PAPER • OPEN ACCESS

Use of body measurements to predict live body weight of Simmental bull in Lembang Artificial Insemination Center, West Java

To cite this article: U S Shoimah *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **888** 012030

View the article online for updates and enhancements.

You may also like

- A comparative technological indicator analysis of bred cow productivity of main breeds in the Voronezh region
V V Krupitsyn, A V Vostroilov, E I Ruzhkov et al.
- Farmer's decision in selecting the bull semen for artificial insemination in Central Java
R Agustine, S Bintara, S Andarwati et al.
- Percentage Value of Membrane Integrity and Acrosome Integrity Spermatozoa in Simmental Liquid Semen with Addition Penicillin and Sweet Orange Essential Oil
S A Sitepu and J Marisa

This content was downloaded from IP address 110.137.39.244 on 16/11/2021 at 03:06

Use of body measurements to predict live body weight of Simmental bull in Lembang Artificial Insemination Center, West Java

U S Shoimah, A Dakhlan, Sulastri and M D I Hamdani

Department of Animal Husbandry, Faculty of Agriculture, University of Lampung, Indonesia, Jl. Prof. Dr. Soemantri Brojonegoro No. 1 Gedung Meneng Bandar Lampung 35145

Corresponding author e-mail: akhmad.dakhlan@fp.unila.ac.id

Abstract. This research aimed to evaluate the use of body measurements (chest girth (CG), body length (BL), and shoulder height (SH)) to predict live body weight (BW) of Simmental bulls in Lembang Artificial Insemination Center, West Java. This research was carried out in December 2019 using a survey method of which all Simmental bulls aged 1—12 years were used in this study. Data were analyzed using simple and multiple correlations and regression models using the R program. Pearson correlation analysis was used to analyze correlation between BW and body measurements, while to find the fittest and more parsimonious regression model we used determination coefficient (R^2) and stepwise regression analysis as criteria of selection. The results showed that the average of BW, CG, BL, and SH were 814.54 ± 144.18 kg, 215.72 ± 16.50 cm, 170.13 ± 17.09 cm, and 142.79 ± 11.01 cm, respectively. The results of this study also indicated that CG, BL, and SH positively and significantly correlated with BW, with correlation value of 0.90, 0.85, and 0.79, respectively. Combination of CG, BL, and SH produced the highest correlations value (r = 0.92) with the fittest regression model for predicting BW, namely BW= -888.64 + 4.21*CG + 2.83*BL + 2.20*SH, with R^2 of 0.86.
Keywords: Simmental bull, Live body weight, Chest girth, Body length, Shoulder height

1. Introduction

The Lembang Artificial Insemination Center (BIB Lembang) is one of the National BIBs mandated by the central government to provide superior frozen semen for livestock. The establishment of this institution is to increase the livestock productivity and population in Indonesia, namely through the Artificial Insemination program (AI). According to the 2018 statistical data, the population of beef cattle in Indonesia is 17,050,006 heads [1]. This amount is not sufficient for domestic meat needs, so the shortfall must be met through imports of beef cattle. With the AI program, the government can reduce livestock import activities from neighboring countries and it is hoped that it can meet the needs of animal protein for people in Indonesia.

Simmental bull is one of the beef cattle raised at BIB Lembang to produce semen. The bull was chosen because it has fast growth and good performance. Besides that, the beef temperament is tame and easy to control. Based on these advantages, Simmental cattle are in great demand by breeders but their distribution in Indonesia is still not evenly distributed. Many breeders choose the AI program to get offspring of Simmental breeds, one of which is Simpo cattle. Simpo cattle are the result of crossing male Simmental cattles with female Ongole cattle or Ongole Grade or “sapi Peranakan Ongole (PO)”.

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

Superiority of Simmental cattle can be seen from its body weight. Body weight is one indicator of livestock productivity that can be estimated based on its body measurements which includes chest girth (CG), body length (BL) and shoulder height (SH) [2,3,4,5,6,7,8,9,10,11,12]. Livestock body weight is a parameter that can be used to determine carcass weight and the selling price of livestock. Furthermore, the BW of bulls has a very significant effect on semen production, including the volume and concentration of fresh semen [13].

Measuring the BW of cattle usually uses a measuring instrument in the form of a scale. However, cattle scales are impractical for use in the field. Therefore, another alternative is needed to determine the BW of cattle, one of which is the estimation using a correlational formula between BW and several dimensions of the body of the cattle. Estimates using the correlational formula between BW and body measurements in Simmental cattle are still not widely carried out so it is necessary to conduct a study on correlation and regression analysis of body measurements and BW in Simmental bulls at BIB Lembang, West Java to get the results of the animal BW prediction and assessment with good accuracy. This study aimed to predict the live body weight of Simmental bulls using their body measurements.

2. Materials and methods

This research was conducted in December 2019 at BIB Lembang, West Java. Fifty-two bulls of Simmental aged 1-12 years were used in this study. The equipment used was the Cas brand digital livestock scale with a capacity of 2 tons with an accuracy of 1 kg, a measuring tape for the Rondo brand with an accuracy of 0.1 cm, a measuring stick for the FHK brand with a capacity of 2 meters with an accuracy of 0.2 cm, stationery, and camera or cellphone for documentation.

The method used in this research was the survey method, namely all Simmental bulls in BIB Lembang were used and measured. The variables observed in this study were BW (kg), CG (cm), BL (cm), and SH (cm). Bodyweight (BW) was measured directly using a digital scale. Chest girth (CG) was measured at the chest cavity by wrapping a meter tape just behind the elbow of the bull's front leg, while body length (BL) was measured straightly from the elbow to the lump of the sitting bone using a measuring stick. Shoulder height (SH) is the perpendicular distance from the highest point of the shoulder to the ground or floor. The data obtained were analyzed using simple and multiple correlations and regression models using the R program [14, 15]. Pearson correlation was used to analyze the correlation between BW and body measurements. We used determination coefficient (R^2) and stepwise regression analysis to find the best regression model for predicting the BW of Simmental bull. The regression model with the highest R^2 and more parsimonious is the best.

3. Results and discussion

3.1 Body weights and body measurements of Simmental bull

Based on the research that has been done, the statistic of body weight and body measurements including CG, BL, and SH are presented in Table 1 and shown in Figure 1.

Table 1. Data distribution of body weight and body measurements of Simmental cattle in BIB Lembang.

Variable	Mean	Sd	Median	Minimum	Maximum
Body weight (kg)	814.54	144.18	839.00	374	1018
Chest girth (cm)	215.72	16.50	218.00	164	237
Body length (cm)	170.13	17.09	174.00	108	194
Shoulder height (cm)	142.79	11.01	143.90	106	172

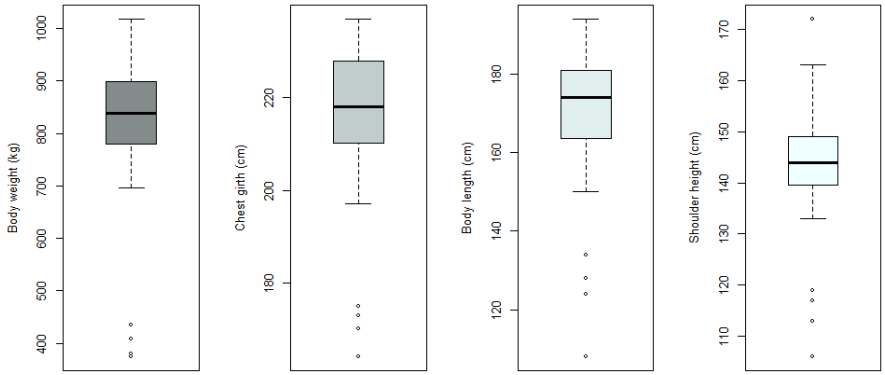

Figure 1. Boxplot of data of body weight, chest girth, body length, and shoulder height of Simmental bulls.

The results of this study indicated that the data of BW and body measurements varied very widely, we can see that, for example, the average BW of Simmental bull at BIB Lembang was 814.54 ± 144.18 kg with a median value of 839 kg, the smallest data of 374 kg, and the largest data of 1018 kg. This might be due to the difference in the age of the bulls which also varied considerably from 1-12 years old. The Bodyweight of Simmental bull of this study was higher than that reported by [2] that BW of male Simbal (Simmental x Bali) cattle aged 1-2 years was 365.12 ± 29.85 kg, and that reported by [16] that BW of male Simbal cattle aged 2-2.5 years was 276.29±7.12 kg, and that reported by [17] that BW of male SimPO (Simmental x PO) cattle whose 2 incisors changed was 387.48±46.43 kg. However, the results of this study are lower when compared to the statements of [18] that the bodyweight of adult male Simmental cattle can reach 1150 kg, while female Simmental cattle can reach 800 kg. This happens because the Simmental bulls rearing at BIB Lembang are not intended as beef cattle, but rather as feeder cattle for which semen will be produced. The raising of beef cattle aims to increase body weight as much as possible in order to achieve production targets while raising feeder cattle aims to maximize semen production with good quality and quantity of semen.

The average body weight of Simmental bulls in this study was 814.54 ± 144.18 kg, almost close to the best bodyweight for feeder Simmental cattle. This is in accordance with the results of research by [13] that the quality of fresh semen from Simmental cattle with the highest value is in the moderate body weight group, namely 840 kg and 846 kg. This quality of fresh semen is based on color, consistency, volume, individual motility, and the number of motile spermatozoa. The best bodyweight can be obtained through good rearing management, one of which is feeding management. Feeding management at BIB Lembang was good enough. The feed given was in the form of concentrate with a special formulation for bull cattle produced by PT. Charoen Pokhpand Indonesia and forage in the form of corn sugar, Odot grass, Elephant grass and African grass, and given supplements in the form of bean sprouts and mineral blocks.

The mean CG, BL, and SH of Simmental bulls in this study were 215.72 ± 16.50 cm, 170.13 ± 17.09 cm, and 142.79 ± 11.017 cm, respectively (Table 1). Body measurements of this study are higher than those reported by [2] that CG, BL, and SH of male Simbal cattle aged 1-2 years were 160.37 ± 7.28 cm, 134.40 ± 6.50 cm, and 124.93 ± 4.85 cm, respectively. These results are greater than the results of [19] that the average size of CG, BL, and SH in male Simsimbal (Simmental x Simbal) cattle aged 1-2 years was 158.40 ± 11.24 cm, 123.63 ± 7.59 cm, and 115.20 ± 4.37 cm, respectively. The results of this study are also greater than the results of [16] that CG, BL, and SH of male Simbal cattle aged 2-2.5 years were 155.3±1.64 cm, 126.6±1.07 cm, and 123.7±2.31 cm, respectively. The results of this study are also greater than the results of [20] that CG, BL and SH of male Simbal cattle aged 1-2 years were 162.53 ± 8.04 cm, 136.46 ± 6.27 cm, and 125.30 ± 5.18 cm, respectively. It is reported by [17] that CG, BL, and SH of male SimPO cattle were 167.80±7.98, 117.54±7.00, and 130.46±3.46 cm, respectively, while

according to [21], those were 164.83±9.58 cm, 124.43±8.76 cm, and 124.65±5.36 cm, respectively. The greater body measurements of the results of this study could be due to the difference in breeds between Simmental, Simbal, SimPO, and Simsimbal cattle. Besides that, the material used in this study was more diverse, namely using the age of 1-12 years.

This is in accordance with the result reported by [22] that livestock breed can affect livestock weight. The weight gain of *Bos taurus* cattle is greater than that of *Bos indicus* cattle. Simmental cattle that is selected as feeder cattle will have good performance so that their body sizes will be higher. In general, the morphology of crossbreeding Simmental cattle will change and differ their phenotypic qualitatively and quantitatively compared to purebred Simmental cattle [21, 23].

3.2 Correlation between body weight and body measurements of Simmental bulls

Based on the research that has been done, the results showed that there was a positive and significant correlation between BW and body measurements in Simmental bulls in BIB Lembang (Table 2). Table 2 and Figure 2 show us that CG has the highest correlation (0.90) with BW, followed by BL (0.86) and SH (0.80). The results of this study are in line with the results of research of [8] reported that the relationship between CG and BW of the SimPO breed cattle aged 2-3 years was very strong with an r-value of 0.851. It is reported by [10] that the relationship between BW and CG, BW and BL, and BW and SH of SimPO cattle were 0.902, 0.808, and 0.789, respectively. It is reported by [6] that the relationship between CG, BL, SH, and BW of Aceh cattle at weaning age were 0.65, 0.56, and 0.64, respectively and at yearling age were 0.69, 0.58, and 0.55, respectively.

Table 2. Simple and multiple correlations between body weight and body measurements of male Simmental cattle in BIB Lembang.

Simple and multiple correlation	Correlation Coefficient (r)	Significance
Simple correlation		
BW ~ CG	0.900	2.2e-16 **
BW ~ BL	0.859	3.612e-16 **
BW ~ SH	0.797	1.551e-12 **
Multiple correlations		
BW ~ CG + BL	0.916	2.2e-16 **
BW ~ CG + SH	0.900	2.2e-16 **
BW ~ BL + SH	0.900	2.2e-16 **
BW ~ CG + BL + SH	0.923	2.2e-16 **

Note: BW = Body weight, CG = Chest girth, BL = Body length, SH = Shoulder height
** = Significance level at 1% (P<0.01).

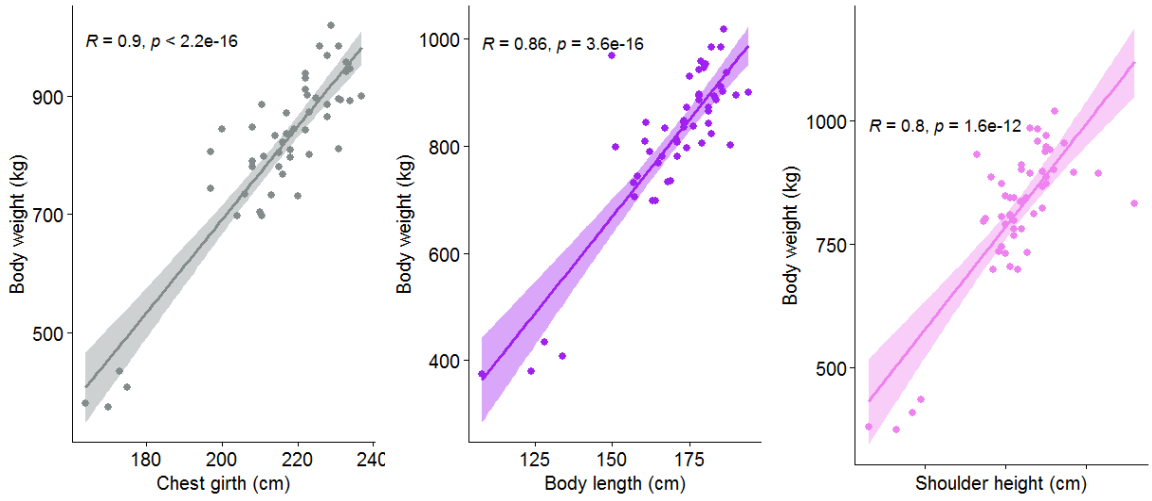

Figure 2. Visualization of correlation between body weight and body measurements.

Chest girth had the highest correlation value with BW in this study, presumably because there are vital organs such as the heart and lungs that grow in the chest cavity so that the enlargement of the chest cavity will be in line with the growth of the cattle. These organs will grow and develop in line with the growth of the livestock. In addition, bodyweight gain will also be influenced by fat accumulation. In addition to CG, BL and SH also had a very strong correlation value with BW meaning that the longer and the higher the body is the more bodyweight increases.

Multiple correlations of the results of this study which has the highest correlation value with BW was the combination of CG, BL, and SH which had a significant correlation value of 0.923. Meanwhile, the lowest significant correlation value was the combination of CG and SH with an r-value of 0.900. This could be because at the age of the cattle that have reached puberty, the growth of the leg bones will stop so that there will only be a buildup of fat on the shoulders so that if SH is combined with CG, the addition of SH variable is not significant to increase r value. These results agree with [24] that, when the bones in the body of cattle (including the leg bones) are in optimum growth, their growth will stop, while the ribs can still grow and develop because they are the bones with the last growth so that it can increase the size of CG.

The results of this study are in accordance with the result of [7] and [25] who reported that CG, BL, and SH are body measurements that have the highest correlation with BW. In addition, these body measurements are very determining variables for the estimation of BW. The closeness of the relationship between BW and body measurements can be used as a basis for determining prospective candidates.

3.3 Regression equations between body weight and body measurements of Simmental bull

The regression equation between BW and body measurements (CG, BL, and SH) of Simmental bulls in BIB Lembang were BW = -882.91 + 7.87*CG, BW = -418.36 + 7.25*BL and BW = -674.98 + 10.43*SH, respectively. Based on the regression equation, for example, every 1 cm increase in CG will be followed by an increase in BW of 7.87 kg, likewise in the regression equation on BL and SH, BW increases according to the magnitude of the regression coefficient. Regression coefficients of the results of this study were higher than those of [8] results in male SimPO, that the regression equation between CG and BW at 1.5-2 years, 2-3 years, and 3-3.5 years were BW = -387.81 + 4.74*CG, BW = -906.27 + 7.34*CG, and BW = -287.34 + 4.27*CG, respectively, and between BL and BW were BW = -215.996 + 4.89*BL, BW = -432.25 + 6.05*BL, and BW = -106.77 + 4.19*BL, respectively. This means that changes in body measurements of Simmental bull affected the changes of BW higher compared to the result of [8]. The simple and multiple regression models in this study are presented in detail in Table 3.

Table 3. The regression equation of body measurements on body weight of Simmental bulls in BIB Lembang.

Regression models	Regression equation	Coefficient of deiermination (R^2)
BW ~ CG	BW = –882.91 + 7.87*CG	0.811
BW ~ BL	BW = –418.36 + 7.25*BL	0.738
BW ~ SH	BW = –674.98 + 10.43*SH	0.635
BW ~ CG + BL	BW = –830.72 + 5.31*CG + 2.93*BL	0.846
BW ~ CG + SH	BW = –945.99 + 6.52*CG + 2.47*SH	0.823
BW ~ BL + SH	BW = –743.55 + 4.99*BL + 4.97*SH	0.810
BW ~ CG + BL + SH	BW = –888.64 + 4.21*CG + 2.83*BL + 2.20*SH	0.856

Note: BW = Body weight, CG= Chest girth, BL = Body length, SH = Shoulder height

Based on Table 3 it can be seen that the combination of CG, BL, and SH had the fittest prediction of BW with the highest coefficient of determination (R^2), namely 0.856 (85.6% of Simmental bull body weight is influenced by CG, BL, and SH, while the rest is influenced by other factors). The regression equation of the three combinations of body measurements was BW = -888.64 + 4.206*CG + 2.831*BL + 2.199*SH which means that every 1 cm increase in CG if the BL and SH are constant, it will be

followed by an increase in BW of 4.2 kg. Meanwhile, the regression equation between SH and BW had the lowest R^2 value (0.635) with the regression equation of BW = –674.98 + 10.431*SH. The results of this study indicated that body measurements (CG, BL, and SH) can be suggested to be used as an estimator of BW in Simmental bulls. The multiple regression in this study was higher than that of [6] results, who reported that multiple regression analysis based on CG, BL, and SH at weaning age of Aceh cattle was BW = -30.23 + 0.48*CG + 0.13*BL + 0.51*SH with a value R^2 0.54 (54%).

The scatter plot and regression line of the regression equation using a single body measurement against BW can be visualized as in Figure 3.

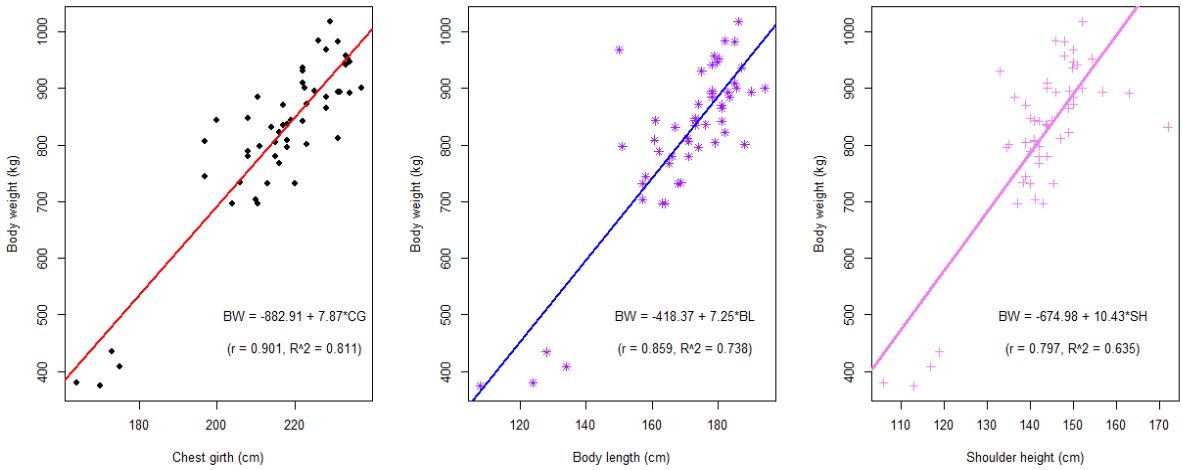

Figure 3. Scatter plot and regression line between body weight and body measurements of Simmental bull in BIB Lembang.

Figures 3 illustrate that the regression between shoulder height and body weight has the highest regression coefficient which means that it has the greatest influence on changes in body weight, while the regression of CG and BL on BW has a similar regression coefficient. However, the three regression equations have very different intercepts. Although the regression equation of SH and BW had a higher regression coefficient, the coefficient of correlation (r) and determination (R^2) of SH on BW was lower than those of CG and BL on BW in Simmental bull. All these differences may be caused by differences in each part of the body that has different growth and content of meat or fat attachment.

4. Conclusion

Body measurements have a positive and significant correlation with body weight with chest girth has the highest relationship with bodyweight. Chest girth is the best predictor for the bodyweight of Simmental bulls if using single body measurement. Combination of chest girth, body length, and shoulder height was the fittest in predicting bodyweight of Simmental bull with a regression model of BW= -888.64 + 4.21*CG + 2.83*BL + 2.20*SH and with R^2 of 0.86.

References

[1] Badan Pusat Statistik 2018 Populasi Sapi Potong Menurut Provinsi 2009-2018. https://www.bps.go.id/linkTableDinamis/view/id/1016

[2] Almakmum H, Depison dan Ediyanto H 2121 Karakteristik Kuantitatif Sapi Bali dan Sapi Simbal (Simmental X Bali) di Kecamatan Renah Pamenang Kabupaten Merangin. *Jurnal Ilmu Peternakan dan Veteriner Tropis* **11(1)** 30-39

[3] Dakhlan A, Hamdani M D I, Putri D R, Sulastri, and Qisthon A 2021 Short Communication: Prediction of body weight based on body measurements in female Saburai goats. *Biodiversitas* **22** 1391-1396

[4] Dakhlan A, Saputra A, Hamdani M D I, and Sulastri 2020 Regression models and correlation analysis for predicting body weight of female Ettawa Grade goat using its body measurements *Adv. in Anim. and Vet. Sci.* **8(11)** 1142-1146. DOI: 10.17582/journal.aavs/2020/ 8.11.1142.1146
[5] Kusuma S B, Ngadiyono N, and Sumadi 2019 The correlation of body measurements and weights of Ongole crossbred (PO) cattle in Kebumen Regency *Proceeding of The 7th International Seminar on Tropical Animal Production*, September 12-14, Yogyakarta, Indonesia. p 880-884
[6] Ikhsanuddin, Nurgiartiningsih V M A, Kuswati dan Zainuddin 2018 Korelasi ukuran tubuh terhadap bobot badan sapi aceh umur sapih dan umur satu tahun *Agripet* **18(2)** 117-122
[7] Agung P P, Putra W P B, Anwar S, and Wulandari A S 2018 Body Weight Estimation of Bali Cattle in Banyumulek Techno Park, West Nusa Tenggara using Several Morphometric Parameters *Buletin Peternakan* **42(1)** 20-25
[8] Suliani S, Pramono A, Riyanto J dan Prastowo S 2017 Hubungan ukuran-ukuran terhadap bobot badan sapi Simmental Peranakan Ongole jantan pada berbagai kelompok umur di rumah pemotongan hewan Sapi Jagalan Surakarta. *Sains Peternakan* **15 (1)** 16-21
[9] Lukuyu M N, Gibson J P, Savage D B, Duncan A J, Mujibi F D N and Okeyo A M 2016 Use of body linear measurements to estimate liveweight of crossbred dairy cattle in smallholder farms in Kenya *SpringerPlus* **5:63** 1-14 DOI 10.1186/s40064-016-1698-3
[10] Prabowo S, Rusman, dan Panjono 2012 Variabel penduga bobot karkas sapi Simmental Peranakan Ongole jantan hidup *Buletin Peternakan* **36(2)** 95-102
[11] Ni'am H U M, Purnomoadi A, dan Dartosukarno S 2012 Hubungan antara ukuran-ukuran tubuh dengan bobot badan sapi Bali betina pada berbagai kelompok umur *Anim. Agric. J.* **1(1)** 541-556
[12] Ozkaya S and Bozkurt Y 2009 The accuracy of prediction of body weight from body measurements in beef cattle *Arch. Tierz.* **52(4)** 371-377
[13] Adhyatma M, Isnaini N dan Nuryadi 2013 Pengaruh bobot badan terhadap kualitas dan kuantitas semen sapi Simmental *Jurnal Ternak Tropika* **14(2)** 53-62
[14] R Core Team 2020 R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.
[15] Dakhlan A 2019 Experimental Design and Data Analysis Using R. Graha Ilmu (Matematika), Yogyakarta.
[16] Syaiful L, Khasrad K, dan Maulida S 2020 Identifikasi ukuran tubuh sapi Bali dan Simbal (Simmental-Bali) di Kecamatan Luhak Nan Duo Kabupaten Pasaman Barat *Jurnal Sains Peternakan Indonesia* **15(2)** 219-226
[17] Dhita N T, Hamdani M D I, dan Adhianto K 2017 Karakteristik kualitatif dan kuantitatif sapi Peranakan Ongol dan Sapi Simpo jantan pada gigi seri berganti 2 di Kecamatan Terbanggi Besar Kabupaten Lampung Tengah *Jurnal Riset dan Inovasi Peternakan* **1(2)** 28-32.
[18] Sugeng B Y 1998 Sapi potong. Penebar Swadaya, Jakarta.
[19] Asri S 2018 Studi Perbandingan Ukuran Linier Tubuh Dan Bobot Badan Sapi Hasil Persilangan Sapi Simmental dan Sapi Simbal Muda Di Kabupaten Lombok Timur. Skripsi. Universitas Mataram, Mataram.
[20] Zafitra A, Gushairiyanto H, Ediyanto dan Depison 2020 Karakterisasi Morfometrik dan Bobot Badan pada Sapi Bali dan Simbal di Kecamatan Bangko Kabupaten Merangin *Majalah Ilmiah Peternakan* **23(2)** 66-71
[21] Triefana I G S, Budisatria, dan Hartatik T 2011 Perubahan fenotip sapi Peranakan Ongole, Simpo, dan Limpo pada keturunan pertama dan keturunan kedua (Backcross) *Buletin Peternakan* **35(1)** 11-16
[22] Depison 2010 Performans anak hasil persilangan induk sapi Bali dengan beberapa bangsa pejantan di Kabupaten Batanghari Provinsi Jambi *Jurnal Agripet* **10(1)** 37-41
[23] Agung P P, Ridwan M, Handrie, Indrawati, Saputra F, Suprapto, dan Erinaldi 2014 Profil morfologi dan pendugaan jarak genetik sapi Simmental hasil persilangan *JITV* **19(2)** 112-122

[24] Pálsson H and Vergés J 1952 Effects of the plane of nutrition on growth and the development of carcass quality in lambs Part I and II. The effects of High and Low planes of nutrition at different ages. *The Journal of Agricultural Science* **42(1-2)** 1-92. doi: 10.1017/S0021859600058718

[25] Hikmawity, Bellavista, A. T. B. A. Mahmud dan A. Salam. 2018. Korelasi Bobot Badan dan Variabel-Variabel Ukuran Tubuh Sebagai Dasar Seleksi Calon Induk Sapi Bali. Agrovital: Jurnal Ilmu Pertanian **3(1)** 11-13.