BIODIVERSITAS
Volume 23, Number 11, November 2022
Pages: 5738-5743

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d231125

The pre-weaning growth of lambs from crossbreeding between Garut ewes and Dorper rams

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Manuscript received: 24 July 2022. Revision accepted: 4 November 2022.

Abstract. *Athifa IR, Sari APZNL, Maharani D, Budisatria IGS, Bintara S, Noor YG, Hidayat R, Panjono. 2022. The pre-weaning growth of lambs from crossbreeding between Garut ewes and Dorper rams. Biodiversitas 23: 5738-5743.* This study was aimed at determining the productivity of lamb from mating between Garut ewes and Dorper rams. The animals used were 108 sheep. A total of 98 heads of Garut ewes were randomly divided into two groups; the first group was mated with Dorper rams (5 heads), while the second group was mated with Garut rams (5 heads) as a control group. The data observed were birth weight, weaning weight, average daily gain (ADG), reproduction index (RI), and productivity index (PI). The data were analyzed with an independent sample T-Test. Birth weight, weaning weight, and ADG of Garut and Dorper crossbred lambs were 2.20±0.54 and 2.60±0.71 kg; 14.91±3.57 and 16.27±3.69 kg; and 90.21±32.11 and 119.12±42.64 g/day, respectively. Pre-weaning growth of Dorper-crossed lambs was higher ($P<0.05$) than those of Garut lambs. The RI and PI of Garut ewes mated with Garut and Dorper rams were 3.15±1.38 and 2.87±1.33 head/year; and 32, 10±15.53 and 38.91±21.00 kg/year, respectively. The PI of ewes mated with Dorper rams was higher ($P<0.05$) than that of Garut ewes mated with Garut rams. It is concluded that the cross of the Garut ewes with the Dorper rams improved productivity by increasing the pre-weaning growth of the lambs.

Keywords: Crossbreeding, Dorper sheep, Garut sheep, pre-weaning period, reproductive performances

INTRODUCTION

Sheep is a small ruminant livestock widely distributed in the community as a source of animal protein. The farmers generally keep this animal because it is easy to raise, quite responsive to good maintenance management, easy to breed, and requires relatively small capital compared to large ruminants (Udo and Budisatria 2011; Ibrahim et al. 2021). Sheep is an animal required for a religious event such as *aqiqah*; this event needs lambs weighing 15-20 kg, whereas, for the culinary industry, the sheep must have 25-28 kg of weight at less than one year of age. Meat quality is influenced by the age of sheep (Li et al. 2018). Meat tenderness decreases with age (Payne et al. 2020); hence, it is preferable to slaughter sheep with sufficient body weight at a relatively younger age.

Improving slaughter weight can be conducted by improving livestock genetics, which will be reflected in livestock productivity (Koesmara et al. 2019). Productivity in livestock is a combination of production and reproduction characteristics and can be increased through genetic quality improvement (Budisatria et al. 2021). One way to improve the genetic quality of livestock is to implement crossbreeding, a strategy to increase growth, reproduction, and production by utilizing the effect of heterosis or hybrid vigor (Getahun et al. 2019). Complementarity and heterosis could be optimized by organizing the crossbreeding system since they present high feeding efficiency, better maturity rate, and high meat productivity (Castillo-Hernandez et al. 2022). Profitability and efficiency are determined by genetic merit for more efficient growth (Chay-Canul et al. 2019).

One of the local sheep that exist sustainably is the Garut sheep, a livestock genetic resource from West Java, Indonesia. The genetic potential of local sheep can be seen from the excellent prolific (Nurcholis et al. 2016). However, its body weight needs to be increased to improve the slaughter weight, where Garut ram and ewe weighed 60-80 kg and 30-50 kg, respectively (Rizal et al. 2015), with an average weaning weight of 11.55 kg (Praja et al. 2020). Moreover, to increase the slaughter weight of Garut sheep, it is necessary to mate it with another breed with higher slaughter weight; one of the candidates is the Dorper.

This sheep is a superior meat in South Africa developed through crossbreeding between the Dorset Horn ram and Black Head Persian ewe (Gavojdian et al. 2013). Dorper can produce lambs with good growth rates, efficient feeding, very fertile, and good carcass characteristics (Mellado et al. 2016). These sheep are also easy to maintain in harsh conditions, have good reproductive performance, are non-selective to feed, and are fast-growing, with a weaning weight of 18.7 kg (Budai et al. 2013). Dorper can reach 36 kg at the age of 110-120 days, with adult rams weighed of 100-120 kg, and adult ewes weighed of 60-80 kg (Gavojdian et al. 2013). Therefore, efforts to implement crossbreeding between Garut sheep

and Dorper were carried out to increase the productivity of the ewes to get the best lambs.

The pre-weaning growth of lambs cannot be separated from the effect of the ewes and the genetics of the sheep itself. Furthermore, pre-weaning growth is affected by breed, and because of that, crossbreeding has been used to exploit heterosis or breed complementarity (Castillo-Hernandez et al. 2022). So, evaluation in pre-weaning growth is an important factor of ewes' performance. The parameters of the success of this crossbreeding were evaluated from the performance of the Garut ewes that were crossed with Dorper rams. Therefore, the purpose of this study was to observe the pre-weaning growth of lamb from the crossbreeding of Garut ewes with Dorper ram.

MATERIALS AND METHODS

Ethical clearance

The Ethical Clearance Commission has approved the design of this research, i.e. Faculty of Veterinary Medicine, Universitas Gadjah Mada, Yogyakarta (No: 0037/EC-FKH/EKs/2020).

Experiment location and duration

The experiment was conducted in the farm-sheep PT. Agro Investama is in Malangbong, Garut district, West Java, Indonesia. The animals were evaluated from ewe and ram mating and giving birth until weaning. This period of research working and collecting data began in November 2019 and lasted until October 2020.

Animal

The experimental animals used in this study were 98 Garut ewes, 5 Garut rams, and 5 Dorper rams. The ewes used were above parity one or over sixteen months old with a live weight of 20 kg or above. The rams used were over two years old, with a live weight of 80-100 kg for Dorper rams and 60-70 kg for Garut. After labor, Garut ewes with Dorper ram produced 16 lambs in single birth and 35 lambs in twin's birth. Garut ewes with Garut ram produced 8 lambs in single birth and 39 lambs in twin's birth.

Procedures

Before the experiment, the Dorper rams were adapted to the environment and fed for a month. Ewes who recently gave birth were randomly divided into two groups. The first group was mated with a Dorper ram, and the second group was mated with a Garut ram as a control. The ewes were kept in colony pens with a capacity of 11-15 heads per colony. The stilt pens were of the size of 8x5 m^2 and were equipped with feed and water bunks. The data recorded were the data of ewes, including the lambs' birth weight, date of birth, weaning weight, date of weaning, date of delivery, litter size, lambs' sex, and pre-weaning mortality.

The next mating period was conducted 40 days after the ewes gave birth by allotting one ram in each ewes' colony pen. A month after, the rams were removed, and at the same time, the lambs were weaned and moved to the weaning pen. All the sheep were fed by complete feed. A month after the mating process, pregnancy checking was carried out using a Draminski ultrasound scanner probe transducer 5 MHz. The non-pregnant ewes were mated again, and those pregnant ewes were kept until the delivery. Two months after the delivery, the ewes were re-mated as in the previous period; the lambs were also weaned at three months as in the previous period. The lambs were given identity right after the delivery. The total of lambs born was 192 heads, with details mating of Garut ewes with Dorper ram producing 94 lambs. The mating of the Garut ewes with the Garut rams produced 98 lambs. The illustration of the reproduction process in the experiment was presented in Figure 1.

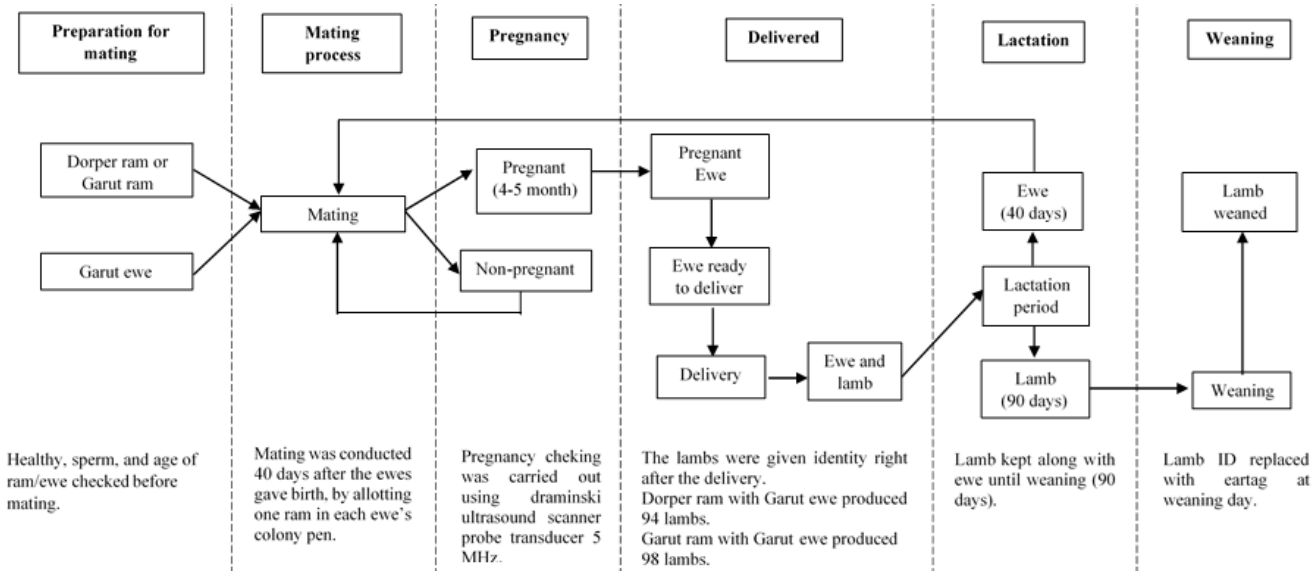

Figure 1. Illustration of the reproduction process in the experiment

Table 1. Sheep consumption in this experiment

Physiological conditions	Complete feed		Content nutrition				
	G (%)	L (%)	DM (%)	CP (%)	TDN (%)	Ca (%)	P (%)
Ewe pregnant	60	40	3-5	7.8-9.8	50-60	0.23-0.38	0.17-0.28
Rams	75	25	3-6	6.9-11.8	50-65	0.14-0.40	0.13-0.36
Ewe lactation	50	50	4	9.1-10.9	55-60	0.27-0.30	0.20-0.22

Note: G: Grass; L: Legumes; DM: Dry matter; CP: Crude protein; TDN: Trude digestible nutrient; Ca: Calcium; P: Phospor

Routine maintenance of ewes, rams, and lambs included cleaning the pens every morning, bathing the sheep once a week, and shearing and trimming the long nails. Lambs' delivery occurred in individual pens, giving IDs to the newborns. After the lambs were two months old, the ewes and lambs were transferred back to the colony cage. Feeding was carried out twice daily, at 08.00 am and 4.30 pm. Drinks were given unlimited at drinking shelters. However, the feed amount was adjusted to the nutritional needs of the sheep according to the NRC (1985).

Data collection

The litter size was counted during delivery, and the sexes were identified. The weight was measured using a Hitachi cattle scale with a capacity of 300 kg and an accuracy of 0.01 g. Birth weight was obtained by weighing the lambs a maximum of 24 hours after the delivery. The lambing interval was calculated by identifying the tie difference between the first and second delivery. Pre-weaning mortality was determined by counting the number of lambs that diet until weaning. Data on litter size, pre-weaning mortality, and birth weight were taken at the second delivery.

Birth weight data were adjusted for rams and single birth, which was conducted to minimize environmental variance between sexes or birth types by equalizing rams to ewes and single births to twin births (Hardjosubroto 1994). The number of living lambs was counted and weighed during the weaning process. Weaning weight was determined based on the weight of the lambs at 90 days of age and adjusted as in the case of birth weight correction. The weaning weight was calculated using the following formula (Hardjosubroto 1994).

The formula for estimating the correction factor of sex was as follows:

$$CF\ sex=\frac{\bar{X}\ ram}{\bar{X}\ ewe}$$

Where:

CF sex: Correction of sex for birth weight/weaning weight

"X"¯ ram: Average birth weight/weaning weight of lambs (ram)

"X"¯ ewe: Average birth weight/weaning weight of lambs (ewe)

The formula for determining the birth type correction factor is as follows.

$$CF\ brith\ type=\frac{\bar{X}\ single}{\bar{X}\ nth\text{-}twin}$$

Where:

CF birth type: Correction factor of birth type for birth weight/weaning weight

"X" ¯single: Average birth weight/weaning weight of single lamb

"X" ¯nth twins: Average birth weight/weaning weight of nth twins (n=1st ,2nd, 3rd, and 4th)

The correction factor corrected birth weight for the ram and single birth is as follows.

c BW = [birth weight] x [CF sex] x [CF birth type]

Where:

c BW: corrected birth weight

CF sex: correction factor of sex

CF birth type: correction factor of birth type

Weaning weight was adjusted to an average weaning age of 90 days old using correction factors for ram and single birth with the following formula:

$$WW_{90}=\left[\frac{WW\text{-}BW}{WA}x90+BW\right](CF\ sex)(CF\ brith\ type)$$

Where:

WW90: corrected weaning weight

WW: weighed weight

BW: birth weight

CF sex: correction factor of sex

CF birth type: correction factor of birth type

WA: Weaning age

Next, average daily gain (ADG), reproduction index (RI), and productivity index (PI) were calculated using the following formula: Average daily gain was calculated by identifying the initial weight (birth weight) and the final weight (weaning weight). The weight used is the adjusted birth/weaning weight. The weighing was conducted before weaning and before the lambs were fed. Average daily gain (ADG was calculated with the following equation:

$$ADG=\frac{[FBW\text{-}IBW]}{t}$$

Where:

ADG: Average daily gain (g/day)

FBW: Final body weight (g)

IBW: Initial body weight (g)

t: duration of observation (days)

The following equation calculated RI:
RI = ([LS-M] x 365/BI)
Where:
RI: reproduction index (head/year)
LS: Litter size/number of lambs delivered (head)
M: Pre-weaning mortality
BI: Birth interval (days)

The following equation calculated PI:

PI = RI x AWW

Where:
PI: productivity index (kg/year)
RI: reproduction index (head/year)
AWW: Average weaning weight in each ewe (kg)

Data analysis

The data analyses included descriptive statistics of lamb and ewe performance, percentage of mortality, mean, and standard deviation. In addition, an ANOVA was used to test the differences between the pre-weaning growth of Dorper crossed lamb and Garut and the performance of Garut ewe mated with Dorper and Garut rams. Means differences were considered significant at $P<0.05$.

RESULTS AND DISCUSSION

Results

Table 2 shows that the birth weight of the Dorper crossbred lamb was higher (P<0.05) than that of the Garut lamb because the Dorper crossbred has 50% Dorper blood. Weaning weights of crossbred lambs were higher (P<0.05) than that of Garut lambs due to the higher birth weight and pre-weaning ADG of Dorper-crossed lamb. The pre-weaning ADG of the lambs from Dorper crossbred was higher (P<0.05) than that of Garut lambs, this shows the influence of the rams' genetic factor. Genetic differences will determine the diversity in animal growth.

Table 3 showed that the lambing interval, litter size, and mortality of the ewes mated with Dorper and Garut rams were not significantly different; Table 3 showed that the RI of Garut ewes mated with Dorper and Garut rams were not significantly different, but the PI of the ewes crossbred with Dorper rams was higher (P<0.05) than that of the ewes mated with Garut rams.

Table 2. Birth weight, weaning weight, and pre-weaning growth of Dorpers crossed lambs and Garut

Variable	Dorper x Garut (n=94)	Garut x Garut (n=98)	Sig.
Birth weight (kg)	2.70±0.71	2.21±0.53	*
Sex			
Male	2.70±0.70	2.19±052	
Female	2.66±0.68	2.21±0.53	
Birth type			
Single	2.70±0.70	2.21±0.52	
Multiple	2.66±0.68	2.21±0.53	
Corrected data	2.69±0.70	2.16±0.53	*
Weaning weight (kg)	16.01±3.41	14.15±2.94	*
Sex			
Male	16.01±0.71	14.17±3.03	
Female	15.90±0.68	14.15±0.53	
Birth type			
Single	16.01±3.41	14.18±2.86	
Multiple	15.90±3.36	14.15±2.94	
Corrected data	13.13±3.30	9.79±2.53	*
Average daily gain (g/day)	145.79±33.22	109.35±27.96	
Sex			
Male	145.79±33.22	108.33±28.04	
Female	144.35±32.70	109.35±27.96	
Birth type			
Single	145.79±33.22	116.96±26.86	
Multiple	144.35±32.70	109.35±27.96	
Corrected data	115.11±32.59	84.64±26.53	*

Note: *P<0.05

Table 3. Performance of Garut ewes which were mated with Dorper and Garut rams

Variable	Dorper x Garut (n=51)	Garut x Garut (n=47)	Sig.
Lambing interval (day)	214.67±18.47	211.79±16.18	Ns
Litter size (head)	1.81±0.66	2.09±0.69	Ns
Mortality (%)	7.45±0.13	9.18±0.16	Ns
Reproduction index (RI) (lambs/year)	2.85±0.80	3.26±0.99	Ns
Productivity index (PI) (kg/year)	36.86±9.36	32.01±8.86	*

Note: *P<0.05; ns: non-significant

Discussion

The birth weight of lambs is regarded as one of the most important contributory factors for improving growth performance, and survival from mortality, resulted in Table 1. Descriptive statistics for pre-weaning growth performance Dorpers crossed lambs were higher than Garut lambs were significantly affected by the genotype of Dorper rams. The increase in birth weight in crossbreds with other breeds was due to 50% of genetic inheritance (Teklebrhan et al. 2014). Dorper is a breed of sheep that is genetically superior in growth, as seen from its large birth weight (Ayichew 2019), which weaning weight has a positive correlation with birth weight. The high birth weight indicates rapid growth, meaning that high birth weight will likely result in high weaning weights due to the high correlation of responses that birth weight was highly correlated with pre-weaning body weight gain (Kuthu et al. 2017). Therefore, the sheep originating from a breed with an advantage in the growth rate will show acceleration in terms of growth, so that breed was superior in birth weight and weaning weight to grow faster and heavier (Teklebrhan et al. 2014). Dorper was a ram that could grow quickly and reach growth rates with ADG of 240-280 g/day (Kandiwa et al. 2020). Teklebrhan et al. (2014); Ngadiyono et al.

(2019) explained that the genetics of rams in a crossbreeding system with local sheep would increase the growth potential of the crossbred lambs.

The result in table 2 showed that the rams' breed did not affect the ewes' lambing interval. Berhan and Van Arendonk (2006) reported that the rams' breed did not affect the conception at the time of ovulation, so it did not have a significant interaction with pregnancy and postnatal heat. The rams did not influence the litter size. Lakew et al. (2014) reported no significant difference in litter size in crossbred between local ewes with local or Dorper rams. Kwon et al. (2015) added that the sheep had higher litter size if the spermatozoa or egg cells were normal and capable of fertilization, regardless of breed. Rams' breed did not affect lambs' mortality. Litter size was related to the prolific score of lambs. Prolific traits in ewes were important because these traits were a combination of the sexual maturity age, the ability of ewes to get pregnant, the rate of ovulation, ease in giving birth, the embryo survival, the continuous supply of milk, the mothering ability of the ewes, and ram fertility (Andara et al. 2022).

Lakew et al. (2014) explained that the effect of rams' breed difference was insignificant in terms of mortality between local and crossbred sheep. The rams' breed did not affect the ewes' reproduction index of the two groups. Lakew et al. (2014) reported that mating local ewes with different rams' breeds did not affect the reproduction rate of ewes in both groups (Garut and Dorper). Increasing the ewes' reproduction can be conducted by suppressing mortality and maximizing the growth potential of the lamb (Berhan and Van Arendonk 2006). An efficient reproduction rate indicates the ewes' ability to handle lamb in the pre-weaning period. Ewes reproduction in the pre-weaning period was expressed in milk consumption, growth, and mortality of their lamb (Warman et al. 2021). In this experiment, the RI of ewes mated with Dorper rams was higher than that of ewe and rams of other breeds. The mated of a local Ethiopian ewe with Dorper ram resulted in an RI value of 1.37±0.01 head/year (Lakew et al. 2014). The RI of local Sumatran thin-tailed ewe mated with Barbados Blackbelly ram was 2.39 cubs/year (Subandriyo et al. 2000).

The weaning weight of the lambs influences the productivity index. So, the PI of the Garut ewes mated with Dorper rams was higher ($P<0.05$) than that of the Garut ewes mated with Garut rams, which was due to the higher weaning weight of Dorper crossbred lambs (Table 2), which affected the ewes' productivity. Budisatria et al. (2021) stated that livestock productivity depends on reproduction and growth. Therefore, ewes' reproduction and weaning weight must be improved to increase productivity. Doloksaribu et al. (2000) added that the body weight of the crossbred, namely the crossbred genotype, was superior to that of the local sheep; the effect of the heterosis phenomenon caused the advantage. Therefore, the PI of Garut ewes mated with Dorper rams in this experiment was higher than that of the ram of another breed. Subandriyo et al. (2000) reported the PI of Sumatran Thin-tailed ewes mated with Barbados Blackbelly rams and St. Croix rams was 19.39 kg/year. In another experiment, the Sumatran ewes mated with Crosses of Virgin Island was 19.4±1.0 kg/year; the Sumatran sheep ewe mated with Barbados black belly rams was 21.3±1.0 kg/year (Doloksaribu et al. 2000). Finally, the conclusion was the Garut ewes crossed with the Dorper rams had higher productivity which can be seen from the better performance of the ewes through the increase in the pre-weaning growth of lambs.

ACKNOWLEDGEMENTS

This study was supported by *Hibah Penelitian Pascasarjana*, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta, Indonesia contract no. 2600/J01.1.25/PASCA/2020.

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