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Relationship between body morphometrics and prolificacy of Jawarandu goats in sun farm Semarang regency

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Abstract

This research aimed to analyse the relationship between body morphometrics and prolificacy of Jawarandu goats in Sun Farm Semarang Regency. The purposive sampling method is used to collect the research object samples. The samples of this research are 10 Jawarandu goat mothers that had given birth (single or twins), aged 2-3 years, and had given birth 2-3 times. This research's observation variables are divided into two variable groups which are prolificacy rate as dummy variables and morphometrics as dependent variables. The morphometric variables observed include body height (BH), body length (BL), chest circumference (CC), and hip width (HW). The data is analysed using regression analysis with the dummy (D) variables. If the prolificacy is low (mother goat with a single kid) then D=0, and if the prolificacy is high (mother goat with twins) then D=1. Based on the regression analysis, the chest circumference and hip width are significantly related to prolificacy with the regression equation of CC = 77,335 + 5,778 D and HW = 16,418 + 1,972 D. The body height and body length are not significantly related to prolificacy. In conclusion, chest circumference and hip width are closely connected with prolificacy. The possibility of twin births in Jawarandu goats increases with bigger chest circumference and hip width.

Keywords: Jawarandu goat; Morphometric; Prolificacy; Relationship

1 Introduction

One of the local livestock that is widely cultivated by residents is Jawarandu goats. Jawarandu goats are economically valuable, especially as a provider of animal protein for Indonesians. Another advantage is that Jawarandu goats can breed all year round and are considered prolific livestock since the average of their births are twins, therefore they are suitable to be reared by local breeders [1]. One of the local farms located in Semarang regency is “Sun Farm” which cultivated Jawarandu goats as meat producing goats to fulfil the people’s demand for goats. However, the amount of Jawarandu goats at Sun Farm is not proportional to the existing demands.

The market demand for goats is increasing alongside the increase in population, economic development, and public welfare. Therefore, there must be efforts done to meet the demand for goats. The goat population in Semarang Regency can not meet the high demand for goat meats in community activities. Based on BPS Central Java data [2] in the years 2018, 2019, and 2020, the goat populations at Semarang Regency consecutively are 117.396, 117.400, and 117.400 goats. Additionally, the production of goat meats at Semarang Regency in the years 2018, 2019, and 2020 is increasing with a production total of 284,40 tons, 330,27 tons, and 333,47 [3].

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Increasing the population total of goats can be done by increasing the productivity of mother goats. The productivity of mother goats can increase in goats that have a prolific trait with twin births [4]. Offsprings of mother goats who have superior genetics will inherit that gene, therefore mother goats selection can be done to obtain offspring with prolific traits [5]. One of the ways in selecting mother goats is by considering the morphometrics (body size) that can be inherited from the parents to the offspring [6]. According to Zulkharnaim et al., [7] goats with twin children will have bigger bodies than goats with single children, this is because goats with twin offsprings have bigger uterus and abdominals due to the offsprings carried by the goat. Goats with prolific traits usually have faster growth, bigger bodies, longer shoulder height and body length compared to goats with single offspring. The livestock's productivity is also affected by the environment and feed factor. The animal's physiological condition may change as a response to environmental factors such as an extreme change in temperature and high humidity [8]. The increase in livestock productivity can be supported by improving the quality of feeding balanced by good practice of feeding management [9].

Based on the explanation above, research on the relationship between body morphometrics and the prolificacy of Jawaradu mother goats in Sun Farm Semarang Regency must be done. The result of this research is expected to provide a description of the morphometric traits of Jawarandu goats which have prolific trait potentials, therefore it can be used as an initial step in selecting superior mother goats to increase the population and productivity of Jawarandu goats in Sun Farm Semarang Regency.

2 Material and methods

2.1 Time and place

This research is conducted at Sun Farm located on Suruhan Street, Timpik, Susukan, Semarang Regency, Central Java, Indonesia. This research started from January to February 2023.

2.2 Material

The material of this research is 10 Jawarandu mother goats who have given birth (single or twins), aged between 2-3 years, and have given birth 2-3 times. The samples are selected using the purposive sampling method since the samples will be used to analyse the morphometric measurements based on the prolificacy groups of the Jawarandu mother goats.

2.3 Method

The data of this research is collected using direct observation and morphometric body measurements of the goats. This research is divided into 2 groups of the prolificacy rate, which are mother goats with the birth of a single last offspring categorized into low prolificacy; and mother goats with the birth of 2 or 3 twins last offspring categorized into high prolificacy.

The goats morphometric measurements are done using measuring tape when the goats are perfectly standing as seen in figure 1.

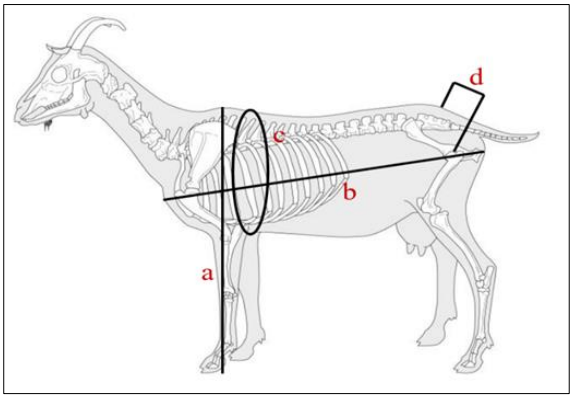

Figure 1 Goat morphometrics measurement

- Body height: measured using measuring tape stretched straightly from the highest point of the shoulder to the ground [10].

- Body length: measured using measuring tape following the straight line from the outer front of the scapula to the protrusion of the sieve bone [10].
- Chest circumference: measured using measuring tape circularly following the body circumference of the goat by placing the measuring tape near the scapula or behind the elbow of the front leg [10].
- Hip width: distance between the outer edges of the left and right thigh joints, measured using the measuring tape [4].

Temperature and humidity measurement of the research location is done using a thermo-hygrometer placed inside and outside the cage. The observation is done every 06.00 AM and 06.00 PM for 30 days.

2.4 Data analysis

Regression and correlation analysis with dummy (D) variable were used to analyze the morphometric data that have been obtained [6]. The dummy variables being used are D=0 for low prolificacy and D=1 for high prolificacy. Morphometrics including height, body length, chest circumference, and hip width serve as the dependent variable of the study.

The general equation for regression analysis using dummy variables is as follows:

$$Y = b_0 + b_1 D$$

Description:
Y = Morphometric
b_0 = Constant
b_1 = Regression coeffisient
D = Dummy variable of prolificacy rate

The following formula can be used to determine the value of b0 and b1:

$$b_0 = \frac{(\sum Y)(\sum X^2) - (\sum X)(\sum XY)}{n\sum X^2 - (\sum X)^2} \quad b_1 = \frac{n\sum XY - (\sum X)(\sum Y)}{n\sum X^2 - (\sum X)^2}$$

Description:
b_0 = Constant
b_1 = Regression coeffisient
X = Prolificacy variable
Y = Morphometric variable
n = Amount of data

The environmental data were analyzed descriptively and the results were compared with the literature review. Tables and figures are used to present the data that were obtained.

3 Result and discussion

3.1 The morphometrics of Jawarandu goat

The results of the observations in Table 1. show that body length (BL), body height (BH), chest circumference (CC), and hip width (HW) of high prolificacy Jawarandu goats tend to be higher than those of low prolificacy Jawarandu goats.

Table 1 Morphometric mean and standard deviation at each prolificacy level

No	Variables	Low prolificacy	High prolificacy
1	Body length (cm)	83.75 ± 5.37	88.46 ± 4.93
2	Body height (cm)	74.91 ± 6.88	79.61 ± 3.47
3	Chest circumference (cm)	77.34 ± 4.85	83.11 ± 1.71
4	Hip width (cm)	16.42 ± 1.79	18.39 ± 0.88

The BL, BH, CC, and HW measurements of low prolific Jawarandu goats were respectively 83.75 ± 5.37 cm; 74.91 ± 6.88 cm; 77.34 ± 4.85 cm; 16.42 ± 1.79 cm. Meanwhile, the Jawarandu goats with high prolificacy had BL, BH, CC, and HW measurements of 88.46 ± 4.93 cm respectively; 79.61 ± 3.47 cm; 83.11 ± 1.71 cm; 18.39 ± 0.88 cm. Body length, body height, chest circumference, and hip width of goats with low prolificacy to high prolificacy each experienced an increase of 5.62; 6,27; 7.46; and 11.9%.

A B

Figure 2 Female Jawarandu goat at *Sun Farm* A: Single mother goat, B : Twin mother goat

The body size of the Jawarandu goat in this study was larger than the body size of the Jawarandu goat in the previous study. Research by Anggraeni et al., [11] in North Samarinda District, Indonesia observing the body size of female Jawarandu goats obtained the results of, namely body length 64.78 ± 4.06 cm, shoulder height 70.22 ± 3.07 cm, and chest circumference 74 .53 ± 2.93 cm. Meanwhile, adult female Jawarandu goats in Blora Regency, Central Java, Indonesia had an average body length of 70.63 ± 5.99 cm, shoulder height 67.99 ± 5.87 cm, chest circumference 75.86 ± 6.02 cm, and hip width 14.68 ± 1.30 cm [12]. The body size of a livestock is influenced by climate, feed, and rearing management which are different in each region [13]. In addition, according to Margatho et al., [14] states that parity can affect the morphometric body of goats and has an impact on litter size and milk production in productive female goats.

3.2 Morphometric relationship with prolificacy

The results of the regression analysis between morphometrics and prolificacy are presented in Table 2. Based on the results of the regression analysis (Table 2), chest circumference and hip width were significantly related to prolificacy ($P<0.05$). Meanwhile, body length and height were not found to be significantly related to prolificacy ($P>0.05$).

Table 2 The results of the regression analysis and the correlation between morphometrics and prolicacy

Morphometrics Variable	Regression Equation	R	R^2	P *Value*
Body length	83.750 + 4.697 D	0.450	0.202	0.192^{ns}
Body height	74.917 + 4.692 D	0.455	0.207	0.187^{ns}
Chest circumference	77.335 + 5.778 D	0.697	0.485	0.025^{*}
Hip width	16.418 + 1.972 D	0.640	0.409	0.046^{*}

Description: R = Correlation coefficient ; R^2 = Determination coefficient; ns = Non significant; * = Significant level 5% ($P<0,05$); D = Dummy variable.

Prolificacy has an effect on chest circumference by 48.5% (coefficient of determination = 0.485), with the remaining influence coming from other factors. The relationship between chest circumference and prolificacy has a correlation coefficient r=+0.697, which is interpreted that the two variables are closely related to the regression equation CC = 77.335 + 5.778 D. This equation proves that there is a straight comparison between chest circumference and prolificacy, the likelihood of twin births in Jawarandu goats will increase along with the larger chest circumference. The chest circumference of Jawarandu goats with low prolificacy is 77.34 cm, while the high prolificacy was 83.11 cm.

Hip width also has a significant relationship with prolificacy. Prolificacy has an effect on the size of the hip width of 40.9% (coefficient of determination = 0.409), with the remaining percentage being influenced by other factors. The relationship between hip width and prolificacy has a correlation coefficient r=+0.640, which is interpreted that hip width has a close relationship with prolificacy with the regression equation HW = 16.418 + 1.972 D. The form of the

regression equation shows that there is an in line comparison between hip width and prolificacy, the possibility of twin births in Jawarandu goats will increase as the width of the hips increases. The hip width of low prolificacy Jawarandu goats is 16.42 cm, while the high prolificacy is 18.39 cm.

The results showed that the prolificacy rate of Jawarandu goats could be predicted using measurements of chest circumference and hip width. Apart from being influenced by genetics and the environment, the number of lambs born is also influenced by the size of the mother's body [6]. This explanation is in line with a statement by Kaunang et al., [15] who argue that genetics and the environment influence livestock litter size. The size of the chest circumference is correlated with the lungs' capacity to bind oxygen levels from the environment which functions in metabolic processes to produce energy [6]. Livestock that consistently produce twins need to consume more energy so that it has an impact on increasing the supply of oxygen needed for metabolic activities, which in turn requires a larger chest and lung area. As with the opinion of Zulfahmi et al., [16] which states that the development of organs has an impact on the size of the chest width. This is because larger ribs will bind more muscles together, thereby increasing the size of the livestock's chest circumference [17]. The size of the chest circumference caused by the development of the chest muscles has an impact on the weight of livestock, as the chest circumference increases, the body weight will increase [18]. An increase in chest circumference followed by an increase in body weight will simultaneously increase uterine volume to support an increase in litter size [19]. Chest circumference and other biometric characteristics can be applied as a reference for genetic improvement in goats [20].

Hip width measurement can be used to select goats that have the potential to give birth to twins. According to research by Sulastri et al., [21] the average hip width of female Saburai goats born in twins is higher than goats single born. This can happen because goats with the twin type grow the bones that make up their hips faster than goats with the single type. The bones that make up the hip are closely related to the uterine and abdominal chambers. The width of the uterus and abdomen follows the size of the wide hips resulting in large hips so that they can accommodate more fetuses during pregnancy [22].

3.3 Environmental conditions of research locations

The results showed that the average ambient temperature at the research site during the observation was 23.23 ± 0.96 °C in the morning and decreased to 22.74 ± 1.59 °C at afternoon. Whereas the temperature in the cage in the morning was 22.66 ± 0.52 °C and in afternoon it was 23.35 ± 1.11 °C. Meanwhile, the environment humidity was 96.07 ± 3.27% in the morning and 95.93 ± 3.76% in afternoon. Cage humidity in the morning was 96.73 ± 2.95% and afternoon 95.53 ± 3.58% (Table 3).

Table 3 Average temperature and humidity in the research location

Variable	Morning	Afternoon
Environment temperature (°C)	23.23 ± 0.96	22.74 ± 1.59
Cage temperature (°C)	22.66 ± 0.52	23.35 ± 1.11
Environment humidity (%)	96.07 ± 3.27	95.93 ± 3.76
Cage temperature (%)	96.73 ± 2.95	95.53 ± 3.58

Descriptiom : Morning (06.00 AM); Afternoon (06.00 PM).

Based on Table 3, the range of temperature in the research location is suitable for livestock rearing. According to Qisthon and Widodo [23] goats' lowest temperature tolerance limit is at 18 °C while their highest temperature tolerance limit is at 30 °C. Those temperature ranges are the thermoneutral zones for the livestock to live. If the temperature exceeds the zone, goats are prone to stress [24]. The farm location has a high level of humidity in the cage and the environment, although it does not have a significant impact on livestock growth. Based on research by Pamungkas et al., [25] the highest level of cage humidity reaches 99.20% in the morning and the lowest humidity level of 47.19% occurs in the afternoon. The humidity in the research location is classified as high because the location is in the area near the mountains and the research was conducted during the rainy season. The air humidity in the highlands is higher than in the lowlands, it is because there are plenty of trees in the highlands so the water content in the air becomes higher. Other than that, the relatively high rainfall in the highlands also results in a higher groundwater content [26]. The research location which is included in the highlands has the potential to better livestock growth. It is because altitude has an indirect impact towards feed consumption, production, and milk quality because it influences environmental temperature, forage availability, and productivity [27].

3.4 Management of goats' feed and cage maintenance

The feed given to the Jawarandu goats in the Sun Farm is forage and given additional concentrate feed. The type of forage used to feed the goats are odot grass, pakchong grass, mahogany leaves, and indigofera leaves. The concentrate feed given has a composition of pollard 15%, copra 15%, corn gluten feed (CGF) 15%, coffee skin 15%, bran 15%, palm kernel 12%, corn 5%, soybean meal 5%, mineral premix 1%, molasses 1%, and salt 1%. In general, forage feed serves as the main feed source and concentrate serves as a secondary nutrient source, especially protein that is not yet contained in forage [9]. Breeders who utilize the concentrate feed usually aim to speed up the process of fattening their goats in order to be sold immediately. The addition of concentrate to animal feed intends to add incomplete feed components, increase feed efficiency, and enhance livestock weight, as well as feed consumption and digestibility [28,29].

The concentrate feed in Sun Farm is given twice for a day and night that is at 7.00 AM and 1.00 PM. Moreover, forage is given twice a day and night about two hours after giving the concentrate that is at 10.00 AM and 3.00 PM. Setting the time interval for distributing concentrate and forage is a decent feeding strategy to increase the body weight of livestock [29]. Heryanto et al., [30] state that proper nutrition accompanied by proper management practices can increase livestock productivity.

Figure 3 The condition of goats rearing cages in *Sun Farm*

The preserving cages at Sun Farm are cages with the stilt model made of wood with asbestos roofs, the feed area is specially designed in front of the cage, and the upper wall of the cage is half open for air circulation. The cage floor is made of wood that is designed to be partitioned to hold the goat's legs, but goat manure is still able to be thrown down. Many breeders prefer the cages with the stilt model because the cage is convenient to handle, including to be cleaned. The cages' roofs that are made of asbestos are highly recommended because the heat generated from extreme temperature changes, which cause an impact on the physiology of livestock, can be dampened with these materials [31].

4 Conclusion

Based on the result of the research, it can be concluded that the size of chest circumference and hip width of Jawarandu goats in Sun Farm is closely related to prolificacy. As the chest circumference and hip width continue to increase, the potential frequency of twin births in Jawarandu goats will also increase.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of ethical approval

The authors has carried out experimental animals in this study according to the rules and the codes of ethics for using animals.

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