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GENETIC EVALUATION OF GROWTH AND WOOL TRAITS IN HARNALI SHEEP

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ABSTRACT
Harnali sheep is a new synthetic strain developed for superior carpet wool, better growth and adaptability, the present investigation was undertaken to evaluate Harnali sheep for growth and wool traits namely birth weight (BW), weaning weight (WW), six month body weight (SMW), one year body weight (YBW), and greasy fleece weight (GFW). Mixed linear model with regression on dam's weight was used to study the effect of non-genetic factors on these traits. Heritability, genetic and phenotypic correlations were estimated using paternal half-sib analysis for body weight at various ages. The effect of period of birth, sex of lamb and dam's weight at lambing were significant on all the traits. The overall least squares means of body weights recorded for birth weight (BW), weaning weight (WW), six month body weight (SMW), one year body weight (YBW) and greasy fleece weight (GFW) were 3.26 ±0.12 kg, 12.85 ±0.05 kg, 16.96±0.04 kg, 24.13±0.04 kg and 1746.89±8.36 gm respectively. No definite trend was observed over the periods for the growth and wool traits. The heritability moderate to high ranging from 0.25 to 0.38 for all the growth and wool traits. The male lambs were significantly heavier than females at all stages of growth. The phenotypic correlation between BW and SMW was high and positive (0.49 ±0.02) and high genetic correlations of BW and WW with SMW were found. Keeping in view the high heritability and positive correlations of six month body weight with other body weights, it was concluded that selection on the basis of SMW can serve as a good selection criteria to improve growth performance at later ages in Harnali sheep.

KEY WORDS: Heritability, Correlations, Growth traits, Harnali Sheep, Wool trait.

INTRODUCTION

The sheep population in India is estimated to be about 65.07 million (BAHS, 2014) ranking second in the world. Sheep contribute greatly to the agrarian economy, especially in the livelihood of a large proportion of small and marginal farmers and landless laborers. There are 40 descript breeds of sheep distributed in various agro-climatic zones of the country (NBAGR, 2015). Cross breeding of indigenous sheep with exotic breeds has been in practice since long to bring about improvement in both wool and mutton production. Such attempts have been resulted in the evolution of some superior breeds, *viz*. Hissardale, Kashmir Merino, Bharat Merino *etc*.

The growth rate is an economic trait of interest in sheep as growth of the lambs is a reflection of the adaptability and economic viability of the animal and hence may be used as criteria for the selection among breeds and the individual within breeds. The study of body weights also helps or even guides the breeders to determine the optimum managemental practices so as to maintain the gain at optimum level. Further, for designing the effective selection programs to increase the efficiency of sheep production, the knowledge of genetic parameters of lamb weights at various ages and the genetic relationships among the traits are of utmost importance (Jafari *et al*., 2014). Harnali sheep is a three breed cross developed at Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar by inter-se mating of synthetic population of Corriedale and Russian Merino with Nali having 62.5 percent exotic inheritance (Verma *et al*., 2016). The literature is dotted with conflicting and sporadic results regarding genetic parameters of growth traits in sheep. Therefore, the present investigation was carried out to evaluate growth and wool traits in Harnali sheep.

MATERIALS AND METHODS

The present study was conducted on the performance data collected over a period of 20 years (1997-2016) pertaining to growth and greasy fleece weight records of 1883 Harnali sheep maintained at Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar. The traits included were birth weight (BW), weaning weight (WW), six month body weight, (SMW), one year body weight (YBW) and greasy fleece weight. The lambs were allowed to suckle the ewes upto 90 days. They were also provided with concentrate feed after 2 months of age.

Mixed linear model with regression on dam's weight: The effect of various factors *viz*. year, sex and dam's weight at lambing on different traits was studied by least square analysis technique using the following mixed model, $Y_{ijkl} = \mu + P_i + B_j + S_k + b\,(X_D - \bar{X}) + e_{ijkl}$ Where, Y_{ijkl} is observation on l^{th} lamb born in i^{th} period and j^{th} sex belonging to k^{th}sire; μ is the overall mean; P_i is the fixed effect of i^{th} period (i=1,2,3.......10), B_j is the fixed effect of j^{th} sex (k= 1, 2) ; S_k is the random effect of k^{th} sire NID (0, $\sigma^2 s$); b is the partial regression of traits on dam's weight at lambing; X_{ijkl} is the dam's weight corresponding to Y_{ijkl} ; $\bar{X}$ is the mean dam's weight at lambing; e_{ijkl} is the random error associated with each observation and assumed to be normality and independently distributed with mean zero and variance σ^2_e.

The least-squares and maximum likelihood computer program (Harvey, 1990) was used to estimate the effect of various factors on different growth traits. Modified Duncan's multiple range test (DMRT) was used for comparing sub group means. Heritability estimates for different traits were obtained from sire component of variances by using paternal half-sib correlation method. The standard error of heritability estimates were obtained by using formula given by Swiger *et al.* (1964). Genetic correlations among different traits were calculated from sire components of variances and co-variances. The standard error of genetic correlations was estimated by using the formula given by Robertson (1959). Phenotypic correlations among various traits were calculated from total variances and covariances. The standard error of phenotypic correlation was computed using the formula given by Snedecor and Cochran (1968).

RESULTS AND DISCUSSION

Least squares means

The analysis of variance and least squares means along with standard error to identify the effect of non-genetic factors on the observed body weights recorded at birth, 3rd, 6th and 12th months of age and greasy fleece weight are given in Table 1 and 2, respectively.

TABLE 1: Analysis of variance for growth and wool traits

Source of variation	Mean sum of squares									
	Df	BW	Df	WW	Df	SMW	Df	YBW	Df	GFW
Sire	130	0.24	130	2.49	130	1.88	128	2.94	128	82265.17
Period	9	1.67**	9	10.11**	9	7.26**	9	19.08**	9	267577.36**
Sex	1	1.08**	1	5.88**	1	0.35**	1	134.54**	1	996715.36**
Dam's weight at lambing	1	30.13**	1	88.99**	1	69.82**	1	136.54**	1	1346871.71**
Error	1741	0.2083	1643	1.67	1611	1.39	1315	3.08	1315	72953.37

**: Significant at $p<0.01$

The overall means for birth weight (BW), weaning weight (WW), six month body weight (SMW), one yearly body weight (YBW) and greasy fleece weight (GFW) were 3.26 ±0.12 kg, 12.85 ±0.05 kg, 16.96 ±0.04 kg, 24.13 ±0.04 kg and 1746.89 ±8.36 gm respectively which are in close agreement with earlier findings in the same breed, Sehrawat, (2005) and Kumar *et al*., 2018. The averages were, however higher than those reported as 1.82 ±0.03 kg in Garole×Malpura (Gowane *et al.*, 2011), 3.25 ±0.17 kg in synthetic sheep (Sehrawat, 2005) for BW; Sehrawat (2005) for WW, SMW and YBW. Higher WW in female lamb reflects better mothering ability of the dam's as compared to other breeds. However, Momoh *et al.* (2013), Vivekanand *et al.* (2014), Nirban *et al.* (2015), Mallick *et al.* (2015) in Bharat Merino×Bannur sheep (3.65 ±0.06 kg), Lalit *et al.*, (2016) in Harnali sheep and Umeel *et al.*, (2018) in Munjal sheep (4.1 ±0.07 kg) reported higher estimates in different indigenous sheep breeds.

The effect of year of birth, sex of lamb and dam's weight at lambing was statistically significant for all the traits under the study (Table1). These results are similar to the findings of earlier workers who reported that year of birth, sex of lamb and dam's weight at lambing significantly affect on all the traits Nehra *et al.* (2006) and Kumar *et al*., 2018 in crossbred sheep. Various workers also reported significant effect of year of birth and sex of lamb on WW and SMW *viz*. Kushwaha *et al*. (2010) in Chokla sheep, Balasubramanyam *et al.* (2012) in Madras Red sheep, Kannojia *et al.* (2016) in Marwari sheep, Lalit *et al.* (2016) in Harnali sheep, Narula *et al*. (2017) in Magra sheep and Reddy *et al.* (2017) in Nellore brown sheep and Umeel *et al.* (2018) in Munjal sheep. However non significant effect of period on BW was reported by Gowane *et al.* (2011) and Das *et al.* (2014). Male lambs were heavier than female for the body weight at all stages in weight. Significant effect of sex on birth weight were also reported by Kannojia *et al.* (2016) in Marwari sheep, Lalit *et al.* (2016) in Harnali sheep, Narula *et al.* (2017) in Magra sheep and Reddy *et al.* (2017) in Nellore brown sheep. The effect of weight of dam at lambing showed an increasing trend in all age groups which may be due to mothering ability and milk yield. Heavier dams gave birth to heavier lambs because of better nutrition and more uterine space provided by them for developing foetus (Prince *et al*., 2011). The results are in conformity with the findings in crossbred sheep by Narula *et al*. (2017). The differences due to period of birth on growth and wool traits of the lambs are the reflections of varying climatic conditions affecting the availability of fodder and natural pastures prevailing in different period could lead to significant period differences.

The estimate obtained in the present study for wool traits were on higher side than those reported by Dixit *et al.* (2009) in Bharat merino sheep (1.28 ±0.09kg), Thiagarajan and Jayashankar (2012) in Crossbred sheep (1.28 ±0.01kg), Jafari, Hashemi (2014) in Makuie sheep (1.21 ±0.38kg) and Lalit *et al.* (2016) in Harnali sheep. The period of birth had significant effect on GFW. Similar results were reported by Dixit *et al.* (2009) in Bharat Merino sheep, Kumar and Singh (2011) in Chokla sheep and Narula *et al*. (2012) in Marwari sheep. Sex had significant effect on GFW. Significant effect of sex on GFW was reported by Gowane and Arora (2010) in Malpura sheep, Parihar (2012) in Magra sheep.

Genetic and phenotypic parameters

The estimates of heritability along with standard error for BW, WW, SMW, YBW and GFW are given in Table 3. The estimates of heritability for SMW was 0.38 indicating high degree of genetic variability in this trait. Heritability estimates for BW, WW, YBW and GFW were moderate suggesting that there is considerable scope of improvement in these traits by mass selection. Similar results for these traits were also reported in the literature. Heritability estimates of BW recorded in the literature for different breeds of sheep ranged from 0.24 in Ghazel (Baneh *et al.,* 2010) to 0.68 ±0.19 in Harnali sheep (Kumar *et al.,* 2018). However Ganeshan *et al.* (2013) reported higher estimates of heritability for WW and SMW as 0.51 ±0.16 and 0.52 ±0.16, respectively in Madras Red sheep. The estimates of heritability for YBW in the present study was higher than 0.07 ±0.02 as estimated by Hussain *et al.* (2014) in Thalli sheep but lower than 0.30±0.11 and 0.65 ±0.19 as estimated by Gowane *et al.* (2011), Ganeshan *et al.* (2013) and Narula *et al.* (2017) in Magra sheep (0.59). Higher estimates of heritability for growth traits in present study pointed towards scope of further genetic improvement.. At six months, maternal effects are reduced considerably and there is also similar plane of nutrition for all the individuals in the flock. This might have helped to reduce the environmental variability resulting in higher heritability values. Therefore, weight at six months can be considered a good criterion for selecting animals.

Genetic and phenotypic correlations

Genetic correlations of BW were low to high (0.10 to 0.59) with other body weights. Similarly WW also had moderate to high genetic correlations with other growth and wool traits. The genetic correlations among the growth traits were found positive and moderate to high. The phenotypic correlations among all the growth traits were positive and significant. Similar results were also reported by Gowane *et al.* (2011), Ganeshan *et al.* (2013), Momoh *et al.* (2013), Mirhoseini *et al.* (2015) in Karakul sheep and Kannojia *et al.,* (2016) in Marwari sheep. The positive and moderate to high association between growth traits suggest that the lambs can be selected on the basis of early body weights. The genetic correlations of BW, WW, SMW and YBW with GFW trait were low to moderate and positive The phenotypic correlations of BW, WW, SMW and YBW with GFW was positive and significant. Similar results were also reported by Sehrawat (2005) and Kumar *et al*. (2018). The results of present study i.e. high heritability and positive and high association between growth and wool traits with SMW suggest that the lambs can be selected on the basis of six month weight and SMW can be a good selection criterion at early age.

CONCLUSION

The moderate to high heritability estimates for body weights at different ages and greasy fleece weight is indicative of the scope of genetic improvement in these traits through selection. Keeping in view of high heritability and high positive correlations of six month body weight with body weights at later ages, it is concluded that selection for body weights and wool traits based on six month body weight would be the best approach for genetic improvement of the Harnali sheep for growth performance.

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TABLE 2: Least squares means along with standard error for growth and wool traits

Effects	No. of observation	Trait BW (kg)	No. of observation	Trait WW (kg)	No. of observation	Trait SMW (kg)	No. of observation	Trait YBW (kg)	No. of observation	Trait GFW
Overall (μ)	1883	3.26±0.12	1785	12.85±0.05	1753	16.96±0.04	1455	24.13±0.04	1455	1746.89±8.36
Period										
1997-1998	146	2.96^{a} ±0.16	130	11.98^{a} ±0.50	126	16.29^{a} ±0.46	105	23.03^{a} ±0.73	105	1555.85^{b}
1999-2000	211	3.04^{b} ±0.14	183	12.85^{b} ±0.43	177	16.52^{b} ±0.39	150	23.04^{a} ±0.64	150	1520.76^{a} ±97.26
2001-2002	177	3.13^{c} ±0.13	159	12.77^{b} ±0.42	155	17.07^{d} ±0.38	132	24.15^{b} ±0.61	132	1624.99^{c} ±94.11
2003-2004	233	3.24^{d} ±0.13	226	12.77^{b} ±0.34	222	17.27^{e} ±0.36	185	24.53^{d} ±0.57	185	1677.13^{d} ±87.66
2005-2006	163	3.24^{d} ±0.13	155	12.04^{a} ±0.34	151	17.05^{d} ±0.36	125	24.39^{cd}	125	1742.53^{e} ±88.27
2007-2008	216	3.76^{g} ±0.12	209	13.34^{d} ±0.39	204	18.08^{g} ±0.35	170	25.63^{e} ±0.54	170	1766.39^{e} ±83.41
2009-2010	206	3.54^{f} ±0.10	201	13.59^{e} ±0.32	198	17.59^{f} ±0.29	165	25.57^{e} ±0.47	165	1736.66^{e} ±71.92
2011-2012	156	3.35^{e} ±0.11	153	13.18^{c} ±0.33	149	16.91^{c} ±0.30	127	24.31^{b}	127	1805.77^{f} ±73.71
2013-2014	188	3.16^{c} ±0.11	188	12.78^{b} ±0.34	184	17.31^{e} ±0.30	152	23.16^{a} ±0.49	152	1979.50^{g} ±74.93
2015-2016	187	3.23^{d} ±0.16	191	13.48^{e} ±0.29	187	17.55^{f} ±0.27	144	24.47^{cd}	144	2018.13^{h} ±66.94
Sex										
Male	928	3.38^{b}±0.02	876	13.58^{b}±0.05	856	17.97^{b}±0.05	560	25.46^{b}±0.08	560	1889.47^{b} ±12.52
Female	955	3.13^{a}±0.02	909	12.18^{a}±0.05	897	15.97^{a}±0.05	895	23.26^{a}±0.06	895	1655.25^{a} ±10.12
Regression of Dam's weight at lambing		0.037±0.003		0.0671±0.009		0.059±0.008		0.094±0.012		9.333±2.172

Means with different superscript for an effect differed significantly (p<0.05)

TABLE 3: Estimates of heritability (diagonal), genetic (above diagonal) and phenotypic (below diagonal) correlations along with standard error between growth and wool traits

Traits	BW	WW	SMW	YBW	GFW
BW	0.25±0.05	0.21±0.04	0.56±0.10	0.38±0.12	0.26±0.14
WW	0.30**±0.02	0.36±0.05	0.58±0.09	0.54±0.12	0.28±0.13
SMW	0.49**±0.02	0.45**±0.02	0.38±0.05	0.55±0.11	0.35±0.14
YBW	0.31**±0.02	0.32**±0.02	0.57**±0.02	0.28±0.04	0.25±0.16
GFW	0.18±0.02	0.21**±0.02	0.39**±0.02	0.04**±0.02	0.38±0.14

**: Significant at p<0.01