Application of Linear Body Measurements for Predicting Weaning and Yearling Weight of Bali Cattle

A Gunawan* and Jakaria

Departemen of Animal Production and Technology, Faculty of Animal Science, Agriculture of Bogor Institute
Jl. Agatis, Kampus IPB Darmaga, Bogor 16680. Telp (0251) 8628379, Indonesia
***Corresponding author email: aagun4780@yahoo.com**

Abstract. The objective of this research was to predict the weaning and yearling weight of Bali cattle using simple linear body measurement. The height wither (HW), body length (BL) and heart girth (HG) were measured in centimeters, using caliper, whereas weaning (WW)and yearling weight (YW) was determined in kilograms using a weighing scale. Results of the correlation coefficient showed that hearth girth (HG) highly correlated with weaning and yearling weight were 0.847 and 0.871 respectively. In all, the height wither (HW) had the least correlation coefficient were 0.328 and 0.782 on weaning and yearling weight respectively. Results of the stepwise regression showed that HG was a good estimator of WW and YW of Bali cattle followed by HW and BL. The comparison of residuals indicated that only two equations (HG and BL) accurately predicted weaning and yearling weight. From these results, it was concluded that weaning and yearling weight of Bali cattle can be estimated using simple linear body measurement of heart girth, body length and height wither especially in most remote areas where farmers are challenged with the unavailability of weighing scale.

Key Words: weaning and yearling weight, linear body measurements, Bali cattle

Introduction

Bali cattle are one of several Indonesian native cattle that plays major role for beef production Improvement of growth traits such as weaning and yearling weight are an increasingly important breeding goal in beef cattle (Peters et al., 1998). Growth traits might be affected by different management, environment and enterprise feeding conditions. Useful information on the suitability of the animals for selection and on the outcome resulting from genetic improvement programs could be evaluated on a morphological basis such as linier body measurement. Besides, linear body measurements have been suggested measures base on body conformation of animals (Janssens and Vandepitte, 2004; Janssens et al., 2004). However, since the early 1980s evaluation systems have changed from conformation scale towards scoring on a linear measurement scale. Thompson et al. (1983) showed that linearly measurements traits exhibited higher heritabilities than subjectively scored traits and, more recently, Serenius et al. (2001) and Gutiérrez and Goyache (2002) advocated a shift towards linear measurement in order to improve the genetic evaluation in beef cattle. Linier body measurement such as chest girth and body length have been proposed as indirect selection criteria for genetic improvement of meat production in cattle (Kahi and Hirooka, 2005; Maiwasha et al., 2002) and for prediction of live weight, growth traits (Mohammed and Amin, 1997) and carcass traits in cattle (Afolayan et al., 2002).

Linear body measurement have been found to be moderately until relatively high heritable and to have a strong positive relationship with growth traits in cattle (Afolayan et al., 2007). Wilson (1996) revealed heritability of the growth traits likely live weight of the mature animal and of the height at rump is 0.47-0.51 and 0.62-0.88, respectively, and there is a close (r = 0.80) genetic correlation between the two characteristics. Estimated heritability of growth traits were weaning and yearling weight of Bali cattle on range 0.3-0.4 (Praharani, 2009). The heritability of weaning and yearling weight were considered as moderate to high which means that the selection program will be more effective and efficient in improving the genetic merits in Bali cattle.

The need to estimate growth traits such as weaning and yearling weight in Bali cattle which have economic value traits from simple and more easily measurable variable likely linear body measurements are important and practice for application in the field. Linear body measurements is very important because it reduces scale setup and teardown time and in some cases transportation of the cattle. Nwosu et al. (1985) reported estimation of body weights using linear body measurements could be beneficial for purposes of treating animals in remote areas with the appropriate doses of drugs and vaccine. The relationship between body measurements and growth traits depends upon breed, age, type, size, condition and fattening level of the animals (Heinricsh et al., 1992, Yanar et al., 1995, Ozakaya and Bozkurt, 2009). Van Marle-Koestzer et al. (2000) described body measurements as selection criteria for growth trait such as weaning and yearling weight in cattle. Caglar and Sekerden (1993) declared that the regression equations must be determined for all beef breeds for different country and region. Heinrichs et al. (1992) developed a modified equation to determine body weight from heart girth for modern-day Holstein heifers. But, it is not known if the same equation will be valid in estimating body weight among other groups animal likely indigenous Bali cattle. The aim of this study was to assess the relationship between linear body measurements and the actual growth traits were weaning and yearling weight in Bali cattle. Results obtained in the present study would also be useful and helpful to farmers and animal scientists who are involved in cattle research

Materials and Methods

A total of 133 weaning weight and 145 to yearling of Bali cattle were used in the study. Linear body measurements were taken on each animal after weighing: height at withers (HW), body length (BL) and heart girth (HG). The height wither (HW), body length (BL) and heart girth (HG) were measured in centimeters using caliper, whereas weaning (WW) and yearling weight (YW) was determined in kilograms using a weighing scale. The data used in this study were collected from Breeding Centre of Bali cattle in Bali province during the period from September 2005 to September 2008. The calf were weaned at about 205 days of age; accordingly, individual weaning weight was adjusted to 205 days of age. Data on weaning weight (WW) and one year weight (YW) at several calf ages were corrected based on 205 and 365-day age respectively. The quotients used in weaning weight and one year weight correction based on 205 and 365-day age (BIF, 2002) were as follows:

WW205= {[(actual weaning weight − birth weight)/actual age] x 205 days} + birth weight

YW365= {[(actual yearling weight − W205)/(actual age −205)] x 160 days} + W205

The linear measurements were subjected to stepwise multiple linear regression analysis, using PROC REG of SAS computer programme. The goodness of fit (R^2) was tested to determine the contribution of each of the three independent variables measured to the prediction of the dependent variable, the weaning and yearling weight of Bali cattle. The linear regression equation used Maschebe and Ezekwe (2010) was: $Y = a + b_i X_i + E$, Where: Y = weaning weight (WW) and yearling weight (YW), the dependent variable a = constanta; bi = Regression coefficient of the i th independent variable; X_i = The value of the ith independent variable. Such that: X1 = Height at withers (HW); X2 = Body length (BL); X3 = Heart girth (HG); E = Standard error of regression

The R^2 (the square of the multiple correlation coefficient between X's and Y) was a measure of the proportion of the variance of Y explained by variation in X's. A detailed description of stepwise regression procedures has been given by previous researchers (Gasperz, 1992). The accuracy of the equations was estimated using residuals (absolute value of the difference between predicted weight by using the developed equations and actual weight measured with the scale (Sulabo et al., 2006).

Results and Discussion

Results of the simple correlation coefficients of the linear measurements to one another and to the weaning weight and yearling weight of Bali cattle are presented in Table 1 and 2. The linear measurements, height wither (HW), body length (BL) and heart girth (HG) were highly correlated with weaning and yearling weight of Bali cattle.

Result on Table 1 and 2 showed that hearth girth (HG) highly correlated with weaning and yearling weight were 0.847 and 0.871 respectively. In all, the height wither (HW) had the least correlation coefficient were 0,328 and 0.782 on weaning and yearling weight respectively. In most studies heart girth was found to be highly correlated with body weight in sheep (Topal and Macit, 2004; Atta and Khidir, 2004; Afolayan et al., 2006), in cattle (Heinrichs et al., 1992, 2007; Goe et al., 2001) and in goat (Khan et al., 2006; Nsoso et al., 2003). The correlation is one of the most common and most useful statistic that describes the degree of relationship between two variable. The high correlations between hearth girth (HG) with growth traits were weaning and yearling weight in Bali cattle proposes that selection either of these trait will result in an increase in the other trait and selection for this two traits should be practiced with caution. Moderate to high correlations between growth traits suggest that growth measure, particularly weight are influenced by a similar set of genes and selection of one weight measure likely to increase weight at the other stages (Maiwashe et al., 2002). The accuracy estimation weaning and yearling weight from live animal simple body measurement is making a fortune for rural livestock enterprise especially without cooperate characteristic (Cam et al., 2009).

The stepwise regression method were used to determine which linear body measurement or combination of measurements was a good estimator of the body weight in weaning and yearling weight of Bali cattle. The regression equation of weaning and yearling weight were presented on Table 3 , 4 and stepwise multiple regression prediction of weaning and yearling weight from body measurements were presented on Table 5 and 6.

Table 3 and 4 showed that the hearth girth (HG) alone was a good estimator on weaning and yearling weight in Bali cattle and explained 71 and 75.9% respectively of the variation. This is in agreement with result in Nigerian cattle (Nwosu et al., 1985) and dairy cattle (Heinrichs, 1992) who developed a modified equation to determine body weight from heart girth for modern-day Holstein heifers. Morever, Heinrichs (2007) reported that heart girth grew as strongly correlated (r^2=0.99) with body weight. Prediction of weaning and yearling weight from HG measurements obtained from a weight-tape were accurate compared to actual weaning and yearling weight and highly repeatable for multiple measurements or measurement by many individuals. In all, it were observed that the nearest estimators of weaning and yearling weight in Bali cattle are hearth girth (HG) and body length (BL), because they explained 75.2 and 78.3% respectively of the variations in weaning and yearling weight when combined. Height wither (HW) could explain only 18.20 and 62.1% of the variation

Table 1. Correlation coefficients showing interrelationships between various measurements of weaning weight of Bali cattle

Measurement	Height wither	Body length	Hearth girth	Body weight
Height wither	-			
Body length	0.832	-		
Hearth girth	0.328	0.410	-	
Weaning weight	0.435	0.517	0.847	-

Table 2. Correlation coefficients showing interrelationships between various measurements of yearling weight of Bali cattle

Measurement	Height wither	Body length	Hearth girth	Body weight
Height wither	-			
Body length	0.849	-		
Hearth girth	0.782	0.782	-	
Yearling weight	0.778	0.778	0.871	-

Table 3. Relationship between weaning weights and linear measurements of Bali cattle

Component	Prediction equation	Correlation coefficient	R^2
Height wither	B205 = - 16.6 + 1.13 HW	0.435	18.90
Body length	B205 = - 20.8 + 1.25 BL	0.517	26.7
Hearth girth	B205 = - 59.6 + 1.39 HG	0.847	71.7

HW : Height wither; BL : Body length; HG : Hearth girth

Table 4. Relationship between yearling weights and linear measurements of Bali cattle

Component	Prediction equation	Correlation coefficient	R^2
Height wither	BB365 = - 229 + 3.61 WH	0.778	62.1
Body length	BB365 = - 149 + 2.88 BL	0.778	60.5
Hearth girth	BB365 = - 151 + 2.28 HG	0.778	75.9

HW : Height wither; BL : Body length; HG : Hearth girth

Table 5. Stepwise multiple regression prediction of weaning weight from body measurements

Hearth girth	Body length	Height wither	Intercept	R^2
1.39			- 59.6	71.5
1.26	0.491		- 87.2	75.2
0.131	0.389	1.26	-90.5	75.3

Table 6. Stepwise multiple regression prediction of yearling weight from body measurements

Hearth girth	Body length	Height wither	Intercept	R^2
2.28			- 151	75.9
1.77	0.922		- 178	78.3
0.178	0.851	1.72	- 183	78.3

indicating that it may not be a fairly good estimator of weaning and yearling weight of Bali cattle respectively (Table 5 and 6). This result in agreement as has also been reported for other animals (Groesbeck et al., 2003; Sulabo e al., 2006 and Machebe and Ezekwe, 2010). The high and significant correlation coefficient between HG and BL with weaning and yearling weight suggest that either of these variables or their combination would provide a good estimator for predicting weaning and yearling weight in Bali cattle especially in villages where weighing scale is not available. Body measurements can be separately or together used in estimating live weight. The existence of positive significant correlation of live weight with body measurements justified the use of linear regression for prediction of live weight (Rahman, 2007). This results of this study showed that with careful measurement of the HG, weaning and yearling weight of Bali cattle can be estimated. This is supported by the high regression coefficient were 71.7 and 75.9% between HG and weaning and yearling weight respectively. For instance, assuming the hearth girth of yearling Bali cattle 130 cm, when fixed into the equation; BB365 = - 151 + 2,28 (130) (Table 3 and 4), the predicted yearling weight around 145 kg. So, with simple and careful measurement of BL, weaning and yearling weight in Bali cattle could be estimated. The comparison of residuals indicated that only two equations (HG and BL) accurately predicted weaning and yearling weight in contrast with HW (Table 5 and 6). This result in agreement with previous report with Cam et al. (2009) who reported the equation base on stepwise regression are closer to real body weight. This prediction through used regression with HG measurement provide a good estimator for predicting weaning and yearling weight in Bali cattle especially in villages where weighing scale is not available. The result of the multiple regression analyses indicated that the addition of other measurements to HG would result in significant improvements in accuracy of prediction even though the extra gain was small. However, under field conditions, weaning and yearling weight of Bali cattle estimation using heart girth alone would be preferable to combinations with other measurements because of difficulty of the proper animal restraint during measurement.

Conclusions

The high correlations between hearth girth (HG) with growth traits were weaning and yearling weight in Bali cattle proposes that selection either of these trait will result in an increase in the other trait and selection for this two traits should be practiced with caution. The results of this study show that simultaneous selection for body measurements and growth traits likely weaning and yearling weight of Bali cattle is feasible. The practical application of these result in those scenarios where weight measurements might not be feasible such as small scale farmers who do not have access to a weighbridge.

Acknowledgement

The authors are grateful to Breeding Centre BPTU especially to Yudi Parwoto, SPt and Drh. Eddy Suprapto who were responsible for providing the full data and support

References

Afolayan RA, MPB Deland, DL Rutley, CDK Bottema, AL Ewers, RW Ponzoni and WS Pitchford. 2002. Prediction of carcass meat, fat and bone yield across diverse cattle genotype using live-animal measurements. Anim. Prod. Aust. 24:13–16.

Afolayan RA, WS Pitchford, MPB Deland and WA Mckiernan. 2007. Breed variation and genetic parameters for growth and body development in diverse beef cattle genotypes. Anim. 1:13–20.

Afolayan R, IA Adeynika and CAM Lakpini. 2006. The estimation of live weight from body measurements in Yankasa sheep. Czech J. Anim. Sci. 51:343-348

Atta M and OA El Khidir. 2004. Use of heart girth, wither height and scapuloischial length for prediction of live weight of Nilotic sheep. Small Rumin. Res 55:233-237.

BIF (Beef Improvement Federation). 2002. Guidelines for Uniform Beef Improvement Programs. 8th Ed. Kansas State Univ., Kansas

Caglar H and O Sekerden. 1993. Predicting live weight from various body measurements in Yerli Kara cattle. J. Agri. Collage of Ondokuzmayıs University 8:45-7

Cam MA, M Olfaz and E Doydan. 2010. Body measurements reflect body weights and carcass yields in Karayaka sheep. Asian J. Anim. and Vet. Advances. 5(2):120-127.

Gasperzs. 1992. Teknik Analisis dan Penelitian Percobaan Jilid ke-2. Penerbit Tarsito, Bandung.

Goe MR, JR Alldredge and D Light. 2001. Use of heart girth to predict body weight of working oxen in Ethopian highlands. Livest. Prod. Sci. 69:187-195.

Groesbeck CN. 2003. Use heart girth to estimate the weight of finishing pigs. Kansas State University Cooperative Extension Service Swine Update Newsletter–Spring

Gutiérrez JP and F Goyache. 2002. Estimation of genetic parameters of type traits in Asturiana de Los Valles beef cattle. J. Anim. Breed. Genet. 119:93–100.

Heinrichs AJ and GW Rogers, JB Cooper. 1992. Predicting body weight and wither height in Holstein heifer using body measurements. J. Dairy Sci. 75:3576-81

Heinrichs AJ, HN Erb, GW Rogers, JB Cooper and CM Jones. 2007. Variability in Holstein heifer heart-girth measurements and comparison of prediction equations for live weight Preventive. Vet. Med.78:333-338

Janssens S, and W Vandepitte. 2004. Genetic parameters for linear measurements and linear type traits in Belgian Bleu du Maine, Suffolk and Texel sheep. Small Rumin. Res. 54:13–24.

Janssens S, D Winandy, A Tylleman, C Delmotte, W Van Moeseke and W Vandepitte. 2004. The linear assessment scheme for sheep in Belgium: breed averages and assessor quality. Small Rumin. Res. 51:85–95.

Kahi AK and H Hirooka. 2005. Genetic and economic evaluation of Japanese Black (Wagyu) cattle breeding schemes. J. Anim. Sci. 83:2021–2032.

Khan HF, R Muhammad, G Ahmad, Nawaz, Rahimullah and M Zubair. 2006. Relationship of body weight with linier body measurements and conformation traits. J. Dairy Sci. 1: 51-54.

Machebe NS and AG Ezekwe. 2010. Predicting Body Weight of Growing-Finishing Gilts Raised in the Tropics using Linear Body Measurements. Asian J. Exp. Biol. Sci. . 1(1):162-165.

Maiwasha AN, MJ Bradfield, HE Theron and JB Van Wyk. 2002. Genetic parameter estimates for body measurements and growth traits in South African Bonsmara cattle. Livest. Prod. Sci. 75:293–300.

Mohammed ID and JD Amin. 1997. Estimating body weight from morphometric measurements of Sahel (Borno White) goats. Small Rumin. Res. 24:1–5.

Nsoso BSJ, AA Aganga, BP Moganetsi and SO Tschwenyane. 2003. Birth weight, body condition score and heart girth in indigenous Tswana goats during dry and wet season in southeast Bostwana. Livest. Res. for Rural Develop. 15 (4) http://www.lrrd.org/lrrd15/4/nsos154.htm (accessed: December 6, 2010)

Nwosu CC, FN Akhionbare and IE Iboh. 1985. Characterization of cattle in Nigeria body measurements. Beitrage trop. Landwirtsch. Veterinärmed. 23:89-97.

Ozkaya S and Y Bozkurt. 2009. The accuracy of prediction of body weight from body measurements in beef cattle. Archiv Tierzucht 52 (4):371-377.

Peters SO, IC Nwosu, MO Ozoje and CON Ikeobi. 1998. Genetic parameter estimates for growth traits in cattle genotypes. Proc 6th World Congr. Genetics Appl. Livest. Prod. 23:101-104.

Praharani L. 2009. Estimation of direct and maternal weights in Bali cattle effect for weaning and yearling. Indonesian Journal of Agriculture 2(2): 74-81.

Rahman F. 2007. Prediction of carcass weight from the body characteristics of Black Bengal goats. Int. J. Agri. Biol. 9(3):431-434.

Serenius T, ML Sevon-Aimonen and EA Mäntysaari. 2001. The genetics of leg weakness in Finnish Large White and Landrace populations. Livest. Prod. Sci. 69:101–111.

Sulabo RC, J Quackenbush, RD Goodband, MD Tokach, SS Dritz, JM DeRouchey and JL Nelssen. 2006. Validation of flank-to-flank measurements for predicting boar weight. Swine Day Report

Thompson JR, KL Lee and AE Freeman. 1983. Evaluation of a linear type appraisal system for Holstein cattle. J. Dairy Sci. 66:325–331.

Van Marle-Köster E, BE Mostert and J Van der Westhuizen. 2000. Body measurements as selection criteria for growth in South African Hereford cattle. Arch Tierz 43:5-15.

Wilson DE. 1996. Angus mature cow size genetic evaluation. Angus J. March, 8.

Yanar M, N Tuzemen, M Ozkan, R Aydin and F Ugur 1995. Prediction of body weights from body measurements in Brown Swiss cattle. Turkish J. Vet. Anim. Sci. 19:357-60.