



Genetic and non-genetic factors affecting growth and reproduction traits in Kashmir Merino sheep

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Kashmir Merino is a crossbred strain developed through crossing Gaddi, Bhakarwal and Poonchi with 50 to 75% exotic inheritance of Rambouillet and Merino sheep to improve the genetic potential of native breeds for good quality apparel wool. The growth traits are good indicators of adaptability of an animal to the existing environmental conditions and are essential for its production, reproduction and survivability (Lalit *et al.* 2016 a). Reproductive traits are the most important traits in all sheep production systems (Matika *et al.* 2003). These are quantitative traits governed by polygenic inheritance and strongly affected by environment in which animal is raised. Therefore present study was undertaken to investigate random and fixed effects on growth and reproduction traits of Kashmir Merino sheep.

The data of 6,300 birth records of Kashmir Merino sheep maintained at Government Sheep Breeding Farm Kralapathri and Goabal were collected over a period of 21 years (1997 to 2017). The descriptive statistics of the data set was computed statistically (Snedecor and Cochran, 1994). The data was analysed using Mixed Model Least Squares and Maximum Likelihood Computer Programme PC-2 (Harvey, 1990). The following general mathematical model was used to determine the random effect of sire and fixed effects period, gender, type of birth, parity and farm on the performance traits under consideration:

$$Y_{ijklmno} = \mu + R_i + G_j + F_k + Y_l + P_m + T_n + e_{ijklmno}$$

$Y_{ijklmno}$, observation of oth lamb, born in nth birth type to dam in mth Parity, in lth period, present in kth Farm/ place of birth, having jth gender and born to ith sire; μ is the overall mean; R_i , random effect of ith sire; G_j , the fixed effect of jth gender of lamb; F_k , fixed effect of kth Farm; Y_l , fixed effect of lth period of birth; P_m , fixed effect of mth parity of dam; T_n , fixed effect of nth type of birth and $e_{ijklmno}$, random error, $N(0, \sigma^2_e)$.

The statistical significance between pairs of levels was tested by Duncan's multiple range test (DMRT) as modified by Kramer 1957.

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The descriptive statistics are presented in Table 1. The coefficient of variations (CV%) of all the traits under study were low to moderate indicating that the traits had low to medium variability. Among all traits ILP had the highest coefficient of variation (33.73%). Das *et al.* (2014) also reported moderate value of CV for BWT (18.75%) in Kashmir Merino Sheep. Mallick *et al.* (2017) in Bharat Merino also reported a moderate value of CV for BWT (17.49%), 6-MBW (15.32%) and 12-MWT (15.61%).

The least squares means and test of significance of the factors affecting body weight and reproduction traits of sheep is presented in Table 2. The values of LSM's for birth weight (BWT), six months body weight (6-MWT) and yearling body weight (12-MWT) observed in the present study are more or less similar to those reported by Lalit *et al.* (2016b), (2017) and Kumar *et al.* (2018) in Hernali sheep. However, Umeel *et al.* (2018) in Munjal sheep reported comparatively higher values for BWT, 6-MWT and 12-MWT. The values of LSM's for AFL and ILP were comparatively higher than reported by Umeel *et al.* (2018) in Munjal sheep. Higher value for AFL in the present study may be attributed to the fact that ewes were put to mating at two and half years of age.

Effect of sire was highly significant ($P < 0.01$) on BWT, 6-MWT and 12-MWT and AFL whereas significant ($P < 0.05$) on ILP. Similar significant effect of sire on growth traits were also reported by Nirban (2013) in Marwari lambs and Yadav (2016) in Chokla. A similar significant variation in AFL and ILP due to sire was also reported by Chander (2012) in Magra sheep. Higher variation in growth and reproduction traits caused by sires indicates that the lambs

Table 1. Descriptive statistics of different traits under study

Trait	N	Mean±S.E	Std. Deviation	CV %
BWT	6300	3.35±0.01	0.65	19.31
6-MWT	4920	19.54±0.05	3.62	18.52
12-MWT	4920	23.44±0.06	3.95	16.83
AFL(days)	1344	1138.32±5.93	211.67	18.59
ILP (days)	874	409.39±4.17	123.19	30.09

Table 2. Least squares means along with standard errors for growth and reproduction traits

Particular	N	BWT (kg)	N	6-MWT (kg)	N	12-MWT (kg)	N	Age at first lambing (days)	N	ILP (days)
<i>Overall Mean</i>	6300	3.34±0.05	4920	19.33±0.45	4050	22.44±0.46	1274	1090.22±19.45	874	401.45±22.30
<i>Sex</i>										
Male	3098	3.47±0.05 ^a	2335	19.85±0.45 ^a	1964	23.19±0.47 ^a				
Female	3202	3.27±0.05 ^b	2595	18.82±0.45 ^b	2086	21.68±0.47 ^b				
<i>Period</i>										
1997–1999	600	4.11±0.10 ^a	534	18.71±0.72 ^{bc}	525	22.87±0.73 ^c	80	1093.90±36.75 ^{ab}	31	373.62±40.58
2000–2002	622	3.66±0.07 ^{ab}	529	18.77±0.56 ^b	466	23.61±0.59 ^b	215	1091.86±29.10 ^a	182	431.43±27.88
2003–2005	777	3.21±0.04 ^{bc}	602	17.21±0.53 ^c	550	20.12±0.56 ^d	217	1233.35±27.32 ^a	193	410.03±26.87
2006–2008	776	2.98±0.06 ^c	629	18.96±0.50 ^b	452	20.44±0.53 ^d	256	1148.03±25.01 ^a	198	418.57±26.06
2009–2011	1009	3.12±0.06 ^{2bc}	750	18.48±0.50 ^{bc}	717	20.44±0.56 ^d	237	1136.01±27.03 ^a	177	379.35±28.68
2012–2014	1197	2.96±0.06 ^c	853	21.57±0.54 ^a	740	24.67±0.57 ^a	184	1073.43±29.42 ^a	93	395.69±31.23
2015–2017	1319	3.36±0.07 ^{bc}	1023	21.64±0.58 ^a	60	24.91±0.64 ^a	85	854.97±43.64 ^b	Nil	
<i>Farm</i>										
Kralapathri	5678	3.39±0.11 ^a	4439	20.51±0.88 ^a	3711	22.40±0.45 ^a	1217	1095.77±23.22 ^a	855	404.81±72.06 ^a
Goabal	622	3.30±0.11 ^a	481	18.16±0.88 ^a	339	22.48±0.51 ^a	57	1084.66±31.07 ^a	19	398.09±77.32 ^a
<i>Type of birth</i>										
Single	5941	3.38±0.04 ^a	4662	19.44±0.49 ^a	3849	22.45±0.40 ^a	1169	1107.86±18.94 ^a	805	400.84±22.02 ^a
Multiple birth	359	3.31±0.03 ^a	258	19.23±0.44 ^a	201	22.42±0.87 ^a	105	1072.57±23.70 ^a	69	402.05±25.42 ^a
<i>Parity</i>										
Primiparous	1695	3.31±0.05 ^a	1293	19.08±0.46 ^a	1044	22.24±0.47 ^a	345	1087.14±21.07 ^a	210	402.68±23.52 ^a
Pleuriparous	4605	3.37±0.05 ^b	3627	19.59±0.44 ^b	3006	22.63±0.46 ^b	929	1093.30±19.58 ^a	664	400.22±22.37 ^a

Values with same superscripts in a column under a subgroup do not differ significantly (P>0.05); NS, Non-significant difference.

born to superior sires have performed better than lambs born to inferior ones.

The effect of period was highly significant (P<0.01) on BWT, 6-MWT and 12-MWT and AFL whereas non-significant on ILP. The significant variations in the body weight traits due to period may be attributed to environmental variations (such as the differences in ambient temperature, humidity, and rainfall) affecting the availability of quality and quantity of forages in pastures. Management differences such as selection of breeding stock, variation in number of multiple births and number of primiparous and pleuriparous dams may also be some contributing factors. Zaffer *et al.* (2015) in Dorper crossbred sheep also reported significant effect of period of lambing on BWT and 6-MWT. Lalit *et al.* (2017) in Hernali, Reddy *et al.* (2017) in Nellore Brown and Umeel *et al.* (2018) in Munjal sheep found that period of birth had a highly significant effect on AFL. The improvement in AFL observed in last period may be attributed to the change in policy of mating of ewes at reduced age of 1.5 years instead of 2.5 years. The non-significant effect of the period on ILP was in consonance with report of Umeel *et al.* (2018) in Munjal sheep.

The sex of lamb had a highly significant (P<0.001) effect on all growth traits, which was consistent from birth to yearling weight. Similar significant variation due to effect of gender in body weights at birth, six and twelve months of age were also observed by Mallick *et al.* (2017) in Bharat Merino, Lalit *et al.* (2017) and Kumar *et al.* (2018) in Hernali sheep and Umeel *et al.* (2018) in Munjal sheep. Male lambs were significantly heavier than female lambs at all ages. The variation in body weights due to gender of lamb may be due to differences in sex chromosomes, difference in position of genes related to growth and difference in secretion of hormones leading to difference in somatic cell growth, growth of long bones and muscles.

The effect of farm on all the traits under study was non-significant. The non-significant effect of farm on birth might be due to reason that both farms are situated in temperate zone, exchange breeding stock and follow same guideline of management in terms breeding and feeding. Similar non-significant effect of farm on the BWT, AFL and ILP was also observed by Gupta (2000) in Rambouillet, Merino, Gaddi and their Crosses. However, Gupta (2000) reported significant effect of farm on 6-MWT and 12-MWT.

Type of birth (single or multiple) had no influence the traits under study however; single born lambs were heavier than multiple born lambs at all ages. The growth advantage of single born lambs over multiple born lambs may be due competition

between twins and triplets for uterine space during pre-natal stage and for milk during neo-natal stage. Similar effect of type of birth on BWT was reported by Assan and Makuza (2005) in Dorper and Mutton Merino and on 6-MWT and 12-MWT by Mallick *et al.* (2017) respectively in Bharat Merino Sheep. However, Mallick *et al.* (2017) in Bharat Merino Sheep observed a significant effect of type of birth on BWT and 12-MWT.

The effect of parity was highly significant ($P < 0.01$) on all growth traits and non-significant on reproduction traits in the present study. The significant effect of parity on the birth weight in the present study might be attributed to reason that dams in first parity have less body weight and small uterine space than dams in advanced parities. The body weight and uterine space of dams increase with advancement of parity. The low body weight and small uterine space of dams in the first parity have negative feedback on prenatal lamb growth. Similar significant effect of parity on BWT was observed by Khan *et al.* (2011 a; b) in Polled Dorset, Ramboillet and Cross bred sheep and Nirban (2013) in Marwari lambs reported significant effect of parity on BWT and 12-MWT. The effect of parity on AFL and ILP was observed to be non-significant. On contrary Deribe *et al.* (2014) reported significant effect of parity on AFL in ewes. Dixit *et al.* (2002) in Bharat Merino and Reddy *et al.* (2017) in Nellore Brown reported significant effect of parity on ILP.

SUMMARY

Data on birth records spread over 21 years of Kashmir Merino sheep maintained at Government Sheep Breeding Farm, Kralapathri and Government Sheep Breeding Farm Goabal Kashmir was analyzed with the Mixed Model Least Square and Maximum Likelihood algorithms, to assess the random and fixed effects on birth weight (BWT), 6 months weight (6-MWT), yearling body weight (12-MWT), age at first lambing (AFL) and inter-lambing period (ILP). Coefficient of variation among all traits under study was observed low to medium indicating that the traits had low to medium variability. The random effect of sire was observed to be highly significant ($P \leq 0.01$) on all the traits under study. Significant effect of sire indicated that sire selection for these traits can bring further genetic improvement in these flocks for these traits. Period had significant effect on all the traits under study and all traits presented fluctuating trends. Significant variation in period indicates role of management in bringing improvement in these flocks. Highest value for birth weight was observed in first period (1997–1999), whereas, highest values for 6-MWT and 12-MWT were observed in 7th period. Lowest values for AFL and ILP were observed in 7th and 1st periods respectively. Sex and parity had a significant effect on growth traits. Male lambs and lambs born to pleuriparous dams were significantly heavier at all ages. Farm and birth type had a non-significant effect on all the traits however single born lambs were heavier than multiple born lambs.

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