with one predictor HW and BD have the lowest R^2 values; 69% and 66.2%, respectively. HG and WH had the highest R^2 values, approximately 90% and 77% respectively. However, in this study, the individual equations with one predictor HW and PL had the lowest R^2 values; 79.9% and 79.2%, respectively. BL and HG had the highest R^2 values, approximately 95.8% and 95.7% respectively (Table 2).

Results of regressions of body weight on the linear, quadratic and cubic effects of each body measurement are presented in Table 3.

Table 3 Regressions of body weight on the linear, quadratic and cubic effects of each body measurement#

Measurements	Intercept	Linear	Quadratic	Cubic	R^2 %
Hip Width (HW)	- 372.8	18.56	-	-	79.9
	- 260.0	12.22	0.08718 ns	-	80.0
	2364	- 214.2	6.476 ns	- 0.05904	81.5
Body Length (BL)	- 549.5	6.677	-	-	95.8
	- 161.8	0.5859	0.02352	-	96.1
	578.6	- 17.04	0.1619	- 0.000358	96.1
Heart Girth (HG)	- 444.7	4.987	-	-	95.7
	27.54	- 1.400	0.02111	-	96.4
	240.8	- 5.802	0.05094	0.000066ns	96.4
Wither Height (WH)	- 786.1	9.294	-	-	93.2
	67.73	- 5.336	0.06203	-	93.7
	5459	- 144.3	1.247	- 0.003349	94.0
Body Depth (BD)	- 605.8	14.79	-	-	87.1
	- 307.9	5.040	0.07863	-	87.3
	5081	- 259.6	4.361	- 0.02285	89.0
Pin Bone Length (PL)	- 236.3	20.91	-	-	79.2
	- 704.7	56.61	- 0.6579	-	81.2
	442.4	- 73.89	4.176	- 0.05838	81.8
Hip Height (HH)	- 854.8	9.550	-	-	90.9
	- 527.4	4.167	0.02194	-	90.9
	9958	- 255.8	2.158	- 0.005815	91.6

#*only none significant regression coefficients had superscripts (ns), the rest were significant at P<0.05*

It was observed in this study that a 1 cm change in HG resulted in almost 5 kg change in weight. Similarly, a 1 cm change in BL, WH, HH, BD, HW, PL, and resulted in 6.67, 9.29, 9.55, 14.79, 18.56 and 20.91 kg change in weight respectively (Table 3). These results were in line with those of Bozkurt [1] that reported a 1 cm change in HG resulted in approximately 4.9 kg change in weight and this value for BL is 6.67 kg change in prediction of weight. Moreover, a 1 cm change in BL, WH, BD and HW resulted in 6.54, 9.33, 11.8 and 14.8 kg change in weight respectively. It was evident that a 1 cm change in HG resulted in lesser weight change compared to the rest of body traits indicating it was a best predictor.

Higher order polynomial equations were examined. The R^2 values from the regressions indicate that body length and heart girth to be the most highly related to body weight considering all linear, quadratic and cubic coefficient terms. For all body traits, addition of the cubic term increased the R^2 slightly. In this study BL and HG contributed 95.8% and 95.7% of variation respectively. However, while all linear, quadratic and cubic terms of HG and BL were significant (P<0.05) HW has not significant quadratic term (P>0.05). However, Heinrichs et al. [4] reported that none-significant cubic term for HG and significant term for WH. The quadratic term of BL was not significant (P>0.05). In contrast Heinrichs et al. [4] found that quadratic term of BL was significant. BD has not significant both quadratic and cubic coefficients term either. All linear terms of all body measurements were significant (P<0.05). These results were in line with Heinrichs et al. [4], Wilson et al. [10], Ulutas et al. [9] and Bozkurt [1].

It can be pointed out that in accuracy of body weight predictions additional body measurements (e.g. HW, BD, BL and even WH) in the equations provided a little appreciable increase except HG alone.

Correlation coefficients of the traits are shown in Table 4.

All correlation values were found to be statistically significant (P< 0.05). Amongst all the body measurements, the highest correlation was found between BL and LW (r=0.979). The second highest correlation was between HG and LW (r=0.978). In addition the correlation value between BL and HG (r=0.971) was higher than the correlation between the rest of the traits. It was expected that BL would give higher correlation coefficient value than the other body measurements since the R^2 value between LW and BL was also high.

Table 4 Pearson correlations between body traits in both breed cattle

Variables	LW	HG	WH	BL	HW	BD	PL
HG	0.978						
WH	0.965	0.958					
BL	0.979	0.971	0.967				
HW	0.894	0.897	0.892	0.893			
BD	0.933	0.928	0.941	0.934	0.873		
PL	0.890	0.885	0.864	0.882	0.897	0.845	
HH	0.953	0.941	0.974	0.951	0.870	0.933	0.846

LW: Liveweight, HG: Heart Girth, WH: Wither Height, BL: Body Length, BD: Body Depth, HW: Hip Width, HH: hip height, PL: Pin Bone Length

CONCLUSION

As the most of previous studies showed, this study also indicated that heart girth and body length can be used with great accuracy in predicting the live weight for Brown Swiss and Holstein cattle grown under small-scale farming condition. Heart girth and body length exhibited the highest correlation to liveweight of the traits studied. The results in this study also showed that linear, quadratic and cubic expressions of both HG and BL are the most useful predictors, and support the findings of Wilson et al. [10] and Bozkurt [1]. When any of the other seven measurements were used in the models that contained linear, quadratic and cubic terms, HG generally made the most important contribution compared with other body dimensions. BL can be considered the second best predictor. Therefore, the use of heart girth and body length provide a simple way of predicting body weight confidently which is the overall purpose applying the technique in the practice. However, there is always a need for further studies for the breeds in this study and other breeds as well to determine and develop different models to predict liveweight in different management and environmental conditions. It is also important to pay a great attention when measuring body dimensions to reduce the experimental errors.

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REFERENCES

[1] Bozkurt Y., 2006: Prediction of Body Weight from Body Size Measurements in Brown Swiss Feedlot Cattle Fed under Small-scale Farming Conditions, Journal of Applied Animal Research, 2006, p 29-32

[2] Enevoldsen C., Kristensen T., 1997: Estimation of body weight from body size measurements and body condition scores in dairy cows. J. Dairy Sci., 1997, p 1988-1995.

[3] Fourie P.J., Neser F.W.C., Olivier, J.J., Vonder Westhuizen C., 2002: Relationship between production performance visual appraisal and body measurements of young Dorper rams. S. Afr. J. Anim. Sci., 2002, p 256-262.

[4] Heinrichs A.J., Rogers G.W., Cooper J.B., 1992: Predicting body weights and height in Holstein heifer using body measurements. J. Dairy Sci., 1992, p 3576-3581.

[5] MINITAB, MINITAB User's Guide. Release 13 for windows. Inc., 2001.

[6] Nesamvuni A.E., Mulaudzi J., Romanyimi N.D. Taylor G.J., 2000: Estimation of body weight in Nquni-type cattle under communal management conditions. S. Afr. J. Anim. Sci., 2000, p 97-98.

[7] Peters A.R., Ball P.J.H., 1995: Reproduction in Cattle. London. Butterworths. 1995.

[8] Tuzemen N., Yanar M., Akbulut O., Ockerman H.W., 1993: Prediction of body weights from body measurements in Brown Swiss calves reared in the eastern region of Turkey. World Review of Anim. Prod., 1993, p 50-54.

[9] Ulutas Z., Saatci M., Ozluturk A., 2001: Prediction of body weights from body measurements in east Anatolian red calves. Ataturk Unv. Ziraat Fak. Dergisi, 2001, p 61-65.

[10] Wilson L.L., Egan C.L., Terosky T.L., 1997: Body measurements and body weights of special-fed Holstein veal calves. J. Dairy Sci., 1997, p 3077-3082.