RESEARCH ARTICLE Agricultural Science Digest, Volume 44 Issue 5: 978-981 (October 2024)

Genetic Analysis of Fitness Traits of Kashmir Merino Sheep at Organized Farms of Kashmir

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ABSTRACT

Background: Fitness traits include measures of reproductive efficiency of sheep. The improvement in reproductive efficiency has significant impact on overall economy of sheep.

Methods: Data spanning over 21 years (1997-2017) were collected from two sheep breeding farm and analyzed with mixed model least-squares maximum likelihood (LSMLMW) computer (PC-2) programme designed by Harvey (1990) to estimate number of lambs born per ewe (NLBE), number of lambs weaned per ewe (NLWE), litter size (LS) and sex ratio (SR) of Kashmir Merino sheep.

Result: Overall estimates of 3.56±0.11, 3.20±0.10, 48.32±0.04 and 1.06±0.01 for number of lambs born per ewe (NLBE), number of lambs weaned per ewe (NLWE), litter size (LS) and sex ratio (SR), respectively were observed in the present study. The period of birth had significant ($p<0.05$) effect on NLBE and NLEE. The effect of sire was highly significant on all the traits under study whereas effect of all the non-genetic factors considered had non-significant effect on LS and SR.

Key words: Lambs born per ewe, Litter size, Number of lambs weaned per ewe, Sex ratio (SR).

INTRODUCTION

Sheep are reared in Jammu and Kashmir from the time immemorial by mankind owing to its multifaceted utility. The region (J&K) possesses rich repository of ovine genetic resources. However, the production potential of native sheep breeds of J&K was poor. Therefore, crossbreeding was adopted to improve the performance of native nondescript sheep population by using Kashmir Merino (a synthetic breed) to improve the production potential of native sheep breeds of Kashmir. Many sheep breeding farm were established in J&K by state Government for production of improved and superior quality Kashmir Merino breeding rams. These high-quality breeding rams, produced at government sheep breeding farms were distributed among progressive farmers for up gradations of nondescript sheep population. The breeding policy so adopted resulted in increased production of quality wool per animal, increased growth rate and profitability of sheep farmers. The contribution off springs to the next generation by an individual is called its fitness. Fitness or life-history traits include measures of reproductive efficiency and survivability of an individual. Improvement in reproductive efficiency has significant impact on sheep husbandry. However, the reproduction traits are not considered while selecting an animal (Gowane *et al*., 2014). The possible reason for not including reproduction traits in selection programs include large environmental influences, low heritability, late expression, non-availability of reliable data and these traits are usually threshold in expression. The components of fitness traits of sheep breed decide its performance and adaptability to particular environmental conditions. Although the genetic studies on the breed in past have been carried by researchers (Das *et al*., 2014; Rather *et al*., 2019 a; b; c; Rather *et al*., 2020 a; b; c; Rather *et al*., 2021a; b) but information regarding fitness traits of Kashmir Merino sheep is scanty. Hence the present study was undertaken with objectives to estimate number of lambs born per ewe (NLBE), number of lambs weaned per ewe (NLWE), litter size (LS) and sex ratio (SR) of Kashmir Merino sheep.

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How to cite this article: Rather, M.A., Hamadani, A., Malik, T.A., Bashir, I. and Ahmad, I. (2024). Genetic Analysis of Fitness Traits of Kashmir Merino Sheep at Organized Farms of Kashmir. Agricultural Science Digest. 44(5): 978-981. doi: 10.18805/ag.D-5401.

Submitted: 02-06-2021 **Accepted:** 14-09-2021 **Online:** 11-10-2021

MATERIALS AND METHODS

Data recording

The data spanning over 21 years pertaining to Kashmir Merino sheep maintained at Government Sheep Breeding Farm Kralpathri and Goabal were collected from flock books. For estimation of number lambs born per ewe (NLBE) and number of lambs weaned per ewe (NLWE) data spraining over 13 years (1997 to 2009) were classified in 4 periods as reflected in Table 1, whereas for estimation of litter size and sex ratio the data were classified into 7 periods each period consisting of 3 years. However, for estimation of the latter 2 traits the data were also classified as pleuriparous and

primiparous (based on parity), single and multiple born (based on birth type) and Kralpathri and Goabal (based on place of birth of lamb). Sex ratio (male to female) was calculated as the ratio of number of males versus females born. The analysis was carried out by using mixed model least-squares maximum likelihood (LSMLMW) computer (PC-2) programme designed by Harvey (1990). The mathematical model used for estimation of number of lambs born per ewe and number of lambs weaned per ewe was

$$Y_{ijkl} = \mu + R_i + P_j + e_{ijk}$$

Where:

Y_{ijk} = Observation of kth lamb, born in j^{th} period to i^{th} sire.
μ = Overall mean.
R_i = Random effect of ith sire.
P_J = Fixed effect of jth period of birth.
e_{ijkl} = Random error, N (0, σ^2_e).

For estimation of litter size and sex ratio following mathematical model used for

$$Y_{ijklmn} = \mu + R_i + F_j + Y_k + P_l + T_m + e_{ijklmn}$$

Where:

Y_{ijklmn} = Observation of nth lamb, born in m^{th} birth type to dam in l^{th} parity, ink^{th} period, present in j^{th} farm of birth and born to i^{th} sire.
μ = Overall mean.
R_i = Random effect of ith sire.
F_k = Fixed effect of kth farmof birth.
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.
e_{ijklmn} = Random error, N (0, σ^2_e).

Heritability estimates for different traits were obtained from sire component of variances using paternal half-sib correlation method (Becker, 1975). The sires with three or more than three progeny were included for the estimation of heritability. The model used to estimate the heritability was:

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

Where:

Y_{ij} = Observation of the jth progeny of the ith sire.
μ = Overall mean.
s_i = Effect of the ith sire, NID (0, σ^2_s).
e_{ij} = Random error NID (0, σ^2_e).

RESULTS AND DISCUSSION

The least square means along with non-genetic factors affecting number of lambs born per ewe (NLBE) and number of lambs weaned per ewe (NLWE) are presented in Table 1. The overall means for NLBE, NLWE were 3.56±0.11 and 3.20±0.10, respectively. The effect of sire was significant (P<0.05) on NLWE, LS and SR whereas effect of all the non-genetic factors included was non-significant on all the traits under study. Contradictory to the results the present study higher estimates of 3.85±0.05 and 3.37±0.05 for NLBE and NLWE, respectively in Malpura sheep were observed by Gowane *et al* (2014). Overall number of 4.80±0.11 lambs per ewe in life time was reported by Nabi *et al*. (2020) in Corriedale sheep. The traits were statistically significantly influenced by the period of birth and sire. Significant effect of period of birth on NLBE and NLWE in Malpora sheep and on NLBE in Corriedale sheep was observed by Gowane *et al.* (2014) and Nabi *et al*. (2020), respectively. Vatankhah *et al*. (2018) in Lori Bakhtiari breed of sheep also reported significant effect of period of birth on TNLB. However, Babar and Javed (2009) in Rambouillet sheep observed a non-significant effect of period of birth on NLBE. Both the traits presented constant decreasing trend from first to last period in Kashmir Merino sheep in the present study. The constant decreasing trend may be attributed to increase rate of culling of ewes at younger age forced by increased sero-prevalence of Brucellosis at the farm. TLBE per ewe ranged from 1 to 11 whereas TLWE ranged from 0-9. More or less similar findings were reported in Malpora sheep by Gowane *et al.* (2014).

The least square means along with non-genetic factors affecting litter size (LS) and sex ratio (SR) are presented in Table 2. The overall means for LS and SR were 48.32±0.04 and 1.06±0.01, respectively. More or less similar average litter size of 1.04 in Malpura sheep at birth and 1.07±0.01 in Corriedale sheep was observed by Gowane *et al.* (2014) and Nabi *et al*. (2020), respectively. Nabi *et al*. (2020) reported average litter size of 1.07±0.01 and sex ratio of 80.90±1.92 in Corriedale sheep. Kumar *et al*. (2001) in Marwari goats reported LS and SR of 54.7% and 1.15, respectively. Tomar *et al*. (1995 and) Kumar *et al*. (2001) in Marwari goats also reported similar values. However, higher estimates of 1.08±0.03 and 1.40±0.04 for LS in Kashmir

Table 1: Least square means for number of lambs born and number of lambs weaned per ewe in Kashmir Merino sheep.

	Number of ewes	N	NLBE	N	NLWE
Overall	949		3.56±0.11	3125	3.20±0.10
Sire			0.117		0.036
Period			0.023*		0.012*
1997-2000	155	695	4.48±0.30^{c}	637	4.11±0.29^{c}
2001-2003	246	910	3.70±0.20^{bc}	803	3.26±0.20^{ab}
2004-2006	261	896	3.43±0.21^{a}	837	3.21±0.21^{a}
2007-2009	283	934	3.30±0.29^{a}	848	3.00±0.28^{a}

N= Number of lambs born. Means with different superscripts in the columns differ significantly. NS indicates non-significant. *indicates significant at 5% level. **indicates significant at 1% level.

Table 2: Least square means for litter size and sex ratio in Kashmir Merino sheep.

Effect	N	SR	N	LS
Overall	6837	48.32±0.04	6336	1.06±0.01
Period		0.101		0.245
1997-2000	600	37.44±0.09	579	1.07±0.03
2201-2003	622	47.18±0.06	578	1.08±0.02
2004-2006	777	55.49±0.06	750	1.08±0.02
2007-2009	836	48.78±0.05	753	1.06±0.02
2010-2012	1041	52.70±0.05	987	1.04±0.02
2013-2014	1507	48.41±0.05	1381	1.02±0.02
2015-2017	1454	48.21±0.05	1288	1.05±0.02
Farm		0.992		0.492
Kralpathri	5771	48.61±0.05	5528	1.03±0.02
Gobal	1066	48.03±0.12	808	1.09±0.04
Birth type		0.026		
Single	6370	51.20±0.04		
Multiple	467	45.44±0.05		
Parity		0.599		0.065
Primeparous	1813	48.72±0.04	1683	1.01±0.03
Pluriparous	5024	47.92±0.04	4653	1.11±0.02

N = Number of lambs born. Means with different superscripts in the columns differ significantly. NS indicates non-significant. * indicates significant at 5% level. **indicates significant at 1% level.

Table 3: Genetic parameters for fitness traits in Kashmir Merino sheep.

Traits	NLBE	NLW	LS	SR
NLBE	0.08±0.08	0.86±0.12	-	-
NLWE	0.94	0.12±0.08	-0.001±0.11	-
LS	-	-	0.06±0.09	
SR	-	-	-0.008	0.09 ±0.02

Merino and Fec-B gene Introgressed Kashmir Merino sheep was found by Rather *et al*. (2019). Gavojdian *et al*. (2015) reported LS of 1.40±0.05, 1.21±0.08 and 1.45±0.03 in Dorper sheep, White Dorper sheep and Tsigai sheep, respectively. The effect of all the non-genetic factors was non-significant on SR and LS. Contradictory to the results of present study Nabi *et al*. (2020) in Corriedale sheep and Rather *et al*. (2019) in Kashmir Merino reported significant effect of period of birth on LS. As we the sex is determined at the union of gamete and it is irrelevant that any factor actually affects the sex of the lamb. Kumar *et al* (2021) reported SR of 50.43±0.28 in Malpura and 51.05±0.32 in Avikalin sheep. Kumar *et al* (2021) also reported non-significant effect of birth type, parity and period of birth on SR. The variation among periods may be caused sampling variances in lambs born to a particular sex. Lowest SR was observed in first period 1997-2000 and highest SR was observed in third period (2004-2006) 55.49±0.06.

The genetic parameters the fitness traits are presented in Table 3. The heritability estimates were low for all the traits under study. The low estimate of h^2 indicated the presence of lower additive genetic variance as the traits were largely influenced by environmental factors. Low heritability estimates for NLB and NLW were also observed by Gowane *et al*. (2014) in Malpura sheep. However, Nabi *et al*. (2020) In Corriedale sheep reported moderate h^2 of 0.40±0.04 for LS and 0.29±0.07 for TLBE. Kumar *et al*. (2021) found h^2 of 0.019±0.003 and 0.04±0.01 in Avikalin and Malpura, respectively. Low heritability estimates of 0.032 for SR were also observed by Mohan (2016) in Malpura sheep. Positive and very high genetic and phenotypic correlations between NLBE and NLWE were observed in the present study.

CONCLUSION

Constant decrease in number of lambs born and number of lambs weaned per ewe indicated that the overall reproductive has decrease over the years. Similarly, low heritability estimates for the traits indicated role of management in improving all the traits except SR over which breeders have minimum control as sex of lamb is fixed at zygote formation.

Conflict of interest

The authors declare that we have no conflict of interest.

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