SHORT COMMUNICATION

Predicting Live Body Weight using Morphometric Measurements in Jersey and Holstein Dairy Cows

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Abstract

Live body weight estimation in dairy animals is an important activity with regard to animal performance monitoring. Traditional weighing bridges/platforms, though accurate are costly for a farmer and have portability issues making them unavailable in field conditions. Present study was conducted to determine the correlation between live body weight and linear/ morphometric measurements in Jersey and HF cattle at an organized farm under the temperate climate of Jammu & Kashmir. Five linear body measurements *i.e.,* body length, chest girth, belly circumference, pelvic girth and withers height were taken at different ages over a period of 3 years wherein a total of 231 recordings from Jersey and 114 from HF cattle pertaining to each of the mentioned parameters were made. The live weights of these animals were also recorded on the same days using conventional weighing bridges. In Jersey cattle, the highest correlation observed was with chest girth (+0.89) followed by pelvic girth (+0.80) and withers height (+0.76). Similarly in HF cattle, highest correlation was observed with chest girth (+0.95) followed by body length (+0.92) and pelvic girth (+0.89). Regression analysis revealed a best-fit equation for predicting live weight with body length, chest girth and withers height in Jersey (R^2= 0.73) and with chest girth and body length in HF (R^2= 0.95) cattle. It was concluded that the correlation between live body weight and linear body measurements can be suitably exploited to predict live body weight in dairy cattle in the absence of conventional means of live weight estimation.

Key words: Cattle, Linear measurements, Morphometry, Prediction, Regression.

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Introduction

Live body weight is an important factor in dairy production with regard to various managemental decisions like diet formulation and suitability for breeding besides predicting the health status of animals (Putra *et al.,* 2014, 2015; Martins *et al*., 2020). It is one of the most suitable managemental tools to access calf performance, reproductive health and milk production in cows and at the same time helps to determine the housing space requirement of the animals. Study indicates that changes in live body weight can be effectively utilized in evaluating responses of lactating dairy cattle in relation to changes in dietary protein (Liu *et al*., 2021). Live body weight in heifers at the time of calving has also been linked to milk yield with heavier heifers yielding more milk in first lactation than the lighter ones (Han *et al*., 2021). Although the estimation of live body weight requires simple calibrated weighing balances/mechanical scales but complexities often arise on account of their size and the consequent portability issues. Cost factor may further be a bottleneck to purchasing these balances for a resource-poor farmer. Various morphometric measurements like heart girth, chest girth, and body length have been used to predict the body weight of cattle with reasonable accuracy (Soul *et al*., 2021). Although the estimation of live body weight through these measurements is comparably less reliable, it offers many operational advantages over the conventional methods. Many formulae for predicting live body weight in cattle using these measurements have been developed by workers in the past (Bhakat *et al.,* 2008; Sahu *et al.,* 2017).

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The body conformation of animals often varies in relation to breed with consequent variation in body measurements. Furthermore, the body size may also vary in relation to climate over a long period of time. Such changes in animal body size are explained as an adaptive response to climate or a consequence of changes in environmental productivity and food availability (Martin *et al.,* 2018). As such no single formula can effectively predict live body weight across breeds and climates. Present study was undertaken to study the correlation between different body measurements and live body weight in Jersey and HF cattle reared under temperate

climate and analyze the suitability of these measurements in predicting live body weight in these animals.

Materials and Methods

Study Area and Selection of Animals

The study was conducted at Mountain Livestock Research Institute (MLRI), Manasbal, a constituent unit of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, India during 2022-2024. The area has a temperate type of climate with a very harsh winter and lies on the bank of Manasbal Lake at a distance of 30 km towards the north of Srinagar. Female Jersey and Holstein cattle of 1-3 years age group were selected for the study.

Body Measurement

Five linear body measurements, *i.e.,* body length (BL), chest girth (CG), belly girth (BG), Pelvic girth (PG) and withers height (WH) were taken from Jersey cattle at different ages over a period of 3 years wherein a total of 231 recordings pertaining to each of the mentioned parameters were made. Similarly, 114 recordings of the same parameters were taken in Holstein Friesian cattle during the same time. Corresponding live body weight (BW) measurements of these animals were taken on the same days using an electronically calibrated weighing platform**.**

Statistical Analysis

The coefficient of correlation between live body weight and various body measurements under study were determined using SPSS software. Regression models with live body weight as the dependent variable and various body measurements as independent variables were developed based on stepwise model using SPSS software. Separate regression model using all the studied linear measurements were initially developed for each of the breeds. Measurements with least correlation with body weight and showing higher p-values (p>0.05) were then excluded and only the remaining measurements were used to develop the best-fit models. The models were developed both using each of the selected independent variables (linear measurements) individually as well as in combination. The best-fit model could then be selected based on the coefficient of determination (R^2).

The regression model used to estimate the body weight of the animals was

$$Y = a+b1X1+b2X2+b3X3+b4X4+b5X5+b6X6+ E$$

The only dependent variable *i.e.,* live body weight (kg) is denoted by "Y". X_1, X_2, X_3,.....X_n represent the individual independent variables/body measurements (inches). The letter "a" is the intercept, b_1, b_2, b_3, b_4.....b_n represent the regression coefficients, and "E" is the error.

Results and Discussion

The mean values for live weight and five linear body measurements of Jersey and Holstein cattle observed are presented in Table 1, and their correlations in Tables 2 and 3. The results indicated highest positive correlation of live body weight with chest girth (0.90) followed by pelvic girth (r=0.81), height at withers (0.77) and body length (0.74) in Jersey cattle. Similarly in HF cattle, highest positive correlation of live body weight was observed with chest girth (r=0.95) followed by body length (r=0.93), pelvic girth (r=0.89) and belly girth (r=0.89) (Table 2, 3). Present study observed positive correlations between live body weight and linear body measurements in both HF and Jersey cattle. Similar positive correlations, though of different magnitudes have also been reported between live body weight and body length, withers height and heart girth in a similar study on Sahiwal cattle (Sahu *et al*., 2017). Similar high positive correlation of live body weight with many body measurements have also been reported earlier in Aceh cattle (Putra *et al.,* 2015).

Regression analysis of the studied parameters in Jersey cattle (Table 4) revealed that live body weight can be predicted using body length alone (Y=-147.44+3.18BL; R^2=0.58), chest girth alone (Y=-307.58+3.71CG; R^2=0.68) or withers height alone (Y=-232.98+4.19WH; R^2=0.43) indicating chest girth as the most reliable parameter among the three. The best-fit equation for predicting live body weight was arrived at using all these parameters in combination (Y= -441.9+1.27BL+2.41CG+1.43 WH) with a higher coefficient of determination (R^2=0.73). Similarly in HF cattle (Table 5), regression analysis revealed that live body weight can be predicted using body length alone (Y=-612.94+6.72BL; R^2=0.86) or chest girth alone (Y=Y=-480.47+4.94CG; R^2=0.91) indicating chest girth to be a more reliable parameter. The best-fit prediction equation for HF could be arrived by using both these parameters in combination (Y= -599.05+3.08BL+3.04CG; R^2=0.95). Earlier studies have also reported that heart girth measurement can be used to predict the live body weight in crossbred HF calves with an R^2 value of 0.95 (Patel *et al*., 2019) and 0.85 (Tebug *et al*., 2016). Similarly, earlier studies on crossbred cattle (Patel *et al.,* 2019) and Sahiwal calves (Bhagat *et al.,* 2016) have indicated that body length alone could be used to predict live body weight in these animals. Another study (Hartati and Putra, 2021) indicated that chest girth alone can be used to predict live body weight in Ongole cattle with a reasonable level of accuracy (R^2 = 0.80).

In conclusion, the present results suggest that many linear/morphometric measurements in Jersey and HF cattle positively correlate with live body weight. Chest girth measurements in particular show high positive correlation in comparison to other measurements in both these breeds. Prediction models based on the regression of these measurements can be used as an alternative tool for weight estimations in field conditions wherein conventional means may not be available. Although a number of regression based prediction equations are available for live weight estimation in dairy animals, present equations may be more relevant in relation to breed (Jersey, HF) and climate (temperate).

Table 1: Average values for live weight and linear body measurements

Variable	Jersey cattle			HF cattle		
	Mean	SD		Mean	SD	
Body weight (kg)	264.70	61.93	23.40	309.00	69.75	22.57
Body length (cm)	129.73	22.04	16.99	137.16	33.36	24.32
Chest girth (cm)	154.24	26.60	17.25	159.79	40.34	25.25
Withers height (cm)	118.72	18.85	15.88	124.63	29.05	23.31
Pelvic girth (cm)	160.62	29.18	18.17	165.33	7.48	4.52
Belly girth (cm)	184.51	40.46	21.93	185.07	8.76	4.73

Table 2: Correlation between live body weight and body measurements in Jersey cattle

	BW	BL	CG	WH	PG	BG
Body weight (BW)	1.00					
Body length (BL)	0.74	1.00				
Chest girth (CG)	0.90	0.78	1.00			
Withers height (WH)	0.77	0.57	0.86	1.00		
Pelvic girth (PG)	0.81	0.69	0.85	0.71	1.00	
Belly girth (BG)	0.40	0.45	0.47	0.41	0.51	1.00

Table 3: Correlation between live body weight and body measurements in HF cattle

	BW	BL	CG	WH	PG	BG
Body weight (BW)	1.00					
Body length (BL)	0.93	1.00				
Chest girth (CG)	0.95	0.86	1.00			
Withers height (WH)	0.68	0.72	0.67	1.00		
Pelvic girth (PG)	0.89	0.81	0.95	0.77	1.00	
Belly girth (BG)	0.89	0.78	0.93	0.80	0.97	1.00

Table 4: Regression analysis of body weight and body measurements in Jersey cattle (n=231)

		SE					
S. No.	Regression equation	Intercept	BL	CG	WH	R^2	Adjusted R^2
1	Y=-147.44+3.18BL	66.03	0.50	-	-	0.58	0.33
2	Y=-307.58+3.71CG	45.32	-	0.29	-	0.68	0.68
3	Y=-232.98+4.19WH	65.66	-	-	0.55	0.43	0.42
4	Y=-365.76+0.99BL+3.26CG	50.20	0.41	0.34	-	0.70	0.69
5	Y=-347.70+3.23CG+0.96WH	50.90	-	0.41	0.58	0.69	0.68
6	Y=-473.32+2.61BL+3.51WH	65.79	0.39	-	0.46	0.63	0.62
7	Y=-441.9+1.27BL+2.41CG+1.43 WH	57.21	0.41	0.47	0.57	0.73	0.71

Y is in kg and body measurements are in centimetres

Table 5: Regression analysis of body weight and body measurements in HF cattle (n=114)

		SE				
S. No.	Regression equation	Intercept	BL	CG	R^2	Adjusted R^2
1	Y=-612.94+6.72BL	82.27	0.59	-	0.86	0.86
2	Y=-480.47+4.94CG	57.38	-	0.35	0.91	0.90
4	Y=-599.05+3.08BL+3.04CG	49.34	0.70	0.50	0.95	0.95

Y is in kg and body measurements are in centimetres

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