The evaluation of body weight and morphometric traits in local and crossbred sheep at birth age

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Abstract. Selection and crossbreeding were implemented by the breeders to improve the livestock performance in Indonesia. The study was aimed to evaluate the progeny performance of crossbred and local sheep, specifically the fat-tailed sheep (FTS) and Garut sheep at birth age. The research method used was a case study in the field with observation variables at birth age such as body weight (BW), chest girth (CG), body length (BL), and body height (BH). The material in this study was 92 sheep aged at birth. The data was analysed using analyses of variance (ANOVA), applying R Studio software. The statistical analysis demonstrated that the breeds exhibited highly significant differences ($P<0.01$) in BW, BH, CG, and BL corrected for single birth, except the BL for twins birth. Additionally, there were significant differences ($P<0.05$) in CG for both single and twin birth. Fat-tailed sheep (FTS) exhibited superior performance in BW, BH, BL, and CG. Crossbred sheep also showed advantages in BW, BH, and CG. The best birth performance in this study was local sheep, specifically the FTS.

1 Introduction

Sheep are one of the important ruminant livestock in supporting food security and increasing the income of farmers in Indonesia. Sheep have an played a important role in the history of human development, both economically and culturally, as a source of food, ancillary products, and in the spread of agricultural civilisation [1]. The main challenge in the sheep farming business is the low productivity of the livestock, as well as the limited availability of a continuous supply of superior sheep with high and efficient productivity and affordable price for farmers [2].

Local Indonesian sheep demonstrate remarkable adaptability to the environmental conditions in Indonesia and exhibit resistance to ectoparasites [3]. Good adaptability to the environment will provide benefits to the performance of local sheep so that they can have good and stable performance. Breeding programs are essential to enhance the productivity of these breeds and ensure they remain competitive [4]. To improve sheep performance in terms of faster growth, higher meat production, and better meat quality, a combination of breeding strategies and genetic selection can be employed. The importance of morphometric identification and body composition of local sheep at different growth stages, with the results of the study showing that selection based on morphometric size is relevant for livestock breeding [5]. Increasing the quality of local sheep production in

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Indonesia is supported by the government through the establishment of Indonesian national standards (SNI). Standardization of sheep performance in Indonesia is regulated at number SNI 7532:2009 and SNI 7532-2-2018. The SNI 7532:2009 explains about local Garut sheep, and SNI 7532-2-2018 explains about fat-tailed sheep (FTS)[6][7]. Assessment of the quality of the sheep or herd offspring can be done by comparing it with the SNI value.

One method for producing superior sheep is by crossing. Crossbreeding is crossing between sheep with different breeds. Crossbreeding is a method of quickly improving productivity by exploiting the effects of heterosis and complementation of traits between two or more parent families [8]. A herd is a group of animals of a species that have distinctive physical characteristics, and these characteristics are passed on to their offspring and have their own economic value [9]. Crossing can produce offspring that have the advantages of both parent breeds. The results of previous research concluded that crossbred sheep have better performance compared to the local sheep [10].

Research on the effects of sire crossbred sheep and selected local sheep on offspring performance is limited. Previous research on the offspring of Dorper-Garut sheep crosses was significantly different compared to Garut-Garut sheep in terms of birth weight and weaning weight [11]. Crossbreeding has been shown to be effective in enhancing production performance and meat quality in sheep [5]. This research needs to be conducted to obtain more complete information on the influence of crossbreeds and local breeds, especially FTS and Garut sheep, on progeny performance. The performance evaluation of the performance of offspring from each breed of sire in accordance with SNI is one of the efforts to improve the genetic quality of livestock.

2 Materials and methods

The research method used was a case study in the field on the performance of offspring of several breeds at birth age. The research was conducted from August to December 2023. The research location was in Bojonegoro district, East Java province. The material in this study was 92 sheep at birth age consist of 41 heads FTS, 28 heads Crossbreed, and 23 heads Garut. These sheep came from three breeds, namely Crossbred, fat-tailed sheep (FTS) and Garut. The parents of FTS and Garut sheep are selected sheep. Crossbred sheep are the offspring of Texel and thin-tailed sheep (TTS) mixed breed sires mated to TTS ewes. The observed variables in this study are:

1. Body height (BH) is measured from a flat surface to the highest part of the shoulder past the scapula perpendicularly in cm.
2. Body Length (BL): measured from the scapula (the most prominent part at the front of the shoulder) to the processus spinisus (the tip of the hip) in cm.
3. Chest Girth (CG): measured circularly on the chest, namely around the chest cavity, precisely behind the shoulders in cm.
4. Body weight (BW): weighed on a digital scale in kg.

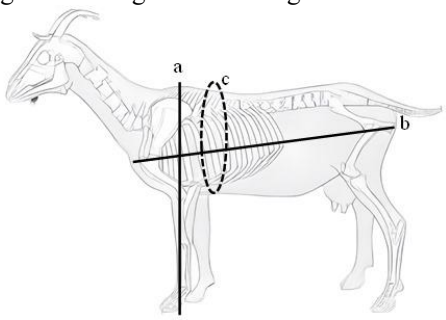

Figure 1 Method measurement of morphometric, a. Body Height, b. Body Length, c. Chest Girth

2.1 Data correction

Correction of livestock performance data is used in order to eliminate or reduce non-genetic variations and have a large data. Correction factors (CF) are very important to know the actual genetic performance of livestock [12]. Correction factors calculated for sheep include gender and type of birth. Data correction at weaning age follows the equation [12]: CF for birth type to single birth type follow this equation:

$$\text{CF birth type twin} = \frac{\bar{X}_{single}}{\bar{X}_{twin}} \quad (1)$$

$$\text{CF birth type triplet} = \frac{\bar{X}_{single}}{\bar{X}_{triplet}} \quad (2)$$

$$performance\ corrected\ to\ single = CF\ birth\ type\ \times actual\ size \quad (3)$$

Data corrections on single birth types were carried out on the performance in each breed to obtain performance that matched the performance of the FTS, Garut, and Crossbred sheep. Data was corrected and managed using Microsoft Excel.

2.2 Data analysis

Data were analysed using descriptive statistics, namely average and standard deviation, also T-test and analysis of variance (ANOVA). T-test and ANOVA was carried out to determine the effect of breeds on sheep performance. The ANOVA test uses the following equation:

$$Y_{ij} = \mu + \pi_i + \beta_{ij} \quad (4)$$

Information:
Y_{ij} : phenotypic value of the traits
μ : overall mean
π_i : Influence of breeds
β_{ij} : Experimental error in the treatment

Statistical analysis was analysed using R Studio software. If the results show significant different, then proceed with further tests, namely the least significant difference (LSD test) with the "Agricolae" package in the R studio environment.

3 Result

Tabel 1 showed the statistic descriptive body weight and morphometric trait of breeds performance at birth-age. Breed of sheep had a influence on the traits of BL twins, CG singles, CG twins and CG corrected to single, while the traits of BL twins, BL triplets, and CG triplets had no effect. BW and BH at birth of single in local (fat tail sheep and Garut sheep) was not different ($P > 0.05$) compared to crossbred and those also for single, twin and triplet, while had highly influence for corrected to single ($P < 0.01$). BW corrected to single of FTS is not different with Garut sheep and Crossbreed sheep, while Garut had significant different with Crossbred. BH corrected to single for FTS was highest value and has significant different with Garut, while crossbred was not different with FTS and Garut sheep. The highest BL in the birth type of twins was in the FTS offspring of 27.04 ± 3.14 cm. The highest CG was in the FTS breed, namely 34.00 ± 4.11 cm (singles) and 29.42 ± 3.29 cm (twins).

Table 1 Average ($\bar{X}$) and Standard Deviation (SD) of Offspring Performance in Single, Twins, and Triplets Birth Type at Birth Age

Trait			FTS	CROSSBRED	GARUT
	Type of birth	**N**	$\bar{X}$ ± SD	$\bar{X}$ ± SD	$\bar{X}$ ± SD
BW (kg)	Single	29	3.00 ± 0.78	3.19 ± 0.83	2.49 ± 0.47
	Twins	37	1.97 ± 0.58	1.82 ± 0.52	1.87 ± 0.32
	Triplets	26	1.54 ± 0.46	1.38 ± 0.21	1.62 ± 0.60
	Corrected to single	92	2.94 ± 0.82^{AB}	3.12 ± 0.77^{A}	2.52 ± 0.48^{B}
	Type of birth	**N**	$\bar{X}$ ± SD	$\bar{X}$ ± SD	$\bar{X}$ ± SD
BH (cm)	Single	29	35.25 ± 4.31	33.40 ± 3.06	33.29 ± 2.63
	Twins	37	32.13 ± 3.59	29.33 ± 3.84	30.83 ± 1.34
	Triplets	26	28.15 ± 3.23	29.17 ± 1.72	29.33 ± 2.08
	Corrected to single	92	35.25 ± 3.99^{A}	33.40 ± 3.41^{AB}	32.08 ± 1.90^{B}
	Type of birth	**N**	$\bar{X}$ ± SD	$\bar{X}$ ± SD	$\bar{X}$ ± SD
BL (cm)	Single	29	30.00 ± 4.47	28.90 ± 4.28	28.57 ± 3.10
	Twins	37	27.04 ± 3.14^{A}	22.46 ± 3.81^{B}	24.33 ± 2.25^{AB}
	Triplets	26	22.03 ± 2.86	21.50 ± 1.05	23.00 ± 2.65
	Corrected to single	92	30.00 ± 3.86	28.90 ± 4.03	28.76 ± 2.73
	Type of birth	**N**	$\bar{X}$ ± SD	$\bar{X}$ ± SD	$\bar{X}$ ± SD
CG (cm)	Single	29	34.00 ± 4.11^{a}	30.20 ± 3.46^{b}	29.71 ± 4.86^{b}
	Twins	37	29.42 ± 3.29^{a}	26.67 ± 2.26^{ab}	27.83 ± 1.81^{b}
	Triplets	26	25.71 ± 4.34	24.42 ± 2.01	27.00 ± 3.61
	Corrected to single	92	34.00 ± 4.67^{A}	30.20 ± 2.79^{B}	28.53 ± 2.98^{B}

Note: $^{a, b}$ Means in rows with different superscripts was significantly different ($P \leq 0.05$) and ^{A,B} Means highly significant different ($P \leq 0.01$). Body Weight (BW), Chest Grith (CG), Body Height (BH), and Body Length (BL).

4 Discussion

BW single twins, triplets, and corrected on single birth type of the offspring for crossbred were 3.19 ± 0.83 kg, 1.82 ± 0.02 kg, 1.38 ±0.21 kg, and 3.12 ± 0.77 kg; FTS were 3.00 ± 0.58 kg, 1.97 ±.058 kg, 1.44 ± 0.46 kg, and 2.94 ± 0.82 kg; Garut were 2.49 ± 0.47 kg, 1.87 ± 0.32 kg, 1.62 ± 0.60 kg, and 2.52 ± 0.48 kg, respectively. The results of the study on single type birth were higher compared to SNI number 7532:2009, which required the birth weight of the sheep to be 2.4 kg in females and 2.8 kg in males, while in the birth type twins and triplets were still below SNI [6]. The differences body weight of single, twins, and triplets caused by capacity of the uterus. The capacity of the uterus is determined by the total mass of the placenta that the dam is able to transport [13]. The number of litter size at a birth is also limited by the capacity of the uterus. A small number of fetuses will provide an opportunity for the fetuses to grow larger. Nutritional intake for the fetus will also have an influence on fetal growth. If there are many fetuses in the uterus, there will be a distribution of nutrients for the fetus. Litter size is the most important phenotypic trait in livestock reproduction, which is influenced by ovulation rate and hormones, as well as fecundity genes. The rate of ovulation and the number of oocytes released from the follicle

during ovulation are directly related to the size of the sheep [14]. Differences size of singles, twins and triplets are also visible in the morphometric traits for Garut sheep, FTS sheep, and crossbred sheep (Table 1).

Studies on genetic evaluation in sheep have shown that different breeds and crossbreeds can have varying growth performances, influenced by factors like heterosis [13]. Environmental factors can also shape traits that are appropriate to the place of development, such as the management of parent rearing, which can have a greater influence in determining these traits [16]. The morphometric of CG and BL has highly significant different in each breed, providing markers or characteristics of each breed. Differences in sheep breeds are caused by breed genetic factors can pass on traits and characteristics to their offspring. Growth and morphometric characteristics in sheep are strongly influenced by genetic factors inherited from the parent [17]. Breed and body size relationships help in understanding the genetic diversity and unique characteristics of different sheep breeds [18].

The analysis of the effect of breed on birth age showed that there was only an influence on a few traits and did not occur in the majority of traits. This suggests that local breeds still have the potential to perform well, with fat-tailed sheep particularly known for their high fertility and adaptability to harsh environments [2]. Indigenous and local livestock breeds and lines require improved productivity through breeding programs to respond to the increasing demand for animal protein and to various changes in the future [8]. The results also indicated that there is room for improvement in genetic selection, especially in local breeds, as progeny results for twins and triplet birth types were below the standard, presenting opportunities for enhancement [4].

5 Conclusion

The body weight of a single birth type at birth age has met with SNI, while twins and triplets birth types still do not meet SNI standards for all breeds. Breed had influenced the performance of BW, BH, BL corrected to single, and BL, CG twins and CG single. The best performance at birth age is in local sheep, especially the FTS sheep because they have many advantages in body weight and morphometrics. Improving performance through a breeding program still needs to be done for the birth type of twins or triplets in accordance with the breeding objectives. Breeding local breeds was highly recommended with selection in accordance with the breeding objective to meet SNI standards for multiple birth types.

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