Correlation Between Morphometric Traits and Body Weight in Fat-Tailed Sheep

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Abstract. This study was conducted to determine the correlation between morphometric traits and body weight in fat-tailed sheep. The materials used this study were 80 Fat-Tailed sheep aged 90 days to 2 years. The variables measured were morphometric traits (body weight, body length, and chest circumference) and body weight. The data obtained were analyzed using pearson correlation and regression methods. The result showed that the correlation between morphometric traits and Body Weight (BW) of Fat-Tailed Sheep were as follows: Body Height (BH) = 0.53, Body Length (BL) = 0.55, and Chest Circumference (CC) = 0.71. The results of this study indicate that the regression between morphometric traits and Body Weight (BW) of Fat-Tailed Sheep aged 90 days to 2 years were as follow: BW = -12.38 + 0.72 BH, BW = -21.35 + 0.88 BL, BW -10.78 + 0.57 CC. The conclusion obtained is that the correlation between morphometric traits and body weight in Fat Tailed Sheep aged 90 days to 2 years, with correlation values ranging from 0.53 to 0.71 indicates a medium to strong correlation coefficient. CC has the highest correlation with BW compared to BH and BL.

Keywords: Fat-Tailed Sheep, Morphometric Traits, Body Weight, Correlation

1 Introduction

The livestock sector plays an indispensable role in national food security, and one of the highly important commodities in the livestock sector is sheep. Sheep are relatively easy to rear and require minimal land. They have the potential to produce meat, milk, and wool, which serve as additional sources of income for farmers. Another advantage is that sheep can adapt to very different environments, making them found in various regions of Indonesia. According to data from the Indonesian Central Statistics Agency in 2022, there were approximately 15,616,300 sheep distributed across Indonesia, with the highest population in West Java Province, with total 9,987,870 sheep. This data illustrates that the sheep farming sector is thriving in Indonesia.

Sheep are small ruminant livestock, which have the potential to be a source of meat production and can grow rapidly. The local sheep population in Indonesia is on the rise as

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people become more aware of the need for animal protein [1]. One type of local sheep in Indonesia is the Fat-Tailed Sheep, characterized by a thick, fat-filled tail. This fat serves as an energy reserve when feed is scarce. Fat-Tailed Sheep generally have white fur, medium-sized ears, and coarse fur in both males and females. The advantages of Fat-Tailed Sheep need to be further developed because they adapt well to areas with limited water supply, can digest different types of feed, have high disease resistance, and hold economic, social, and cultural value in society.

The size and body shape of livestock can be used as indicators of estimated body weight and carcass quality and provide insights into the physical characteristics of animals representing a particular breed [2]. The heavier the body weight, the higher the market value of sheep. Many rural farmers and markets still rely on estimates in sheep transactions without first weighing the animals. This leads to losses for many farmers due to inaccuracies in weight estimation [3]. Errors in weight estimation leading to losses for farmers will impact their profitability. Farmers will face difficulties in developing their sheep farming businesses, especially in feed management and care, which require substantial investment if the profits do not match expectations.

Morphometrics in sheep refer to the measurement and analysis of various body dimensions and anatomical proportions. Morphometric measurements in sheep provide valuable information about physical characteristics and body structure. The correlation between morphometrics and weight gain can be used as an indicator of livestock productivity and as a reference for selecting breeding stock or potential breeding stock [4]. Morphometric measurements generally include body length, height, and chest circumference. The correlation between morphometrics and livestock weight gain reflects the animal's potential for growth and breeding. Livestock with larger body sizes tend to have higher growth potential and market value.

This research examines the correlation between morphometrics and body weight in Fat-Tailed Sheep with the aim of providing information regarding their growth and development. The observed morphometric parameters include body length, body height, and chest circumference. Through this understanding, it is hoped that body weight estimation can be done more accurately, enabling farmers to avoid errors in estimating sheep body weight. This information is crucial for determining the right care management, including planning.

2 Materials and Methods

2.1 Experimental design

This research was conducted at PT Juara Agroniaga Sejahtera, located in the Simbatan Village, Kanor District, Bojonegoro Regency, from August to December 2023. The research was carried out using a survey method and vital statistics were measured, including body weight. The subjects of the study included 80 Fat-Tailed Sheep aged 90 days to 2 years. The sheep were recorded for body measurements using measuring sticks and measuring tapes, and their body weight was measured using digital scales.

2.2 Data Analysis

The data obtained from measurements were analyzed to derive several statistical values, including the correlation coefficient (r), determination coefficient, linear regression equation, and deviations. This analysis aims to determine the extent of the relationship between variable X (e.g., body length) and variable Y (e.g., body weight). In correlation analysis, a method is used to determine the strength and direction of the relationship between variable

X and variable Y. Meanwhile, in linear regression analysis, a method is used to establish a linear equation that can be used to predict the value of Y based on the value of X. Additionally, the nature of the relationship between variable X and variable Y can also be identified through correlation and linear regression analysis. The formula for the correlation coefficient (r) used according to Wahyudi et al. [5] is as follows:

$$r = \frac{n(\Sigma XY)-(\Sigma X)(\Sigma Y)}{\sqrt{\{n(\Sigma X2)-(\Sigma X)2\}\{n(\Sigma Y2)-(\Sigma Y)2\}}} \quad (1)$$

Description:
r : correlation coefficient
X : values of body linear measurements
Y : values of body weight
n : amount research

The influence of morphometric Traits of sheep on the body weight of Fat-Tailed Sheep can be determined by calculating the coefficient of determination. The determination coefficient (R^2) is a measure that describes how well the variability in body weight can be explained by the variability in morphometric measurements. The formula for the determination coefficient, according to Wahyudi et al. [5] is as follows:

$$R^2 = r \times 100\% \quad (2)$$

Description:
R^2 : determination coefficient
r : correlation coefficient

To analyze the relationship between morphometric Traits (chest circumference, body length, and body height) with the body weight of Sheep can use regression analysis. The general equation for linear regression, according to Wahyudi et al. [5], is as follows:

$$Yi = a + bX \quad (3)$$

Description:
Yi : body weight
X : Morphometric Traits measurement
a : constant
b : regression coefficient

To determine the accuracy of the prediction formula, the magnitude of the deviation between the body weight estimated using the formula and the body weight measured using a scale is calculated using the following formula. [6]:

$$\%Deviation = \frac{BW\ Estimated - BW\ Actual}{BW\ Actual} \times 100\% \quad (4)$$

Description:
BW Estimated : Body weight obtained through the simple linear regression equation (kg)
BW Actual : Actual body weight obtained through direct weighing (kg)

3 Results and Discussion

3.1 Morphometric Traits and Body Weight of Fat-Tailed Sheep

The results of body weight measurements and body size, including body length, height, and chest circumference in Fat-Tailed Sheep, are presented in Table 1.

Table 1. Mean, Standard Deviation (SD), and Coefficient of Variation (CV) for morphometric traits and body weight of sheep aged 90 days to 2 years.

Variable	N	Mean ± SD	CV (%)
BW	80	28.04 kg ± 8.81	31.43
BH	80	55.80 cm ± 6.43	11.53
BL	80	56.34 cm ± 7.47	13.26
CC	80	68.63 cm ± 11.02	16.06

The average body weight of Fat-Tailed Sheep aged 90-2 years from this study (28.04 kg ± 8.81) is lower than the findings of [7], where female Fat-Tailed Sheep had an average weight of around 40 kg. This difference in body weight can be attributed to the fact that this research involved Fat-Tailed Sheep ranging in age from 90 days to 2 years, resulting in varying body weights. Additionally, these discrepancies are influenced by different genetic, environmental factors, housing conditions, and the nutritional feed provided.

The average height in this study (55.80 cm ± 6.43) falls slightly short of the Sapudi sheep standard, which is 56 cm. On the other hand, the average body length in this study (56.34 cm ± 7.47) is higher than the average body length of female Fat-Tailed Sheep according to [8], which was 52.67 cm. The average body length in this study meets the Indonesian National Standard (SNI) for Sapudi sheep, which is 56 cm. As for the chest circumference, the average of Fat-Tailed Sheep in this study (68.63 cm ± 11.02) meets the SNI for Sapudi sheep, which is 64 cm [9]. These results are lower than the measurements in the study by [10], where they found an average chest circumference of 72.80 cm for 60 Fat-Tailed Sheep aged 1 to 2 years. Conversely, the findings are higher than the results from [11], which reported an average chest circumference of 63 ± 3.98 cm for Fat-Tailed Sheep.

In the coefficient of variation, if a measurer produces variability below 15%, the result indicates that the obtained data is similar [12]. This can be observed in the measurements of body weight and circumference, which yielded varied results with values of 31.43% and 16.06%, respectively. Meanwhile, for height and body length data, results of 11.53% and 13.26% were obtained, indicating that the collected data is similar.

Table 2. Correlation Coefficients (r), Coefficient of Determination (R^2), Regression Equation, and Average Deviation for morphometric measurements to body weight.

Variable	N	r	R^2	Regression equations	Average Deviation (%)
BH	80	0.52	27.96	-12.38 + 0.72	13.08
BL	80	0.55	30.35	-21.35 + 0.88	7.42
CC	80	0.7	50.06	-10.78 + 0.57	8.18

3.2 Correlation between Body Height and Body Weight

The results of correlation coefficient calculations, determination coefficient, regression line equation, and the average deviation of estimated values for height (X) with body weight (Y) are presented in Table 2.

Height is closely related to livestock body weight. Height measurement can provide insights into the overall body size. Height is influenced by bone development in the animal's body [5]. The leg bones of the livestock tend to develop earlier than other body parts because one of the main functions of the legs is to support the body. This early leg bone development can provide an indication of the overall growth and development of the animal. Optimal height indicates that bone development and body structure in livestock are progressing well. Good height measurements can also indicate the animal's ability to support an ideal body weight.

The correlation coefficient value of 0.52 for height with body weight in 90-day to 2-year-old Fat-Tailed Sheep suggests a moderately positive correlation. This result is not significantly different from [13], who obtained a correlation coefficient of 0.5 for young female sheep. A positive correlation value means that an increase in height is associated with an increase in body weight, and vice versa. This value indicates that height has a moderate influence on the body weight performance of sheep.
The correlation among the independent variables was below 0.90, signifying an absence of multicollinearity. Multicollinearity occurs when two or more predictors are correlated. In such cases, the standard error of the coefficients will rise, implying that the coefficients for some or all of the independent variables might exhibit a significant deviation from 0 [14].

The determination coefficient value for 90-day to 2-year-old fat-tailed sheep is 27.96%, indicating that height contributes approximately 27.96% to the variation in livestock body weight, while other factors such as genetics, environment, and nutrition play a significant role in influencing the remaining 72.04%. The determination coefficient for height with body weight in this study is the same as [15], who obtained a determination coefficient of 27% for height with body weight in 1-3-year-old female DEG. The difference is due to variations in data sources, such as the number and age of sheep and the research location.

The simple regression line equation for 90-day to 2-year-old DEG is BW = -12.38 + 0.72 BH. This result indicates that for every 1 cm increase in the animal's height, there will be an approximate 0.72 kg increase in body weight. The estimation of body weight based on height shows an average deviation of approximately 13.08%, indicating that this method may be less accurate in predicting body weight precisely, especially when the deviation exceeds 10% [6].

3.3 Correlation between Body Lenght and Body Weight

The results of correlation coefficient calculations, determination coefficient, regression line equation, and the average deviation of estimated values for body length (X) with body weight (Y) are presented in Table 2.

Body length is one of the body measurements closely related to the weight of an animal. Analogously, body length can be compared to the volume of a cylinder, which is influenced by the diameter of the base and its height [16]. In this context, data on body length are required to estimate or predict the weight of sheep accurately. This is different from the statement made by [17], which states that there is no significant difference in body length between different breeds or within a single breed with different classes. This suggests that body length as a parameter may be less precise when used as the primary guideline to obtain sheep with high quality or weight. Therefore, the use of body length as a parameter needs to be combined with other more relevant parameters directly related to the desired sheep weight class.

The correlation coefficient value of 0.55 for body length with body weight in 90-day to 2-year-old Fat-Tailed Sheep suggests a moderately positive correlation. A positive correlation value means that an increase in body length is associated with an increase in body weight, and vice versa. This value indicates that body length has a moderate influence on sheep's body weight performance. This result is considerably higher than [18], who obtained a correlation coefficient of 0.466 for sheep aged 1.3-1.6 years, and lower [19], who found that body weight had the highest correlation with body length (r = 0.84). The strength of the correlation between body length and body weight is related to the action of the testosterone hormone on the rate of muscle cell growth and increased activity in stimulating bone growth [8]. The difference is attributed to the age of the animals used in the research, where in this study, animals aged 90 days to 2 years were used.

The determination coefficient value for 90-day to 2-year-old DEG is 30.35%, which means that body length influences body weight by approximately 30.35%, while the remaining 69.65% is influenced by other factors. The other factors include genetic factors, different environmental conditions, and the nutritional feed provided. This result differs from the study by [20], who obtained determination coefficient values of 23.95. The difference in determination coefficient values can be attributed to the different growth rates of body length at each age and among different breeds.

The simple regression line equation for 90-day to 2-year-old DEG is -21.35 + 0.88 BL. The regression coefficient of 0.88 means that for every 1 cm increase in body length, there will be an increase in body weight of approximately 0.88 kg. The estimation of body weight using the body length regression equation shows an average deviation of approximately 7.42%. This result indicates that estimating body weight based on the morphometric variable of body length is accurate, as the deviation is below 10% [6].

3.4 Correlation between Chest Circumference and Body Weight

The results of correlation coefficient calculations, determination coefficient, regression line equation, and the average deviation of estimated values for chest circumference (X) with body weight (Y) are presented in Table 2.

Chest circumference is an important indicator for estimating body size and the potential production of sheep. An increase in chest circumference in sheep generally corresponds to an increase in body weight [21]. With a larger chest circumference, there is a tendency for sheep to have more chest muscles and a larger abdominal cavity, which can contribute to increased body weight [22]. Therefore, chest circumference measurements can provide insights into the physical development and growth potential of sheep. In the context of the relationship between chest circumference and body weight in livestock, chest circumference has a closer relationship with body weight than body length [23].

The correlation coefficient value of 0.7 for chest circumference with body weight in 90-day to 2-year-old Fat-Tailed Sheep indicates a strong positive correlation. A positive correlation value means that an increase in chest circumference is associated with an increase in body weight, and vice versa. This value indicates that chest circumference has a strong influence on sheep's body weight performance. This result is lower than [24] The correlation coefficient value between chest circumference and body weight of 0.89. The difference can be attributed to data sources, such as the type, number, age of sheep, and the research location. Generally, the correlation between body weight and body length provides high values, except for adult males, which show moderately correlated values. This suggests that in adult males, chest circumference plays a more significant role in determining body weight proportions than body length. Therefore, the correlation between body weight and chest circumference tends to be better than the correlation between body weight and body length in adult males [25].

The determination coefficient value for 90-day to 2-year-old DEG is 50.06%, which means that chest circumference influences body weight by approximately 50.06%, while the remaining 49.94% is influenced by other factors. The other factors include genetic factors, different environmental conditions, and the nutritional feed provided. This result is lower than [26], who obtained determination coefficient values of 92% and 87% for male and female sheep groups, respectively. Based on this analysis, it can be stated that chest circumference plays a significant role in estimating body weight because it can be seen in the nearly perfect correlation coefficient and the determination coefficient that is close to 100%.

The simple regression line equation for 90-day to 2-year-old DEG is -10.78 + 0.57 CC. The regression coefficient of 0.57 means that for every 1 cm increase in chest circumference, there will be an increase in body weight of approximately 0.57 kg. The estimation of body weight using the chest circumference regression equation shows an average deviation of approximately 8.18%. This result indicates that estimating body weight based on the morphometric variable of chest circumference is accurate, as the deviation is below 10% [6].

4 Conclusion

The correlation between body measurements and body weight in Fat-Tailed Sheep varies, with correlations ranging from moderated positive to strong-positive. Chest circumference measurement has the closest relationship with body weight compared to other body measurements in age group, indicating its significance in predicting body weight.

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