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Original article

Effects of non-genetic factors on growth traits and survival rate in Karacabey Merino lambs

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Abstract

This study was conducted with the aim of determining the growth characteristics and survival rate of Karacabey Merino lambs, as well as the non-genetic factors affecting these traits. The study included data from a total of 17659 lambs and 12263 ewes raised in 30 herds between the years 2011 and 2016 as part of the National Sheep and Goat Improvement Project. The average birth weight of the lambs was determined as 3.73±0.05 kg, the average 45th day live weight was 18.43±0.58 kg, the average weaning (average 91.8 days) weight was 31.83±0.24 kg, and the average daily live weight gain until weaning was 289.1±3.91 g. The average survival rate of lambs at weaning was calculated to be 95.67% ± 1.15. The effects of the factors herd, birth year, birth type, birth season and sex were found significant for all traits ($p<0.01$). It was established that the mortality rate in lambs in large herds was higher during 6 years in which the project was carried out. Due to the high twinning rate in large herds, the number of lambs per worker is increased, and as a result, they cannot be adequately cared for. For this reason, large farms may be encouraged to increase workmanship services in addition to being provided with protective health practices for lambs throughout the birth period. On the other hand, it was determined that the twinning rate was low in small farms. On farms with fewer sheep populations, it may be advised to flush or administer exogenous hormone treatments to ewes in order to increase fertility and help them bear twins.

Keywords: body weight, daily weight gain, environmental factors, Merino sheep

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Introduction

The Karacabey Merino sheep breed is raised as a purebred and crossbreed mainly in the Southern Marmara region and in some parts of the Thrace and the Aegean. Karacabey Merino, which is composed of the German Mutton Merino (approximately 95%) and Kıvırcık (5%) breeds, has a high adaptability and produces good meat, wool and fertility (Kaymakçı 2016). The National Sheep and Goat Improvement Project primarily aims to develop high fertility herds while preserving breed characteristics through the selective breeding of the best animals.

Growth characteristics are influenced by a number of genetic and non-genetic factors, making it difficult to properly define genetic potential (Thiruvenkadan et al. 2011). For non-genetic factors, data must be corrected; for various traits, genetic parameters must be estimated; and for important economic traits, accurate estimations must be obtained and the correctness of selection must be increased (Dixit et al. 2011). Hence, it is possible to more accurately estimate adult live weight by revealing the effect of genetic and environmental factors on growth and a rapid genetic improvement in the herd can be achieved via a selection in this manner (Akpa et al. 2013). It is critical to conduct an accurate performance evaluation and estimate genetic parameters between various traits in order to establish successful selection strategies and genetic improvement programs (Tesema et al. 2022).

The growth potential of lambs is one of the most important traits in the genetic improvement scheme. At the same time, it reflects the animals' economic viability in terms of a more productive sheep breeding (Petrovic et al. 2011). In this context, it has been aimed to help lambs reach market weight more rapidly by achieving a higher daily weight gain (DWG) starting from weaning and until they reach the slaughtering weight (Prakash et al. 2012). Birth weight is a characteristic which can be measured in the early stages of development and since it has a positive genetic correlation with the other body weight traits, it bears great importance (Lalit et al. 2016). For this reason, it can be used to estimate the growth performance of an animal. Moreover, because of its effect on lamb growth rate, survival rate, and hence, the total lamb weight available in the market, birth weight is an important component of ewes' overall fertility (Iman and Slyter 1996). Since birth weight is a quantitative trait, it is strongly affected not only by genetic factors but also by different environmental and physiological factors (Lalit et al. 2016). Since a lamb meets most of its nutritional needs from its mother, weaning weight is highly associated with the mothering ability of the ewe (milk yield and mothering instinct), and hence, differences in weaning weights are essentially a reflection of mothering ability while also reflecting natural growth differences (Lalit et al. 2016). The survival rate of lambs was evaluated by calculating the ratio of live-born lambs that lived until a certain age to live-born lambs that did not reach that stage. During weaning, survival rate is an important criterion (Morris et al. 2000).

The purpose of this study, which was conducted between 2011 and 2016 within the scope of the genetic improvement of Karacabey Merino sheep project, a sub-project of the National Sheep and Goat Improvement Project, was to examine the growth and survival rate traits of Karacabey Merino lambs, to determine the effects of non-genetic factors such as herd, birth year, birth season, sex and birth type on these traits and to observe the reflection of supervised breeding on the field.

Materials and Methods

Data collection and studied traits

The animal material of the study was composed of 17659 Karacabey Merino lambs and 12263 ewes from 30 herds between 2011 and 2016. Birth weight (BW), 45th day live weight (LW45), weaning weight (WW) and daily weight gain from birth to weaning (DWG) were used as the growth traits in lambs. The assigned number of the ewe giving birth, the number of lambs at birth, the lamb's / lambs' birth date, ear number, sex, birth weight and live weight on the 45th day were all recorded in this scope. The lambs were weaned at 90 days of age and their weaning weights were recorded at this time. The survival rate was defined as the proportion of live – born lambs reaching weaning age.

Statistical analyses

Herd (n=30) and birth year (6 years) were considered as random factors. The fixed factors were defined as birth season (spring, summer, autumn, winter), sex (male, female), birth type (single, twins). The groups light, medium and heavy were formed for BW and LW45 and the groups short, medium and long were formed for the weaning period (WP). To achieve this, the value found via the equation (maximum value – minimum value) / 3 was added to the smallest value and the lower limit of each group was determined. For BW, a weight of 1.5-3.1 kg was determined as light, 3.2-4.8 kg was determined as medium and 4.9 kg and over was considered heavy; for LW45, a weight of 7.8-16.8 kg was determined as light, 16.9-25.9 kg

Table 1. Descriptive statistics of the growth traits of Karacabey Merino lambs.

Growth Trait	N	Mean	SEM	St Dev	CV	Minimum	Median	Maximum
BW	17659	3.78	0.01	0.81	21.3	1.5	3.7	6.5
LW45	15870	18.12	0.03	4.01	22.2	7.8	17.7	34.6
WW	16885	30.70	0.04	4.86	15.8	15.3	30.6	50
WP	16885	91.83	0.11	14.87	16.2	50	91	150
DWG	16885	298.12	0.47	61.51	20.6	77	292	675

BW: birth weight. LW45: 45th day live weight. WW: weaning weight (90 days). WP: weaning period. DWG: daily weight gain from birth to weaning. SEM: Standard error of mean. St Dev: Standard deviation. CV: Coefficient of variation.

Table 2. Variation of survival and twinning rates in lambs and ewes according to birth year.

	Alive		Twin	
Birth Year	N	%	N	%
2011	298	97.3	258	47.3
2012	929	95.1	844	31.6
2013	3447	96.4	2590	28.4
2014	5643	95.7	3793	35.4
2015	5493	95.6	3583	32.9
2016	1849	93.9	1495	22.0
Chi-square	20.642		131.554	
p-value	0.001		0.000	

was determined as medium and 26.0 kg and over was determined as heavy; and for WP, a duration of 50-82 days was determined as short, 83-115 days was determined as medium and 116-150 days was determined as long. The Mixed Linear Model was performed to determine the effects of the factors on growth traits; Tukey test was used in the determination of the distinct groups. In the assessment of the survival rate in lambs and the twinning rate in ewes, Chi-square analysis was employed (Minitab 2019). The model used can be written in matrix notation as follows:

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Za} + \mathbf{e}$$

where: **y** is observation vector, **X** and **Z** design matrices for fixed and random effect, respectively, **b** and **a** solution vector for these effects, **e** is random residual effect vector.

Season, birth type and gender were used as fixed factors as well as random factors (herd and year) for BW. For LW45, birth weight group effect (light, medium, heavy) was used as an additional fixed to those used in BW. For WW and DWG, 45th day live weight group effect (light, medium, heavy) and weaning period group effect (short, medium, long) were used as additional fixed factors to those used in LW45.

In addition, two way interactions between random factors and two way interactions between fixed factors were also included in the models.

Results

Characteristics of the data structure were summarized in Table 1. The coefficients of variation (CV%) for all these traits under investigation had medium variability. The highest CV for LW45 (22.2%) showed that 45th day live weight had the maximum variability among all the traits studied. On the other hand, the lowest CV was observed for WW (15.8%). Identifying the CVs of these traits may enable improvements to be made in terms of proper selection procedures and management practices.

Birth year had a significant effect on the survival rate of lambs in the present study ($p<0.001$) (Table 2). The effect of birth year on the twinning rates in ewes was statistically significant ($p<0.001$) and the variations by year can be seen in Table 2.

The observed difference between the herds in relation to the lambs' survival rates was found to be significant ($p=0.002$). The lamb mortality rates in the herds varied between 1.4% and 7.2%.

The difference observed between the survival rate of twins and single lambs was significant ($p<0.05$). Sex had no significant effect on survival rate ($p>0.05$) (Table 3).

The effect of lambing season on survival rate was significant ($p<0.001$) (Table 4). Lambs born in spring had the lowest survival rate (93.6%), while lambs born in winter had the highest (96.0%). The twinning rates of

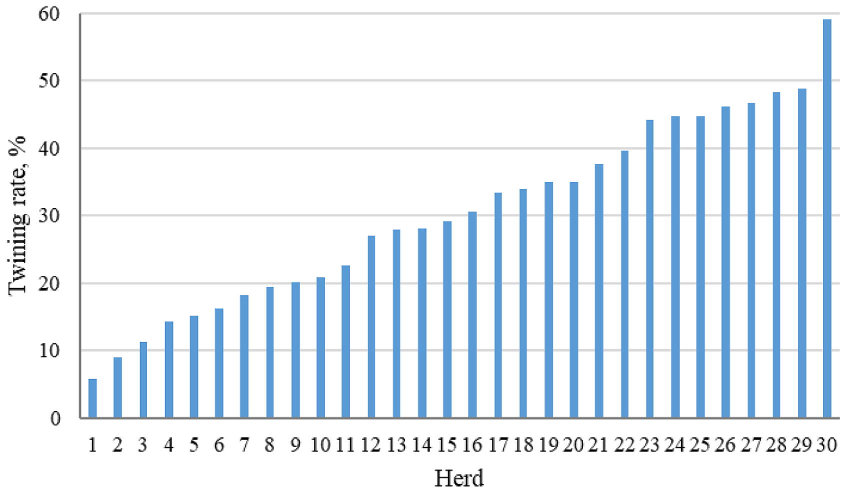

Fig. 1. Variation according to herd of twinning rate in ewes.

Table 3. Variation of survival rates in lambs according to birth type and sex.

Factors	Alive	
Birth Type	N	%
Twin	7657	95.3
Single	10002	95.9
Chi-square	4.128	
p - value	0.042	
Sex		
Female	9748	95.4
Male	7911	95.9
Chi-square	1.919	
p-value	0.166	

Table 4. Variation of survival and twinning rates in lambs and ewes according to lambing and mating season.

	Alive		Twin	
Season	N	%	N	%
Winter	8183	96.0	2323	37.5
Autumn	7262	95.7	6949	33.5
Summer	651	95.6	2565	22.7
Spring	1563	93.6	426	20.0
Chi-square	17.732		167.38	
p-value	0.000		0.000	

ewes varied significantly ($p<0.001$) according to the ram-mating season. While the highest twinning rates were observed in ewes that have had a winter ram-mating season, this is followed by those with ram-mating seasons in autumn, summer and spring (Table 4).

The difference observed between the herds in terms of twinning rate was very significant ($p<0.001$). In fact, whereas some farms had a twinning rate of 59%, it was 5% in the others (Fig. 1).

Table 5 displays the analysis of statistics results, means and standard error for BW, LW45, WW and DWG estimation of environmental factors including birth season, birth type, lamb's sex, BWG, LW45G and WPG. The herd and year were also included in the models used in these analyses, but means was omitted; instead, BW and WW were shown in Fig. 2. The effect of herd and year on growth traits were statistically significant ($p<0.01$). The ratios of herd, year and herd-year

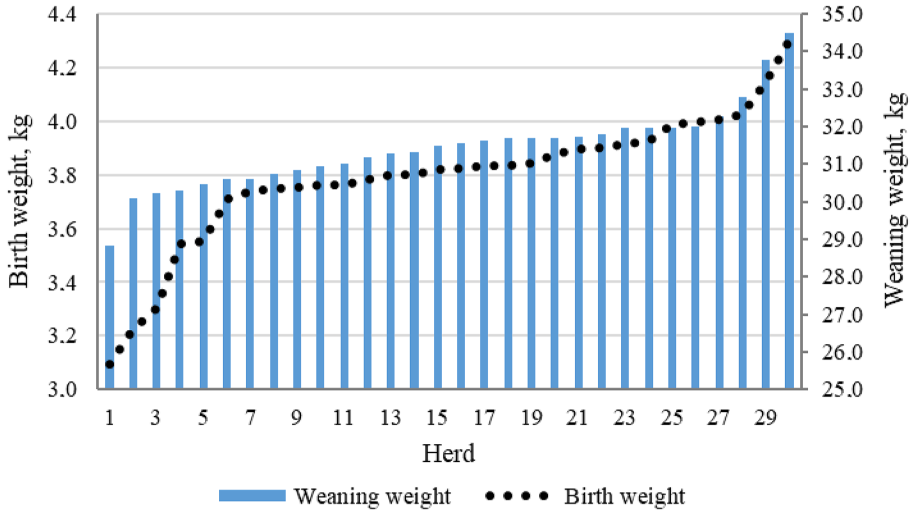

Fig. 2. Differences between sheep herds for birth and weaning weight.

Table 5. Environmental factors affecting growth traits in Karacabey Merino lambs.

	N	BW	N	LW45	N	WW	DWG
Birth Season		**		**		**	**
Spring	1563	3.74±0.1 a	6604	17.6±0.6 c	1282	31.9±0.3 b	286.3±4.7 b
Winter	8183	3.76±0.1 a	432	17.8±0.6 c	7289	32.2±0.2 b	298.7±3.9 a
Autumn	7262	3.68±0.1 b	7481	18.8±0.6 b	6476	32.7±0.2 a	296.2±3.8 a
Summer	651	3.73±0.1 ab	1353	19.6±0.7 a	418	30.4±0.4 c	274.8±5.8 b
Birth Type		**		**		**	**
Single	10002	3.98±0.1 a	8982	18.8±0.6 a	8763	32.2±0.2 a	292.3±3.9 a
Twin	7657	3.47±0.1 b	6888	18.1±0.3 b	6702	31.4±0.3 b	286.0±4.1 b
Sex		**		**		**	**
Male	7911	3.79±0.1 a	7077	18.8±0.6 a	6905	32.1±0.3 a	292.6±4.1 a
Female	9748	3.66±0.1 b	8793	18.1±0.6 b	8560	31.6±0.3 b	285.7±3.9 b
BW Group				**		ns	**
Light			3510	17.5±0.6 c	3424	31.6±0.3	295.4±4.2 a
Medium			10605	18.2±0.6 b	10320	31.9±0.2	290.5±3.8 a
Heavy			1755	19.6±0.6 a	1721	32.0±0.3	281.6±4.7 b
LW45 Group						**	**
Light					6164	27.3±0.2 c	252.1±3.8 c
Medium					8775	32.2±0.2 b	295.2±3.6 b
Heavy					526	36.0±0.5 a	320.1±4.4 a
WP Group						**	**
Short					3169	29.8±0.4 c	328.6±5.4 a
Medium					11396	31.7±0.2 b	292.7±3.7 b
Long					900	33.9±0.3 a	246.1±4.4 c
General	17659	3.73±0.05	15870	18.43±0.58	15465	31.83±0.24	289.1±3.91

** p<0.01, ns – non-significant

interaction in total variance were found to be approximately 22%, 36%, 17% and 17% for BW, LW45, WW and DWG, respectively.

The effects of birth season, birth type and sex on BW in Karacabey Merino lambs and were significant (p<0.01) (Table 5).

Discussion

The survival rate of lambs was observed to decrease with later birth year. The highest survival rate (97.3%) was observed in 2011 and the lowest survival rate (93.9%) was observed in 2016. Around the world, Merino lamb mortality rates vary between 9 and 20% (Mousa-Balabel 2010). However, in Australia, the average survival rate of lambs from birth to weaning is less than 90% for single lambs and 80% for twins (Brien et al. 2009). Hatcher et al. (2010) reported a survival rate of 72.4% for Merino lambs, whereas Cloete and Cloete (2015) reported a survival rate of 78%. The survival rate values found in this study are rather high when compared to those reported in the literature. Under the effects of varying environmental and management conditions, as well as climatic conditions (precipitation, moisture and temperature), the year of birth affects survival rate by causing fluctuations in body weight. Climate and environmental changes have an effect on the feed amount and quality of pasture, influencing the feed supply for animals, as well as other requirements. These changes, which occur according to the year, affect the mothers' nutrition and, consequently, the amount of milk produced and, as a result, impacting the survival rate of the lambs due to their different weaning weights. Due to differences in management and environmental conditions, a herd may have a substantial effect on the survival rates of lambs (Baneh and Hafezian 2009). In this study where the mortality rate disparitites were high, the factor of herd, particularly as a result of care and feeding conditions, had an effect on the weight and growth traits of the lambs, indicating its great importance in terms of survival rate. Similar findings were reported by some researchers (Bela and Haile 2009, Lupi et al. 2015).

Twins theoretically consume less breast milk compared to single lambs. For this reason, the fact that single lambs have a higher weaning weight and thus a higher survival rate is expected. The high mortality rate in twin lambs was associated with their low birth weights (Baş et al. 1986). For lambs with low birth weights have difficulty sucking their mothers; for this reason, in cases of a twin birth, extra attention should be paid to feeding weak lambs, particularly during the initial weeks. Besides this, the colostrum quality in ewes and insufficient passive immunity transmission to lambs or diseases causing lamb deaths can also be evaluated among important environmental factors affecting survival rate.

In this study, the effect of sex on survival rate was not significant. Similarly, while Ünal et al. (2006) and Güngör and Akçapınar (2013), too, found that the effect of sex on the survival rate of the lambs was insignificant, Ürüşan and Emsen (2010) discovered a significant effect of sex on the survival rate of lambs.

Since the ram-mating procedure on a herd-basis was not carried out within a specific period but over a rather long period of time, it was observed that the born lambs were largely affected by the season factor. This variance in lambing season naturally resulted in the mothers and lambs benefiting from the pasture at different levels. However, it was observed that lambs born in the winter had higher survival rates compared to those born in the other seasons. The reason for this could be that the ewes did not graze on the pasture but stayed in the closed holding pen environment for a long period of 2-3 months together with their offspring during the winter season, resulting in a strengthened immune system in lambs and with the arrival of spring, the mothers and offspring benefited more from the pasture. The high mortality rate in lambs born in the spring can be explained by the mothers going out to pasture, but the lambs remaining on the farm. However, Susic et al. (2005) reported that the survival rates of the lambs born in the summer were higher than of those born in the winter. The different effects of lambing season on lambs may have resulted from varying physical environmental conditions, feeding, conditions of pasture during different seasons and differences in ram selection. In addition, maybe it would be the potential role of coccidia and gastrointestinal nematodes to which ewes and as a result also lambs are exposed when mothers give birth during the grazing season. In order to increase their survival rate, lambs should be given more attention.

The twinning rate, fell from 47.3% to 22% from 2011 to 2016. The differences observed between the years in terms of twinning rate might have resulted from changes in management conditions. The reason why twinning rates increased again in 2014 and 2015 might be the breeders' efforts to maximize their benefits from the support given by the project for lambs. In fact, breeders are encouraged to expand their herds in the project implementation guideline. As is known, due to the low heritability of twinning, it is a highly environment-dependent trait. This could be explained by the fact that the farms with higher twinning rates had access to better concentrate feed, especially during the ram-mating season. Moreover, since a support payment is made twice to lambs born as a result of the "hand-mating" practice, the in-hand mating practice has become more common in herds.

The finding in this study that fertility increased in response to the decrease in daylight during the autumn and winter months, which were the ram-mating seasons with the highest twinning rates, is in line with the literature (Abdoli et al. 2016). Besides this, it is considered that the positive effect of ram-mating in the winter season twinning might have occurred as a result of continuously keeping the ewes and rams together in the shelter due to the inability to go out to the grazing land. Twenty to twenty-two percent of the ram-mating was done in the seasons of summer and spring.

Birth weights varied between 3.1 and 4.3 kg between herds, with a considerable fluctuation in the distribution. What is noteworthy here is that the ordering of birth weights by herds continued in the WW period, too. Hence, it can be stated that the variation in birth weight observed between the herds decreased in the advancing periods (LW45 and WW). Rather than a high BW in lambs, a high live weight increase in the WW period is more important for productive breeding. On the other hand, it is evident that there were serious differences of up to 5.7 kg between the herds in terms of WW. It can be assumed that this difference resulted entirely from such farm conditions as care-feeding-sheltering practices and its workforce capacity.

Birth season, birth type, and, sex had a significant effect on the BW of lambs in the present study. Similarly, Sezenler et al. (2013) and Rather et al. (2020) reported that the effects of birth year, birth type and sex on BW were significant. The birth weight, which was at an average of 3.78 kg at the beginning of the project, reached the highest value in 2012 at 3.97 kg. Along with physiological traits such as the mother's age, it is believed that some environmental factors such as the quality and efficiency of the grazing land and the farm's care-feeding conditions influenced the results.

In terms of live weight gain in lambs, the first 45 days of life are a critical period. Moreover, since it is the sucking period, it is critical in the determination of the course of an animal's growth and development. In the study, the effects of birth season, birth type, sex and BWG on LW45 in Karacabey Merino lambs were found to be significant. Sezenler et al. (2013) reported that all these traits had a significant effect on LW45 in Karacabey Merino lambs also. In the study, the WW fluctuated between 30.3 and 32.7 kg in Merino lambs. This finding is higher than the value (29.1 kg) reported by Cloete and Cloete (2015) for Australian Merino lambs. Moreover, in this study, the effects of birth year, birth season, birth type, sex, WPG and LW45G on WW were found to be significant, but the effect of BWG was found to be insignificant. Similarly, it was reported in some previous studies that the weaning weight in lambs was greatly affected by sex (Balasubramanyam et al. 2010, Sezenler et al. 2013, Mane et al. 2014).

The daily rise in the live weight of lambs until weaning varies according to both the mother's milk yield and the farm's care-feeding conditions. In this study, DWG varied between 262.2 and 293.4 g between years in lambs. Ullah et al. (2020) found that while the effect of birth season on DWG was significant ($p<0.001$), but, the effect of sex was insignificant ($p>0.05$) in Kajli ewes. However, similarly to this study, Parihar et al. (2016) determined that the effect of sex on DWG was significant ($p\leq0.01$).

BW increased or decreased by 0.02-0.18 kg throughout the years, LW45 by 0.4-2.4 kg, WW by 0.7-2.4 kg and DWG by 4.3-17.1 g, and these differences were found to be significant ($p<0.01$). Hence, when the overall situation is evaluated according to years, since the increases did not exhibit a consistent and permanent condition in terms of all the traits, it is evident that there was no improvement. The differences observed in birth weights over the six-year period might be a reflection of the changes in the feedstocks as a result of the positive and negative effects of variances in the annual total precipitations and the precipitation distributions on the efficiency and quality of the grazing land. Moreover, the significant effect of birth year on BW, LW45 and WW indicates that management played an important role in the improvement of these traits. Similarly, Dangi and Poonia (2006) reported that the effect of birth year on WW was significant. However, there is previous research reporting that the birth year did not have a significant effect on BW (Mishra et al. 2008, Gowane et al. 2011).

Birth season is the another factor which should be taken into consideration in the development and, hence, the reproduction management of animals. Throughout the year, depending on the season, feed production varies significantly and both the quantity and quality of feed on a farm fluctuate. This situation has an effect on lambs' physical traits (Baneh and Hafezian 2009, Momoh et al. 2013). The effect of birth season on all the examined traits was found to be significant ($p<0.01$). Similarly, it was stated that birth season had a significant effect on the weaning weight in different ewe breeds as well (Albial et al. 2014, Devendran et al. 2014, Nirban et al. 2015). However, Mourad et al. (2000) reported that birth season did not have a significant effect on live weight.

There are some studies reporting that weaning weight is greatly affected by sex (Balasubramanyam et al. 2010, Mane et al. 2014). However, some researchers were reported that sex did not affect WW (Momoh et al. 2013, Mane et al. 2014, Vivekanand et al. 2014, Ullah et al. 2020). It was observed that the lambs with a high BW had higher LW45, while WW were similar. On the other hand, it was found that the lambs with a low BW had a higher DWG ($p<0.01$).

It was found that a higher LW45 in lamb was associated with both a higher WW and a higher DWG ($p<0.01$). Since the weaning practice is performed on a herd basis in traditional sheep breeding, weaned lambs have varying ages. For this reason, the WWs were grouped according to their weaning period. When the weights of the lambs were grouped according to the weaning period, the WWs of lambs who consumed milk for a longer period of time were found to be higher, but their DWGs were lower ($p<0.01$).

Conclusion

In conclusion, environment and management factors had a significant effect on the growth of Karacabey Merino lambs. For this reason, in order to alleviate their negative effects on the growth of lambs, these factors must be taken into consideration. When lambs with a low birth weight were provided with the necessary care feeding, it was observed that this was made up for in the advancing periods. The survival rate of lambs born in winter is higher. For this reason, it may be suggested that births should be moved to the winter in order for lambs to remain with their mothers for a longer period of time and even to go out to pasture together after birth. However, it is believed that paying more care to lambs during the spring months, when survival rates are the lowest, will reduce losses. Autumn and winter months should be selected as the optimum ram-mating period on all farms to increase twinning, an important variable in enhancing fertility. Breeders that do not employ any protocols such as flushing during ram-mating season can be advised to apply feedings by considering the increasing food requirement of ewes during the last period of pregnancy, as this contributes to lambs' birth weights and survival rates. It is believed that combined with the use of the assessments made on environmental factors in this study, the selection program that is likely to be developed will have beneficial effects. In future research, new selection programs can be developed incorporating additional efficiency and performance parameters.

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References

Abdoli R, Zamani P, Mirhoseini SZ, Ghavi Hossein-Zahed N, Nadri S **(2016)** A review on prolificacy in sheep. Reprod Domest Anim 51: 631-637.

Akpa GN, Ambali AL, Suleiman IO **(2013)** Body conformation, testicular and semen characteristics as influenced by age, hair type and body condition of Red Sokoto goat. NY Sci J 6: 44-58.

Albial AM, Singh J, Singh DP, Niwas R **(2014)** Environmental influences on growth traits of Nali sheep. Indian J Anim Res 48: 75-77.

Balasubramanyam D, Jaishankar S, Sivaselvam SN **(2010)** Performance of Madras Red sheep under farmer's flock. Indian J Small Rumin 16: 217-220.

Baneh H, Hafezian SH **(2009)** Effects of environmental factors on growth traits in Ghezel sheep. Afr J Biotechnol 8: 2903-2907.

Baş S, Özsoy MK, Vanlı Y **(1986)** The effects of feeding at different durations pre ram-mating on fertility in sheep, growth and survival rate. Turk Vet Anim Sci 10: 221-234.

Bela B, Haile A **(2009)** Factors affecting growth performance of sheep under village management conditions in the south western part of Ethiopia. Livest Res Rural Dev 21: 189.

Brien FD, Hebart ML, Jaensch KS, Smith DH, Grimson RJ **(2009)** Genetics of lamb survival: A study of Merino resource flocks in South Australia. Proc Assoc Advmt Anim Breed Genet 18: 492-495.

Cloete SW, Cloete JJ **(2015)** Production performance of Merino and Dohne Merino ewes and lambs in pure or crossbreeding systems. Proc Assoc Advmt Anim Breed Genet 21: 217-220.

Dangi PS, Poonia JS **(2006)** Factors affecting weaning and six month body weight in crossbred sheep. Indian J Anim Res 40: 161-163.

Devendran P, Cauveri D, Murali N, Kumarasamy P **(2014)** Growth profile of Madras Red sheep in farmer's flock. Indian J Small Rumin 20: 20-23.

Dixit SP, Singh G, Dhillon JS **(2011)** Genetic and environmental factors affecting fleece traits in Bharat Merino sheep. Indian J Anim Sci 81: 80-83.

Gowane GR, Chopra A, Prince LL, Mishra AK, Arora AL **(2011)** Genetic analysis for growth traits of prolific Garole × Malpura (GM) sheep. Trop Anim Health Prod 43: 299-303.

Güngör İ, Akçapınar H **(2013)** The production traits of Bafra sheep reared in Ankara conditions. Lalahan Hay Araşt Enst Derg 53: 59-73.

Hatcher S, Atkins KD, Safari E **(2010)** Lamb survival in Australian Merino Sheep: A genetic analysis. J Anim Sci 88: 3198-3205.

Iman NY, Slyter AL **(1996)** Lifetime lamb and wool production of targhee or Finn-Dorset-Targhee ewes managed as farm place or range flock: II. Cumulative lamb and wool production. J Anim Sci 74: 1765-1769.

Kaymakçı M **(2016)** Advanced sheep breeding, 1-9; Meta Press, Izmir, Türkiye, ISBN 978-605-85998.

Lalit, Malik ZS, Dalal DS, Dahiya S, Magotra A, Patil CS **(2016)** Genetics of growth traits in sheep: A review. IJRRLS 3: 12-18.

Lupi TM, Nogales S, León JM, Barba C, Delgado JV **(2015)** Analysis of the non-genetic factors affecting the growth of Segureño sheep. Ital J Anim Sci 14: 124-131.

Mane PM, Pachpute ST, Nimase RG **(2014)** Growth and reproductive performance of Deccani sheep in an organized farm. Indian J Small Rumin 20: 23-27.

Minitab 2019. Minitab® 19 Statistical Software. https://www.minitab.com/en-us/

Mishra AK, Arora AL, Prince LL, Kumar S **(2008)** Performance evaluation of Garole×Malpura half-bred sheep evolved in semiarid region of Rajasthan. Indian J Anim Sci 78: 746-750.

Momoh OM, Rotimi EA, Dim NI **(2013)** Breed effect and non-genetic factors affecting growth performance of sheep in semi-arid region of Nigeria. J Appl Biosci 67: 5302-5307.

Morris CA, Hickey SM, Clarke JN **(2000)** Genetic and environmental factors affecting lamb survival at birth and through to weaning. New Zealand J Agric Res 43: 515-524.

Mourad M, Gbanamou G, Balde IB **(2000)** Performance of West African dwarf goats under the extensive system of production in Faranah, Guinea. In: Proceedings of the 7th International conference on goats, 15-21 May, France, pp. 227-230.

Mousa-Balabel TM **(2010)** The relationship between sheep management and lamb mortality. WASET 4: 372-377.

Nirban LK, Joshi RK, Narula HK, Singh H, Bhakar S **(2015)** Genetic and non-genetic factors affecting body weights in Marwari sheep. Indian J Small Rumin 21: 106-108.

Parihar K, Yadav SB, Narula HK, Pannu U, Bais B **(2016)** Factors affecting in growth performance and greasy fleece yield in Magra sheep under arid condition of Rajasthan. Int J Agric Sci 9: 4095-4096.

Petrovic MP, Muslic DR, Petrovic VC, Maksimovic N **(2011)** Influence of environmental factors on birth weight variability of indigenous Serbian breeds of sheep. Afr J Biotechnol 10: 4673-4676.

Prakash V, Prince LL, Gowane GR, Arora AL **(2012)** Factors affecting post-weaning average daily gain and kleiber ratios in Malpura sheep. Indian J Anim Sci 82: 1598-1600.

Rather MA, Bashir I, Ahanger SA **(2020)** Effect of genetic and non-genetic factors on birth weight of Corriedale sheep in an organized farm in Kashmir. Anim Sci Quarterly 1: 13-16.

Sezenler T, Köycü E, Özder M **(2008)** The effect of body condition score in Karacabey Merino at lambing on the lamb growth. J Tekirdag Agric Fac 5: 45-53.

Sezenler T, Soysal D, Yıldırır M, Yüksel MA, Ceyhan A, Yaman Y, Erdoğan İ, Karadağ O, **(2013)** Influence of some environmental factors on litter size and lamb growth performance in Karacabey Merino sheep. J Tekirdag Agric Fac 10: 40-47.

Susic V, Pavic V, Mioc B, Stokovic I, Kabalin A E **(2005)** Seasonal variations in lamb birth weight and mortality. Vet Arhiv 5: 375-381.

Tesema Z, Deribe B, Lakew M, Getachew T, Tilahun M, Belayneh N, Kefale A, Shibesh M, Zegeye A, Yizengaw L, Alebachew GW, Tiruneh S, Kiros S, Asfaw M, Bishaw M **(2022)** Genetic and non-genetic parameter estimates for growth traits and Kleiber ratios in Dorper × indigenous sheep. Animal 16(6): 100533.

Thiruvenkadan AK, Karunanithi K, Muralidharan J, Babu RN **(2011)** Genetic analysis of pre-weaning and post-weaning growth traits of Mecheri sheep under dry land farming conditions. Asian-Aust J Anim Sci 24: 1041-1047.

Ullah F, Javed K, Salim M, Rehman IU, Khan M, Ali S, Rehman ZU, Bhunesh Babar A, Hussain MA, Khan S, Rahim N, Hosseini SM **(2020)** Identification of non-genetic factors affecting birth weight, weaning weight, pre-weaning weight, yearling weight and greasy fleece performance of Kajli Sheep at two ecologies in Pakistan. Ann Agric Crop Sci 5: 1065.

Ünal N, Akçapınar H, Atasoy F, Aytaç M **(2006)** Some reproductive and growth traits of crossbred genotypes produced by crossing local sheep breeds of Kivircik × White Karaman and Chios × White Karaman in steppe conditions. Arch Tierz 49: 55-63.

Ürüşan H, Emsen H **(2010)** Effect of lambing season, lamb genotype, maternal and birth related factors on growth and viability of lambs. J Tekirdag Agric Fac 7: 163-172.

Vivekanand Joshi RK, Narula HK, Singh H, Chopra A **(2014)** Effect of genetic and non-genetic factor on growth of Magra sheep in arid region of rajasthan. Indian J Small Rumin 20: 19-22.