MJAVL
Manas Journal of Agriculture Veterinary and Life Sciences
ISSN 1694-7932 | e-ISSN 1694-7932
Volume 10 (Issue 1) (2020) Pages 52-57

The Assesment of Body Weight of Sumba Ongole Cattle (*Bos indicus*) by Body Measurements

Widya Pintaka Bayu PUTRA

Research Center for Biotechnology, Indonesian Institute of Science, Bogor, INDONESIA

http://orcid.org/0000-0002-1102-6447

e-mail: widya.putra.lipi@gmail.com

ABSTRACT

The aim of this study was obtained the best linear regression equation for body weight (BW) through body measurements in 58 heads of Sumba Ongole (SO) cattle raised at the breeding centre (PT. Karya Anugerah Rumpin). Total of 17 bulls and 41 heifers were used in this study. Three body measuremens of withers height (WH), body length (BL) and heart girth (HG) were used in this study. The average of ages, BW, WH, BL and HG in SO cattle were 588.47±186.78 days, 247.86±96.94 kg; 116.86±17.14 cm, 121.34±15.63 cm and 150.38±26.08 cm respectively. The highest coefficient of determinaton value was reached in linear regression using HG variable i.e. 0.94 (bulls) and 0.87 (heifers). Three body measurements in this study were non-collinearity and reveal that the linear regression in this study were accurate. The T-test analysis was showed that effect of sex to the cattle performance was not significantly different. It was concluded that the BW of SO cattle in this study can be predicted with linear regression equation of BW=4.55(HG)-448.73 for bulls at 673.71 days of age and BW=3.26(HG)-244.93 for heifers at 553.12 days of age.

ARTICLE INFO

Research article
Received: 06.05.2020
Accepted:14.06.2020

Keywords:
Sumba Ongole, Body weight, Body measurements, Coefficient of determination, Linear regression

INTRODUCTION

Sumba Ongole (SO) cattle is one of Indonesian native cattle that capable to adapt well at Sumba Island, Nusa Tenggara Timur Province of Indonesia. The SO cattle was imported from India since 1906 by Dutch colonial government for drought animals. Many studies reported that the highest average of carcass weight and body weight in male SO cattle were reached of 358.06±15.35 kg and 474.08±25.98 kg respectively (Agung et al. 2015; Said et al. 2016). In addition, the heritability (h^2) of body weight and and some body measurements of SO cattle included of high category (h2 > 0.30) i.e. body weight (0.66), weaning weight (0.65), yearling weight (0.67), withers height (0.41) and 0.47 for body length (Putra et al. 2018; Putra and Agung 2018).

As the native cattle, the genetic improvement in SO cattle is important to increase productivity traits. Body weight is the important trait that used for selection criteria and market price decision. Body weight of a cattle can only be known precisely through weighing. In certain situations and conditions (especially in smallholder farms) there are rarely or not available cattle scales, so more practical way to estimate the weight of livestock is needed. Previous studies reported that the body weight in many Indonesian breeds cattle can be predicted through body measurements (Gunawan and Jakaria 2010; Paputungan et al. 2013; Tisman and Putra 2015; Putra et al. 2015; Agung et al. 2018). In addition, many studies reported that heart girth measurement had very high positive correlation value (r>0.90) with body weight of cattle (Ozkaya and Bozkurt 2009; Sawanon et al. 2011; Kashoma et al. 2011).

The previous study regarding to predict body weight in SO cattle so far is not reported. Based on the reason above, this study was carried out to obtain the best linear regression equation for body weight prediction in SO cattle based on three body measurements of withers height, body length and heart girth. The results of this study can be used as an alternative method for predicting body weight in SO cattle.

MATERIALS AND METHODS

Research site and data collection

This research was conducted at the breeding station (PT. Karya Anugerah Rumpin), Rumpin District, Bogor Regency, West Java Province, Indonesia. The area is situated at along latitude 06°26’30” S to 06°26’50” S and longitude

106°38'50" E to 106°39'15" E about 3500 to 4000 m above the sea level. The humidity 70% to 80% with temperature 28°C to 30°C and rainfall occuring average 2500 mm/year. Records data of body weight (BW) and body measurements from first generation of 58 heads of SO cattle (17 males and 41 females) were used in this study. Data of animals were collected from herd book year 2013 to 2015. Thus, records data of cattle after year 2015 was not available in the research site.

Animal management

Animals were divided into groups of 20 to 30 animals based on sex at the colony stall. Thus, feed composition consisted of Elephant grass (*Pennisetum purpureum*), rice straw and cassava meal. They were fed a complete ration feed *ad libitum* approximately 60% of the energy provided by silage and 40% by concentrate.

Animal measurements

The cattle were weighed every month using digital weight scale. The measurements were taken on each animal were wither height (WH), body length (BL) and heart girth (HG) as shown in Figure 1. Data of WH was measured with a stick-ruler as the distance from the surface of the platform to the dorsal point (*Os vertebrae thoracalis III*) of the withers. Data of BL was measured (using a tape) of the distance between the point of the shoulder (*Tuber humerus* on *Os humerus*) and the pinbone (*Tuber ischiadicum* on *Os coxa*). Data of HG was measured with a tape measure as circumference of the chest just behind the foreleg (*Os costa V*).

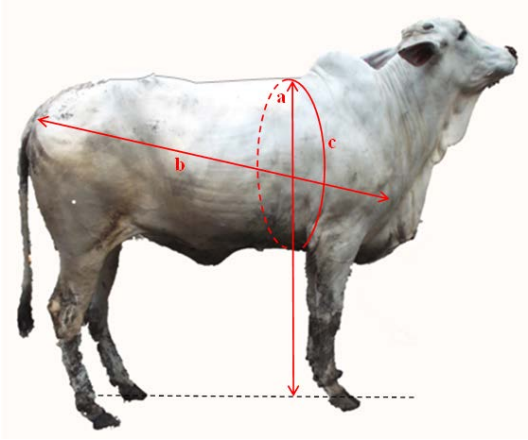

Figure 1. Scheme of body measurements for withers height (a), body length (b) and heart girth (c) in the SO cattle

Data analysis

Data of BW, WH, BL and HG were analyzed using SPSS 16.0 computer program to obtain the descriptive statistic (mean, standard deviation, coefficient of variation, minimum and maximum values). The T-test analysis was performed in this study to confirm the effect of sex. Thus, the linear regression analysis was made by BW as dependent variable and body measurements (WH, BL, HG) as independent variables). Pearson's coefficient of correlation (r) was analyzed to obtain r value between BW and body measurements. The linear regression equation referring to Steel and Torrie (1993) as follows:

$$Y = \alpha + \beta 1.X1 + \beta 2.X2 + ...+ \beta n.Xn + E$$

Note:

Y = dependent variable (BW)
α = intercept
β = regression coefficient
X = independent variable (WH, BL, HG)
E = error term

Accuracy of prediction equation for BW was estimated through the coefficients of determinations (R^2) and linear relationship between BW and other three body measurements using Pearson's correlation coefficients (r) was also calculated. Therefore, the collinearity analysis was performed in this study for detecting the correlation among independent variables. Detecting collinearity for body measurements in animal studied based on tolerance (T) and variance inflation factor (VIF). A variable suggested to collinearity when T<0.10 or VIF>10.00 (Yakubu 2009).

RESULTS AND DISCUSSION

Performance

Research showed that the performance data (BW, WH, BL and HG) in male and female animals were not significantly different as presented in Table 1. However, research showed that the performance of males animals was higher than

females animals but not significantly different. The mechanism of sex hormonal (androgen) can be influenced growth rate in male animal that was faster and havier than female animal (Soeparno 2005). Said et al. (2016) reported that the average BW in SO cows at 593.29 days of age was 159.43±27.66 kg and lower than SO cows (553.12 days of age) in this study. Thus, Putra and Agung (2018) reported that the body measurements in SO cattle at 365 days of age were 112.12±11.43 cm (WH); 115.56±14.20 cm (BL); 144.98±17.90 cm (HG) and were lower than in this study. The high coefficent of variation values (CV>20%) were showed in BW of male and females animals. High CV value in one trait reveals that this trait had highly variation and can be increased through selection (Steel and Torrie 1993).

Table 1. *Descriptive statistic of body weight and body measurement in SO cattle**

Measurement	Mean	SD	CV (%)	Min.	Max.
Bulls (N =17)					
Ages (days)	673.71	185.59	27.55	318	1075
Body weight (kg)	299.18	89.31	29.85	154	487
Withers height (cm)	122.53	8.75	7.14	105	136
Body length (cm)	129.41	11.75	9.08	113	147
Heart girth (cm)	164.47	18.99	11.55	127	209
Heifers (N = 41)					
Ages (days)	553.12	177.67	32.12	288	835
Body weight (kg)	226.59	92.83	40.97	102	445
Withers height (cm)	114.51	19.20	16.77	95	215
Body length (cm)	118.00	15.93	13.50	87	146
Heart girth (cm)	144.54	26.56	18.37	85	193
Total (N = 58)					
Ages (days)	588.47	186.78	31.74	288	1075
Body weight (kg)	247.86	96.94	39.11	102	487
Withers height (cm)	116.86	17.14	14.67	95	215
Body length (cm)	121.34	15.63	12.88	87	147
Heart girth (cm)	150.38	26.08	17.34	85	209

*(P>0.05); N= number of observation; SD= standard deviation; CV= coefficient of variation; Min.= minimum value; Max.= maximum value

Pearson's correlation coefficient

Pearson's correlation coefficient (r) between BW and among body measurements were ranged from 0.77 to 0.97 (bulls) and 0.45 to 0.93 (females) as presented in Table 2. The highest r value was showed in correlation between HG and BW i.e. 0.97 (bulls) and 0.93 (heifers) and included of very high category (0.81<r<1.00). The very high r value between HG and BW has been reporting in many breeds cattle such as Brow Swiss (0.98), Nyalawi (0.88), Tanzania Shorthorn Zebu (0.94), Kamphaengsaen (0.91), Aceh (0.93) and 0.83 in Bali (Serkan and Yalcin 2009; Alsiddiq et al. 2010; Kashoma et al. 2011; Sawanon et al. 2011; Putra et al. 2015; Agung et al. 2018). Thus, high category r value (0.60<r<0.80) between HG and BW were showed in Friesian Holstein (0.78) and Bali (0.70) cattle (Serkan and Yalcin 2009; Tisman and Putra 2015). The moderate r value (0.40<r<0.60) between HG and BW were showed in Nguni (0.58) and Ongole cross (0.48) cattle (Nesamvuni et al. 2000; Wijono et al. 2007).

Table 2. *Pearsons coefficient of correlation (r) between body weight and body measurements in bulls (above diagonal) and heifers (under diagonal)*

Correlation**	BW	WH	BL	HG
Body weight (BW)	-	0.92	0.86	0.97
Withers height (WH)	0.45	-	0.80	0.91
Body length (BL)	0.89	0.48	-	0.77
Heart girth (HG)	0.93	0.47	0.91	-

**(P<0.01)

Linear regression

Result showed that no collinearity detected in the all independent variables for both sexes (Table 3). The investigation the collinearity effect between two independent variable with highly r value is important to reduce error term in the linear regression equation (Aziz and Sharabi 1993). It can be concluded that there are no inter-correlation among

dependent variable. Hence, the regression analysis based on body measurements are accurate. The coefficient of determination (R^2) value in simple linear regression using HG as the independent variable (Model C) in both sexes was included of very high kategory ($0.81<R^2<1.00$) as presented in Table 4 and Table 5.

Table 3. *Tolerance (T) and varian inflation factor (VIF) values for the body measurements of SO cattle*

Sex	Body measurements	T	VIF	Remarks
Male	Withers height	0.15	6.64	Non-collinearity
	Body length	0.35	2.85	Non-collinearity
	Heart girth	0.17	6.03	Non-collinearity
Female	Withers height	0.76	1.31	Non-collinearity
	Body length	0.18	5.60	Non-collinearity
	Heart girth	0.18	5.59	Non-collinearity

Table 4. *Simple and multiple linear regression coefficient between body weight (dependent variable) and body measurements (independent variables) in SO bulls*

Model	Variable	Intercept	Regression coefficient			R	R^2	SE
			WH	BL	HG			
A	WH	-847.46	9.36	-	-	0.92	0.84	36.89
B	BL	-546.27	-	6.53	-	0.86	0.74	47.11
C	HG	-448.73	-	-	4.55	0.97	0.94	23.41
D	WH; BL	-842.53	6.48	2.69	-	0.94	0.89	32.27
E	WH; HG	-564.98	2.17	-	3.64	0.97	0.94	22.72
F	BL; HG	-555.63	-	2.11	3.54	0.98	0.97	17.47
G	BL; HG; WH	-588.09	0.72	1.98	3.30	0.98	0.97	17.92

WH= withers height; BL= body length; HG= heart girth; R= coefficient of correlation; R2= coefficient of determination; SE= standard error of the estimation

Table 5. Simple and multiple linear regression coefficient between body weight (dependent variable) and body measurements (independent variables) in SO heifers

Model	Variable	Intercept	Regression coefficient			R	R^2	SE
			WH	BL	HG			
A	WH	-24.24	2.19	-	-	0.45	0.21	83.81
B	BL	-382.90	-	5.17	-	0.89	0.79	43.48
C	HG	-244.93	-	-	3.26	0.93	0.87	33.74
D	WH; BL	-392.34	0.20	5.05	-	0.89	0.79	43.91
E	WH; HG	-249.69	0.07	-	3.24	0.93	0.87	34.16
F	BL; HG	-298.48	-	1.35	2.53	0.94	0.88	32.86
G	BL; HG; WH	-298.76	0.01	1.35	2.53	0.94	0.88	33.30

WH= withers height; BL= body length; HG= heart girth; R= coefficient of correlation; R2= coefficient of determination; SE= standard error of the estimation

Previous studies reported that very high category of R^2 were reported in many breeds cattle such as Tanzania Shorthorn Zebu (0.88), Horro (0.87), Kamphaengsaen (0.83), Nilotic (0.95), Sahiwal (0.97), Boran cross (0.90) and 0.94 for Somba (Kashoma et al. 2011; Goe et al. 2011; Sawanon et al. 2011; Milla et al. 2012; Siddiqui et al. 2015; Odadi 2018; Vanvanhossou et al. 2018). Meanwhile, high category of R^2 value ($0.61<R2<0.80$) in Model C regression were reported in some breeds cattle of Abyssinian (0.65), Friesian Holstein (0.61), Bali (0.76), crossbred dairy (0.67) and 0.73 for Lagune (Goe et al. 2001; Serkan and Yalcin 2009; Zurahmah and Enos 2011; Lukuyu et al. 2016; Comlan et al. 2017). Alsiddiq et al. (2010) reported that low R^2 value ($0.21<R^2<0.40$) in Model C regression was showed in Nyalawi cattle (0.38). Thus, $R^2 = 0.94$ in Model C regression (bull) reveals that about 94% of BW was influenced by HG variable and the remaining 6% was influenced by other factors outside the model such as cattle condition when measured and weighed, measurements method, accuracy of measuring instruments and others. According to Model C regression, increasing 1 cm of HG was followed by increasing 4.55 kg (bull) and 3.26 kg (heifer) of BW. The simple linear regression line of Model C in both sexes was presented in Figure 2.

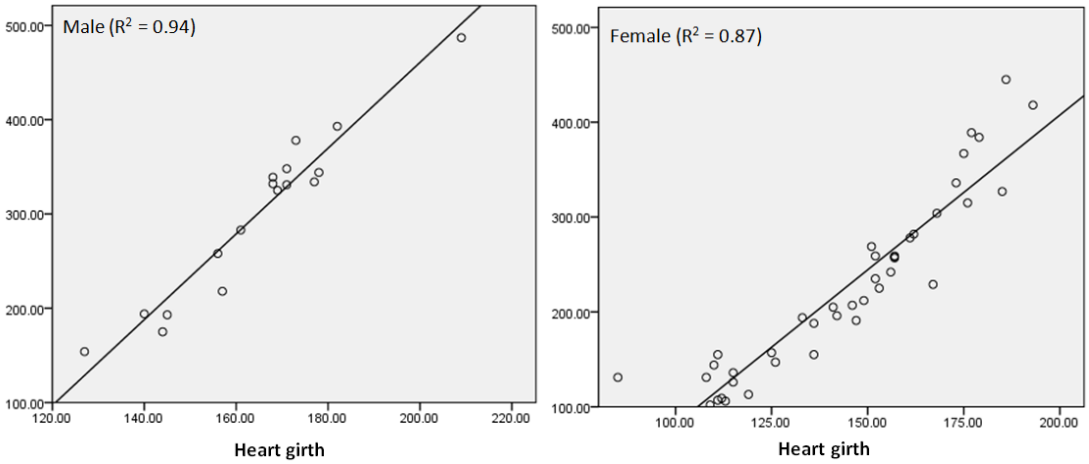

Figure 2. The linear regression line for body weight based on heart girth in SO cattle

Several studies reported that simple linear regression based on HG variable were accurately to predict BW in some breeds cattle of Kamphaengsaen, Aceh, Sahiwal, Bali cross and Bali (Sawanon et al. 2011; Putra et al. 2015; Tisman and Putra 2015; Siddiqui et al. 2015; Agung et al. 2018). In contrast, Hapsari et al. (2018) obtained the R^2 value of 0.68 (moderate) in SO bulls and not accurate for weight prediction. According to Table 4, the R^2 value in between Model C regression close to R^2 value in multiple linear regression (Model E, F and G) and reveals that BW prediction in this study can be predicted efficiently with HG measurements.

CONCLUSION

The strong relationship between BW and HG in SO cattle indicated that HG variable can be used as BW predictor for SO cattle at 673.71 days of age (bulls) and 553.12 days of age (heifers). Thus, the simple linear regression with HG as the predictor variable had highly of R2 value and can be used to predict BW in SO cattle.

ACKNOWLEDGMENT

The authors would like to thank to Mr. Karnadi Wiyaga (director), Mr. Aditya Sudiro (farm manager) and all staff at PT. KAR for help in data collection.

REFERENCES

Agung PP, Anwar S, Sudiro A, Said S, Tappa B 2015. The potency of Sumba Ongole (SO) cattle: A study of genetic characterization and carcass productivity. J Indonesian. Trop. Anim. Sci. Agric. 40: 71-78. DOI:10.14710/jitaa.40.2.71-78

Agung PP, Putra WPB, Anwar S, Wulandari AS 2018. Body weight estimation of Bali cattle in Banyumulek Techno Park West Nusa Tenggara using several morphometric parameters. Bullet. Anim. Sci. 42:20-25. DOI:10.21059/buletinpeternak.v42i1.29840

Alsiddiq MA, Babiker SA, Galal MY, Mohammed AM 2010. Phenotypic characterization of Sudan Zebu cattle (Baggara type). Res. J. Anim. Vet. Sci. 5: 10-17

Aziz MA, Sharabi MA 1993. Collinearity as a problem in predicting body weight from body dimensions of Nadji sheep in Saudi Arabia. Small Rum. Res. 12: 117-124. DOI: 10.1016/0921-4488(93)90076-T.

Comlan ABG, Adjasin JS, Alkoiret TI (2017). Use of body measurements to estimate live weight of Lagune cattle in southern Benin. HAYA Saudi J. Life Sci. 2: 23-32. DOI: 10.21276/haya.2017.2.2.1.

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

Gunawan A, Jakaria 2010. Application of linear body measurements for predicting weaning and yearling weight of Bali cattle. Anim. Prod. 12: 163-168.

Hapsari TA, Socheh M, Purbojo SW, Yuwono P, Warsiti T 2015. The body weight estimation in Sumba Ongole cattle using linear body measurements. In: Proceedings of the 3th National Seminar of Animal Husbandry Resurrection, July 7 2018, Semarang, Indonesia, pp. 316-320.

Kashoma IPB, Luziga C, Werema CW, Shirima GA, Ndossi D 2011. Predicting body weight of Tanzania Shorthorn Zebu cattle using herat girth measurements. Livest. Res. Rur. Dev.23.

Lukuyu MN, Gibson JB, Savage DB, Duncan AJ, Mujibi FDN, Okeyo AM 2016. Use of body linear measurements to estimate liveweight of crossbred dairy cattle in smallholder farms in Kenya. Springer Plus. 5: 63-77. DOI:10.1186/s40064-016-1698-3

Milla AP, Mahagoup MMM, Bushara I 2012. Estimation of live body weight from heart girth, body length and in condition score in Nilotic cattle - Southern Sudan. Agric. Tech. Trans. Soc. Meg. 1: 15-19.

Nesamvuni AE, Mulaudzi J, Ramanyimi ND, Taylor GJ 2000. Estimation of body weight in Nguni-type cattle under communal management condition. South Afr. J. Anim. Sci. 30: 97-98. DOI: 10.4314/sqjqs.v30i4.3927.

Odadi WO 2018. Using heart girth to estimate live weight of heifers (Bos indicus) in pastoral rangelands of northern Kenya. Livest. Res. Rur. Dev. 30.

Ozkaya S, Bozkurt Y 2009. The accuray of prediction of body weight from body measurements in beef cattle. Arch. Tierz. 52: 371-377. DOI: 10.5194/aab-52-371-2009.

Paputungan U, Hakim L, Ciptadi G, Lapian HFN 2013. The estimation accuracy of live weight from metric body measurements in Ongole grades cattle. J. Indonesian Trop. Anim. Agric. 38: 149-155. DOI: 10.14710/jitaa.38.3.149-155.

Putra WPB, Sumadi, Hartatik T, Saumar H 2015. Relationship between body weight and body measurements of Aceh cattle. Malaysian J. Anim. Sci. 18: 35-43.

Putra WPB, Agung PP, Said S 2018. Non-genetic factor and genetic parameter analysis for growth traits in Sumba Ongole (SO) cattle. J. Indonesian Trop. Anim. Sci. Agric. 43: 94-106. DOI: 10.14710/jitaa.43.2.94-106.

Putra WPB, Agung PP 2018. The estimated breeding value of body measurements in Sumba Ongole cattle at yearling age. In: Proceedings of the 3th National Seminar of Animal Husbandry Resurrection, July 7 2018, Semarang, Indonesia, pp. 327-334.

Said S, Agung PP, Putra WPB, Anwar S, Wulandari AS, Sudiro A 2016. Selection of Sumba Ongole (SO) cattle based on breeding value and performance test. J. Indonesian Trop. Anim. Sci. Agric. 41: 175-187. DOI:10.14710/jitaa.41.4.175-187.

Sawanon S, Phoompong B, Preecha I 2011. Body measurements of male Kamphaengsaen beef cattle as parameters for estimation of live weight. Kasetsart J. Nat. Sci. 45: 428-434.

Serkan O, Yalcin B 2009. The accuracy of prediction of body weight from body measurements in beef cattle. Arch. Tierz. 52: 371-377. DOI: 10.5194/aab-52-371-2009.

Siddiqui MU, Lateef M, Bashir MK, Bilal MQ, Muhammad G, Mustafa MI, Rehman S. 2015. Estimation of live weight using different body measurements in Sahiwal cattle. Pak. J. Live Soc. Sci. 13: 12-15.

Soeparno 2005. Meat Science and Technology. 4th ed. Gadjah Mada University Press, Yogyakarta, Indonesia.

Steel RGD, Torrie JH 1993. Principle and Procedure of Statistics: A Biometrical Approach. 2nd ed. Mc-Grawhill International Book Inc., Toronto, Canada.

Tisman R., Putra WPB 2015. Relationship between body measurements and body weight in Bali (Bos javanicus) and Bali cross (Bos taurus × Bos javanicus) bulls in Muaro Jambi Regency of Indonesia. J. Appl. Anim. Sci. 8: 33-42.

Vanvanhossou SFU, Rodrigue VCD, Luc HD 2018. Estimation of live body weight from linear body measurements and body condition score in the West African Savannah Shorthorn cattle in North-West Benin. Cogent Food & Agric. 4: 1549767.DOI: 1080/23311932.2018.1549767.

Wijono DB, Hartati, Dicky MD 2007. Correlation of body size with growth rate of live weight of Ongole crossbred cattle. Proceedings of the 20th National Congress of Animal and Veterinary Technology, July 27 2007, Bogor, Indonesia, pp. 236-239.

Yakubu A 2009. Fixing collinearity instability in the estimation of body weight from morpho-biometrical traits of West African Dwarf goat. Trakia J. Sci. 7: 61- 66.

Zurahmah N, Enos T 2011. The estimation of body weight of bulls candidate of Bali cattle using some body dimension. Bullet. Anim. Sci. 35: 160-164.