Deviation of Body Weight Estimation using Lambourne Formula Against Aceh Bull's Actual Body Weight

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Abstract. This study aims to determine the percentage of body weight deviation of Aceh bull using the Lambourne formula and compared to the actual weight of Aceh bull. The sample used in this study was 50 Aceh bull aged 2-2.5 years in BPTU-HPT Indrapuri Aceh. The parameters observed were Body Length (BL), Chest Circumference (CC), and Body Weight (BW). BL measurement procedure was conducted by measuring the distance between the lateral humeral tuberculum to the ischiadium tuberculum using a measuring stick. CC was measured by encircling the chest cavity which is behind the shoulder bone joint (os scapula) using measuring tape. BW measurement procedure was carried out in two ways, first with digital livestock scales and second with Lambourne formula. The percentage of body weight deviation of Aceh bull using Lambourne formula to the actual's Aceh bull body weight was 3.41% with regression equation was $Y = -350.30 + 2.27x_1 + 2.06x_2$.

Keywords: chest circumference, body length, Lambourne formula, and Aceh bull.

1 Introduction

Aceh cattle are a local cows that have been designated as one of the original Indonesian cattle based on a Decree of the Ministry of Agriculture No. 2907 / Kpts / OT.140 / 6/2011 on June 17, 2011. Aceh cattle are commonly found in Aceh Province and are generally kept as a source of meat and are used as working cattle in agricultural land management. Aceh beef is still in great demand by the Acehnese people, so the price of Aceh beef is relatively more expensive than other cattle [1]. Livestock body weight is one of the parameters of livestock productivity. Livestock body weights are usually used to determine the sale value of livestock [2]. Besides livestock body weight is also needed as a reference for calculating the dosage of medicines given if livestock are sick. Determination of ideal body weight will provide an appropriate therapeutic effect on cattle [3]. Therefore, accurate determination of body weight in livestock is very important.

Determination of livestock body weight can be conducted in two ways, first by weighing using a scale and second by estimating through measurement of several body measurements such as chest circumference, body length and chest width [4]. In general, determining the actual bodyweight of livestock through weighing livestock is not always possible and is considered to be impractical. Although some types of scales for livestock are easy to carry and are widely sold in the market, this has not been able to overcome the problem in measurement because it is impractical and expensive [5].

Several studies have been conducted related to the assessment of livestock body weight by measuring certain body parts of livestock. The measurement is then calculated using a formula, thus the formula can be obtained in determining animal body weight. Livestock body parameters that are often used in measuring livestock body weight include breast circumference and body length [6]. This can be done because the animal body measurements have a relationship between the components and the body condition of the animal including body weight [7]. According to [8], the correlation value of chest circumference to cow's weight is 0.93, while the correlation value of body length to body weight is 0.84.

One formula for estimating or estimating livestock body weights such as cattle, sheep, or goats is using the Lambourne formula. Estimation of animal body weight using the Lambourne formula is based on chest circumference and body length. However, the use of this formula does not always provide the results of body weight according to the actual body weight. This is due to variations in types of livestock, so the deviation with actual body weight is different in each type of livestock, for example the deviation observed on Sumba horses was 4.94% [9] while in cattle, horses and large sheep was below 10% [2]. Therefore, it is necessary to evaluate the deviation of the Lambourne formula before it is applied to

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Aceh cattle. Until now, the deviation value of the formula Lambourne in estimatinge the bodyweight of Aceh bull is not yet known.

2 Materials and Methods

This research was conducted at BPTU-HPT Indrapuri Aceh Besar from November-December 2018. Samples used in this study were 50 Aceh bull aged 2-2.5 years old . In determining the research object, analysis of available recording data is performed and determining the age by estimating the condition of incisors. The instrument used in this study consisted of a measuring tape, a measuring stick and a scale of livestock with a capacity of 1000 kg with a sensitivity of 0.1 kg.

2.1 Methods

2.1.1. Body Length Measurement

According to BPTP NTB [10], measurement of livestock body length (BL) is done by measuring the distance between the lateral humeral tuberculum to the ischiadium tuberculum (Figure 3). Livestock body length is measured using a measuring stick (units in cm).

Figure 1. Body Length Measurement

2.1.2. Measurement of Chest Circumference

BPTP NTB [10] states that cattle chest circumference (CC) is measured using a measuring tape by encircling the chest cavity behind the scapular bone joint (unit in cm, Figure 4).

Figure 2. Measurement of Livestock Chest Circumference

Figure 3. Weighing of Actual Cattle Weights

2.1.3. Body Weight

Measurement of cattle body weight was carried out in two ways:
a) TUsing acattle weighing device by putting the cattle into the container that has been connected to the weighing instrument. The cattle body weight directly appeared on the scales.
b) Calculating using the Lambourne formula

$$BW = (CC^2 \times BL) / 10{,}840$$

Information:
BW = Body weight (kg)
CC = Chest circumference (cm)
BL= body length (cm)
10.840 = Provision of the Lambourne formula.

2.1 Data Analysis

1. To find out the deviation of the Lambourne formula in actual livestock body weight, an analysis of the percentage of deviations (%) was carried out using the difference between the actual livestock body weight and the Lambourne version of catlle body weight divided by the actual catlle body weight and multiplied by 100%

$$\text{Percentage of deviation } (\%) = | BA\text{-}BL | / BA \times 100\%$$

In which:
BA = Actual body weight
BL = Lambourne version of body weight

2. To get a more precise formula in estimating body weight of Aceh bull from CC and BLPB sizes, multiple linear regression analysis was performed with the variable Y was bodyweight, variable x1 was body length, and variable x2 was chest circumference:

$$Y = a + bx_{(1)} + bx_{(2)}$$

where:
Y = Body weight (kg)
a = constant
b = Regression coefficient
x1 = Chest circumference (cm)
x2 = body length (cm).

3 Results and Discussion

The results of measurements of chest circumference (CC), body length (BL), actual body weight, Lambourne body weight, and deviation of the Lambourne formula to the actual bodyweight of 50 male cows Aceh aged 2-2.5 years in BPTU-HPT Indrapuri Regency Aceh Besar wass shown in Table 1.

Table 1. Average (± SD) of chest circumference (CC), body length (BL), actual body weight, Lambourne body weight, and percentage deviation of 50 bulls

Description	Results
Chest Circumference (LD)	105,88 ± 4,58 cm
Body Length (PB),	130,18 ± 9,28 cm
Actual Body Weight	163,69 ± 30,26 kg
Lambourne Body Weight	166,98 ± 28,47 kg
Percentage Deviation	3,41%

3.1 Chest Circumference and Body Length of Aceh Bull

Based on Table 1, the average chest circumference (CC) of Aceh bull was 105.88 ± 4.58 cm. The CC of Aceh bull at BPTU-HPT Indrapuri was lower than the standard set by the Ministry of Agriculture. Based on the Decree of the Ministry of Agriculture Number: 2907 / Kpts / OT.140 / 6/2011, the CC of Aceh bull was153 ± 32 cm.

Based on Table 1, the average body length of Aceh bull was 130.18 ± 9.28 cm. The length of Aceh bull in Indrapuri BPTU-HPT was slightly higher than the standard set by the Ministry of Agriculture. Based on the Decree of the Ministry of Agriculture No. 2907 / Kpts / OT.140 / 6/2011 stipulates that the body length of Aceh bull was 121 ± 26 cm.

According to Abuzar and Juliana [16] the use of standard deviations to assess the average dispersion of a sample. The difference in standard deviation results obtained in CC and BL was due to the anatomical shape of the catlle itself. Some cattle look elongated and have large BL, while other cattle have large CC and look fat.

3.2 Deviation of Aceh bull Body weight Using the Lambourne Formula to the Actual Weight

Based on Table 1, the body weight of Aceh bull using the Lambourne formula was 166.98 ± 28.47 kg. The Lambourne formula used two variables namely chest circumference and body length. Chest circumference has a high correlation value with body weight, the greater the chest circumference, the heavier the weight of a cow [9]. This is due to the increase in body weight of cow, the chest size will be deeper and wider due to muscle and fat deposits [11].

The size of a large chest circumference shows that the metabolic process of livestock is going well. This is due to the support of blood circulation that works optimally with the help of heart and lung organs in the chest cavity. Besides that, cattle also have a cylindrical body shape so that the process of increasing cattle body weight is in line with an increase in body length [12]. [13] stated that body length has a high correlation to carcass weight.

Based on Table 1, the average of actual body weight of Aceh bullwas 163.69 ± 30.26 kg. The actual body weight of Aceh bulls in Indrapuri BPTU-HPT was slightly lower than the standard set by the Ministry of Agriculture. Based on the Decree of the Ministry of Agriculture Number: 2907 / Kpts / OT.140 / 6/2011 the body weight of Aceh bullle was 253 ± 65 kg.

The percentage of body weight deviation of Aceh bull using the Lambourne formulaobserved in this study was 3.41%, which mean that if the Aceh bull weight using Lambourne formula was 200 kg, thus the actual body weight of Aceh bulls was 193.18 kg The result indicated that there was a deviation of Aceh bull body weight using the Lambourne formula as compared to the actual body weight.,.

The factors that might influence the deviation of cattle body weight calculated using the formula was due to the different of body structures [14]. Livestock bodyweight deviations calculated using the formula against actual weight usually ranges between 5-10% [9]. The deviation of the estimated body weight of Aceh bulls using the Lambourne formula was smaller than 5%, which indicated that the Lambourne formula can be used to estimate the Aceh bull body weight. However, if using multiple linear regression equations will be more appropriate because these measurements are more specific for Aceh bull.

3.3 Equation of Multiple Linear Regression from the Size of the Chest Circumference (CC) and Body Length (BL) of Aceh bull

Multiple linear regression analysis with variable Y was bodyweight, variable x1 was body length, and variable x2 was the chest circumference of 50 male cows of Aceh bull aged 2-2.5 years at BPTU-HPT Indrapuri was, shown in Table 2.

Based on Table 2, the constants of the regression equation wew -350.30. Negative value constants generally occur because the range between x (independent variable) and Y (response variable) is quite far. CC and BL coefficients were both positive for body weight. The regression coefficient for CC was 2.27 meaning that if CC has increased by one unit, the bodyweight will increase by 2.27. While the regression coefficient for BLwass 2.06, this can also be interpreted if PB increases by one unit, then bodyweight will increase by 2.06.

Based on Table 2, the coefficient of determination of 0.86 or 86% means that CC and BL affect 86% of body weight, while the remaining 14% was influenced by variables other than CC and BL. [15] stated those body length and chest circumferences are effectively used to estimate body weight with multiple linear regression equations.

Table 2. Equation of multiple linear regression analysis of Aceh bull with variable Y was bodyweight, variable x1 was chest circumference, and variable x2 was body length

Estimating Variable	Results
CC and BL Regression Equations	$Y = -350,30 + 2,27x_1 + 2,06x_2$
Coefficient of Determination (R^2)	0,86
Example of Calculation with One Sample with CC 130 cm and BL 104 cm	$Y = -350,30 + 2,27 \times 130 + 2,06 \times 104$ $= -350,30 + 295,10 + 214,24$ $= 159,04 \text{ kg}$
Equation of Lambourne Formula	$BW = \dfrac{LD^2 x\ PB}{10.840}$ $= \dfrac{130^2 x\ 104}{10.840}$ $= 162,14 \text{ kg}$
Actual Body Weight	157 kg

4 Conclusion

The percentage of body weight deviation of Aceh bull using Lambourne formula to the actual body weight was 3.41% with regression equation was Y = -350.30 + 2.27x1 + 2.06x2 .

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