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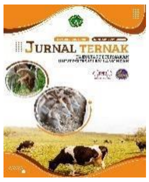

Response to Selection for Birth Weight in Priangan Sheep (Case Study on a Local Farm in Nenggeng Village, Darangdan Sub-District, Purwakarta Regency)

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ABSTRACT

This study aims to determine the response to selection based on variations in selection intensity for birth weight in Priangan sheep. The study was conducted at a local farm in Nenggeng Village, Darangdan Sub-District, Purwakarta Regency, using a case study approach. The data analyzed were derived from the recorded birth weights of 108 lambs, which were the progeny of 6 rams and 36 ewes. Data analysis used descriptive statistics and analysis of variance (ANOVA). The response to selection was calculated based on standard deviation, heritability, and selection intensity. The most optimal selection intensity was achieved with the use of 0.44% (1 male lamb) and 4.11% (10 female lambs). The results of the analysis indicated that the response to selection was 0.138 kg. If selection is applied to the current generation, the birth weight of the next generation is expected to increase from 2.17 kg to 2.308 kg.

Introduction

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Sheep are classified as livestock commodities with significant potential, widely recognized by communities, and distributed across the world. In general, sheep are raised primarily for their meat. Sheep farming can make a substantial contribution to household income. West Java is the province with the largest sheep population. The increasing sheep population in West Java is closely related to the birth rate of lambs that will be used as progeny stock.

Progeny stock refers to livestock with superior characteristics that can inherit desirable traits and meet specific breeding requirements. In sheep farming, the selection of progeny stock plays an important role in supporting the success of the farming business. The selection of sheep to be raised as progeny stock depends on consumer preferences and the objectives of the fattening business. These factors are closely related to the types of sheep commonly raised and the ease or difficulty of marketing them. The selection of prospective sheep for breeding is generally based on criteria such as age, physical conformation, growth performance, and animal behavior.

Selection is a key component of breeding programs and is applied to choose or replace breeding animals in the next generation. The selection process aims to produce superior sheep progeny and to improve the genetic quality of the sheep population. This study aims to evaluate the response to selection based on variations in selection intensity for birth weight in Priangan sheep, in order to determine the effectiveness of selection in enhancing genetic quality and increasing birth weight in the next generation. The results of this study are expected to serve as a reference for decision-making in determining effective selection strategies in Priangan sheep breeding programs.

Method

The study was conducted at a local farm in Nenggeng Village, Darangdan Sub-District, Purwakarta Regency, from mei to july 2020. The data collected consisted of birth weight data. The research sample included 108 lambs, comprising 54 male lambs and 54 female lambs, which were the progeny of 5 rams (adult male lambs) and 74 ewes (adult female lambs).

The research method used was a case study with direct field observation and comprehensive population data collection. Birth weight data were obtained from existing records. In addition to using original data collected during the study, the estimation of genetic correlation values also used corrected data, adjusted for factors such as sex (gender), year and season of birth, type of birth, and parity. The correction factor formula used refers to Lasley (1978) as follows:

$$FK = \frac{x_1}{x_2} \text{ x } x_1$$

The collected data were analyzed using analysis of variance (ANOVA). According to Warwick et al. (1990), the estimation of genetic correlation values was performed using the half-sibling analysis of variance model with a one-way classification ANOVA. The statistical model is as follows:

$Y_{ij} = \mu + \alpha_i + e_{ij}$

Where:

Y_{ij} = observation value for the j-th individual progeny of the i-th male lamb

μ = overall mean

α_i = effect of the i-th male lamb

e_{ij} = random deviation due to uncontrolled environmental and genetic factors in the j-th individual progeny of the i-th male lamb

The birth weight and weaning weight data were analyzed using the half-sibling analysis method. The selection accuracy for birth weight and weaning weight was then determined using the following formula:

$$h_1 = \text{birth weight} = \sqrt{h_1}$$

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The estimation of the response to selection for birth weight in Priangan sheep was calculated based on Hardjosubroto (1989). The response to selection for birth weight in Priangan sheep is determined using the following formula:

$$\boldsymbol{R = ixh^2 \, x \, \sigma^2 p}$$

Where:
R = Response to selection per generation
i = Selection intensity (for both male lambs and female lambs)
h^2 = Heritability
$\sigma^2 p$ = Phenotypic standard deviation

Results And Discussion

1.1. Effect of Sex on Birth Weight of Priangan Sheep

Data analysis showed that the birth weight of male lambs was higher than that of female lambs in the Priangan sheep population at the Neglasari Village Farm, Darangdan Sub-District, Purwakarta Regency. The effect of sex on the birth weight of Priangan sheep progeny is presented in Table 1.

Table 1. Effect of Sex on Birth Weight of Priangan Sheep

Sex	Number of Progeny (head)	Birth Weight (kg)
Male Lamb	54	2.33 ± 0.68
Female Lamb	54	2.21 ± 0.55

Based on Table 1, the birth weight of male lambs (2.33 kg) was higher than that of female lambs (2.21 kg). According to Ramsey et al. (1994), male lambs generally have heavier birth weights than female lambs, and birth weight is positively correlated with weaning weight. The difference in weight between sexes is likely caused by hormonal factors, where androgens in male lambs are more effective at retaining nitrogen (N) and converting it into protein, which is subsequently stored in muscle tissue, compared to female lambs (Swatland, 1984). Additionally, male lambs have a higher capacity to produce testosterone, which plays an important role in muscle development in various parts of the body. This hormonal effect is thought to be influenced by three key growth-regulating genes: Insulin-like Growth Factor I (IGF-I), Androgen Receptor (AR), and Myostatin.

1.2. Effect of Type of Birth on Birth Weight of Priangan Sheep

Data analysis showed that sheep with a single type of birth had heavier birth weights compared to those from twin or triplet births. The effect of type of birth on the birth weight of Priangan sheep progeny is presented in Table 2.

Table 2. Effect of Type of Birth on Birth Weight of Priangan Sheep

Type of Birth	Number of Progeny (head)	Birth Weight (kg)
Single	39	2.67 ± 0.54
Twins	49	2.16 ± 0.49
Triplets	20	1.76 ± 0.40

Based on Table 2, progeny from triplet births had the lowest birth weight (1.76 kg) compared to those from twin births (2.16 kg) and single births (2.67 kg). This result is consistent with Rahmat (2000), who stated that single-born lambs generally have heavier birth weights than those from multiple-born. The effect of type of birth and sex on the birth weight of sheep has been widely studied. Robinson et al. (1977) reported that in Dorset sheep, there was a 19% reduction in birth weight for twin births and a

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20% reduction for triplet births compared to single births. Similarly, Donald and Russel (1970) estimated that the birth weight of twin lambs reached 80% of the weight of single lambs, while triplet lambs reached only 77% of the weight of twins. The difference in weight between type of birth is likely due to competition among fetuses for nutrients from the female lamb during gestation, as twin and triplet fetuses must share nutrients that would otherwise fully support a single fetus. Gatenby (1986) also noted that single-born lambs tend to grow faster than twin or triplet lambs.

1.3. Effect of Parity (Female lamb's Age) on Birth Weight of Priangan Sheep

Data analysis regarding the effect of parity on the birth weight of Priangan sheep are presented in Table 3. Based on Table 3, after the second parity, birth weight increased, but a decrease in birth weight was noted at the fifth parity. This decrease is likely associated with reduced productivity of the female lamb at the fifth parity. This result is consistent with Laing (1970), as cited by Hunter (1975), who stated that the maximum reproductive performance in sheep is generally reached at 5 to 6 years of age, after which productivity gradually reduces. This decrease may be related to the physical condition of the uterus; older female lambs typically have a more relaxed uterine wall compared to younger female lambs, potentially affecting optimal fetal growth.

Table 3. Effect of Parity on Birth Weight of Priangan Sheep

Parity	Number of Progeny (head)	Birth Weight (kg)
1	25	2.51 ± 0.69
2	47	2.19 ± 0.58
3	26	2.22 ± 0.44
4	8	2.21 ± 0.59
5	2	1.85 ± 0.05

According to Subandriyo and Sitorus (1985), the age of the female lamb is one of the factors that causes variations in the birth weight of sheep progeny, both under rural farming systems and at research stations. The study by Bathaei et al. (1996) on fat-tailed sheep showed that pre-weaning lamb growth was significantly affected by the age of the female lamb, although this effect tended to diminish as the lamb aged. Hafez (1969) stated that in older female lambs with repeated parity, fat accumulation in the uterus can negatively affect the birth weight of lambs.
Conversely, Black (1983) reported that young or primiparous female lambs tend to give birth to progeny with lower birth weights compared to older female lambs or those of multiparous female lambs. Subandriyo et al. (2000) also emphasized that the age of the female lamb at lambing significantly affects the body weight of lambs from birth to six weeks of age, although this effect tended to diminish as the lamb reaches weaning age.

1.4. Estimation of Heritability of Birth Weight

The estimated heritability value (h^2) for the birth weight of Priangan sheep was 0.12, which falls within the moderate category ($0.1 < h^2 < 0.3$). This estimate is higher than the heritability value reported by Dudi (2003), who found a heritability of 0.09 in Priangan sheep. However, it is lower than the heritability estimate reported by Siregar (1994), which was 0.43 ± 0.02. These differences may be attributed to several factors, including differences in sample size, study period, environmental conditions, and analytical methods used (Hardjosubroto, 1994).
A low heritability value does not necessarily indicate that the trait is minimally affected by genetic factors. According to Martojo (1993), the probability of error in selecting progeny stock (male lambs and

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female lambs for breeding) is higher for traits with low heritability compared to those with high heritability. Misinterpretation of heritability estimates (h^2) can negatively affect the selection process, especially during the selection of progeny stock. Such errors frequently occur when phenotypic superiority is primarily the result of environmental influences rather than a true reflection of genetic merit or breeding value.

1.5. Estimation of Selection Intensity

Based on the birth weight data, the average birth weight of male lambs was 2.33 kg, while the average birth weight of female lambs was 2.21 kg. Therefore, the selection criteria for progeny stock were set for male lambs with birth weights above the male average and female lambs with birth weights above the female average. Of the total 54 male lambs, 29 had birth weights above the average, while of the total 54 female lambs, 25 had birth weights above the average.

Table 4. Selection intensity based on the percentage of male lambs and female lambs selected

		Male lamb						
		Head	1	2	3	4	5	6
Female lamb	Head	%	0.44	0.88	1.32	1.76	2.20	2.64
	10	4.11	2.53	2.42	2.35	2.30	2.26	2.22
	20	8.23	2.38	2.27	2.20	2.15	2.11	2.08
	30	12.35	2.29	2.18	2.11	2.06	2.01	1.98

Based on Table 4, the fewer the animals selected, the higher the selection intensity, and conversely, a larger selection proportion results in lower selection intensity. Generally, fewer male lambs are required compared to female lambs, as a single male lamb has the capacity to mate with many female lambs (Pallawarukka, 1999). The male-to-female ratio at the study location was 1:20, which corresponds to a selection intensity of 2.38 as shown in Table 4. Based on this analysis, the optimal selection intensity was achieved at 1.92, corresponding to the selection of 3 male lambs and 60 female lambs.

1.6. Response to Selection

The magnitude of the genetic progress in birth weight of sheep in the next generation can be estimated by calculating the response to selection based on the birth weight of the progeny stock resulting from the selected breeding animals. The response to selection per generation is directly proportional to the product of selection intensity (i), heritability (h^2), and phenotypic standard deviation (σ_p). The magnitude of the response to selection depends on the value of the selection intensity (i), which is affected by the proportion of male lambs and female lambs selected as breeding animals for the next generation. The average selection intensity can be estimated by calculating the mean of the selection intensity of males (i_m) and females (i_f) divided by two [$(i_m+i_f)/2$]. The proportion of animals selected is determined by the number of male lambs and female lambs retained as breeding animals. The estimated response to selection per generation at various selection intensity levels is presented in Table 5.

Tabel 5. Response to Selection based on the percentage of male lambs and female lambs selected

		Male lamb						
		Head	1	2	3	4	5	6
Female lamb	Head	%	0,44	0,88	1,32	1,76	2,20	2,64
	10	4,11	0,138	0,132	0,128	0,126	0,123	0,121
	20	8,23	0,130	0,124	0,120	0,117	0,115	0,114
	30	12,35	0,125	0,119	0,115	0,112	0,110	0,108

Based on Table 5, the response to selection is higher when fewer animals are selected, and conversely, the response to selection decreases as the number of selected animals increases. The highest response to selection was achieved when the selection intensity was 0.44% (1 head) for male lambs and 4.11% (10

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heads) for female lambs, which yielded a response to selection value of 0.138 kg. This means that if selection is applied to birth weight in the current generation at this selection intensity, the estimated birth weight of progeny stock in the next generation would increase from the current average birth weight of 2.17 kg by 0.138 kg, reaching approximately 2.308 kg.

The lowest response to selection was obtained at a selection intensity level of 2.64% (6 heads) for male lambs and 24.69% (60 heads) for female lambs, with a response to selection value of 0.098 kg. This means that if selection is applied at this selection intensity, the estimated birth weight of progeny stock in the next generation would increase from the current average birth weight of 2.17 kg by 0.098 kg, resulting in an estimated birth weight of approximately 2.268 kg.

Conclusion

The optimal selection intensity at the Neglasari Village Farm, Darangdan Sub-District, Purwakarta Regency was achieved with a value of 2.53, using a selection proportion of 1 male lamb and 10 female lambs. The highest response to selection was 0.138 kg at a selection intensity of 2.53, while the lowest response to selection was 0.098 kg at a selection intensity of 1.79. The estimated birth weight of progeny stock in the next generation is 2.308 kg per head.

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