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Genetic and environmental factors affecting fleece traits in Bharat Merino sheep

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The Bharat Merino, a fine wool synthetic breed of sheep was developed at the Central Sheep and Wool Research Institute, Avikanagar. In 1982, 3/4th crossbreds of Rambouillet and Russian Merino with Chokla, Jaisalmeri, Malpura and Nali breeds were considered as a foundation stock of sheep breeding population in this study. Since then, multiple trait selection of ram lambs and *inter se* breeding was practiced for the genetic improvement of the productivity.

The performance records of 2425 Bharat Merino lambs sired by 154 rams were collected over a period of 15 years (1982–96). The flock was housed in asbestos-roofed shed during summer. The rams, ewes and lambs were separately grazed under the semi-free range grazing system. The shearing of wool of the animals was taken twice a year first in the spring (March to April) and second in the autumn (August to September). The fibre diameter and medullation percentage of wool samples were taken from the lateral mid-side region at about 90 days of age, and staple length at about 180 days of age was recorded.

Least square techniques based on mixed model methodology (Harvey 1990) were used to analyze data on fleece traits. Genetic parameters were estimated by the paternal half-sib method.

The least-square means along with respective standard errors for the greasy fleece weights and fleece quality as influenced by year and season of shearing, sex of lamb, type of birth, age and weight of lamb are presented in Tables 1 and 2 respectively. The analyses of variance revealed that the fixed effects considered in the model had influenced to the tune of 8 to 42% of the phenotypic variability in the traits studied. Year of shearing significantly influenced all the traits, whereas season of shearing and sex of lamb had significant influence on first and adult six-monthly greasy fleece weights and fleece quality except medullation percentage. Weight of lamb also influenced all traits except medullation percentage. The greasy fleece weight at first and second 6-monthly clips, fibre diameter and staple length increased by 0.031 and 0.022 kg, 0.09 microns and 0.03 cm, respectively, for every 1 kg increase in their corresponding body weight. Significant differences in 6 monthly greasy fleece yield and staple length were observed due to type of birth. Age of lamb also influenced first and subsequent adult 6–monthly clips. There was an increase of 155 g in the first clip with an increase of one month in the age at shearing. The younger animals of the age group between 2–5 years produced the heaviest clip (1.307–1.342 kg) and older animals (>6 years) produced the lowest (1.201 kg) clip (Table 1). The effect of ram on the traits studied was significant.

The genetic and phenotypic correlations and heritability estimates are presented in Table 3. The heritability estimates of first and second 6-monthly clips, fibre diameter and staple length varied from fairly high to very high and that of medullation percentage was low. The genetic correlation of first 6-monthly greasy fleece weight with fibre diameter and that of fibre diameter with medullation percentage was significant. The genetic correlation of fleece traits with growth traits did not reveal any consistent trend except those of greasy fleece weights with body weights. The wool yield had desirable positive genetic association (0.48–0.72) with body weights. The estimates of phenotypic correlation among fleece traits varied from low (0.12) to moderately high (0.49), and those between fleece and growth traits were low positive (0.09–0.11) except between medullation percentage and weaning weight. A perusal of environmental correlations revealed that the correlations among greasy fleece weight, staple length and body weights were desirable, whereas those among the 3 fleece quality traits were undesirable.

The estimates of the greasy fleece yield were comparable to the reported estimates of greasy fleece yield for other newly developed breeds of sheep like Avivastra and Kashmir Merino for fine wool (Shiekh 1984, Singh and Dhillon 1992). The fibre diameter, medullation percentage and staple length of Bharat Merino were lower than those reported for other

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Table 1. Least-square means (±SE) for 6–monthly greasy fleece weights (kg) of the Bharat Merino sheep

Effects			Greasy fleece weight (kg) at		
			1st six-monthly clip	2nd six-monthly clip	Adult six-monthly clip
No. of observations			1770	1250	4894
Population mean			0.874±0.015	1.010±0.017	1.285±0.009
C.V. (%)			40.95	32.32	35.42
Year of shearing			**	**	**
Season of shearing			**	ns	**
Spring			0.814[a]±0.026	1.006±0.013	1.306 [a]±0.011
Autumn			0.933 [b]±0.011	1.014±0.028	1.264 [b]±0.011
Sex of lamb			**	ns	**
Male			0.844 [a]±0.017	1.005±0.019	1.426 [a]±0.015
Female			0.903 [b]±0.017	1.015±0.019	1.144 [b]±0.008
Type of birth			**	ns	–
Single			0.914 [a]±0.013	1.021±0.014	–
Twin			0.833 [b]±0.023	1.000±0.025	–
Age at shearing (months)			**	ns	**
1st 6–monthly clip	2nd	Adult			
6	12	<24	0.698 [a]±0.022	1.000±0.027	1.246 [a]±0.012
7	13	36	0.883 [b]±0.019	1.011±0.018	1.307 [bc]±0.12
8	14	48	1.039 [c]±0.022	1.019±0.025	1.340 [b]±0.015
–	–	60	–	–	1.342 [b]±0.017
–	–	72	–	–	1.274 [ac]±0.019
–	–	>72	–	–	1.201 [d]±0.019_
Lamb weight (kg) at			**	**	–
6 month		12 month			
<21		<25	0.738 [a]±0.020	0.824 [a]±0.026	–
25		30	0.864 [b]±0.018	0.980 [b]±0.021	–
>25		35	1.020 [c]±0.020	1.055 [c]±0.022	–
		>35	_	1.181 [d]±0.027	–

CV, Coefficient of variation.Means with similar superscripts within a column do not differ from one another at P < 0.05.*P <0.05; ** P <0.01; ns P >0.05.

newly developed breeds. Environmental influences on most of the traits studied were in agreement with those reported by (Singh and Dhillon (1992), Arora and Singh (1995), and Singh and Arora (1995). The variability in fibre biometry due to years may partly be due to differences in environment, feeding and grazing resources and selection of rams. The possible reason for heavier (15%) first clip of the autumn-shorn lambs may be the better nutrition and also due to plentiful succulent grasses available in monsoon months prior to the shearing of lambs and coincided with favourable weather conditions. The heavier (3%) adult 6- monthly clip during the spring season may be due to better nutritional status of the ewes because spring was the main lambing season and possibly due to favourable climate. Higher ambient temperature preceding the autumn shearing may be responsible for breakage and slower growth of wool fibres due to heat stress resulting in shorter staple length (32%) compared to the spring shearing. The heavier (7%) first 6-monthly clip of the female lambs may be due to coarser (2%) wool fibre with longer (5%) staple length. The differences in staple length and fibre diameter of the male and female lambs may be due to differences in their endocrine profile. The selection of male lambs for greasy fleece weight and larger body size at 6 months of age would be the possible reasons for heavier (25%) adult 6-monthly clip in males. Single born lambs produced more (10%) greasy fleece at first clip with longer (8%) staple length compared to twin born lambs, possibly due to better growth rate of single born lambs. The increase in wool production with advancement of age up to certain stage may be due to increase in body weight and/or surface area. The significant effect of ram on all the traits studied indicated that superior sires could be used effectively for improvement of these traits.

High estimates of heritability indicated the existence of considerable additive genetic variance in fleece traits except medullation percentage. The genetic differences in these traits can, therefore, be exploited through mass selection for genetic improvement of these traits of Bharat Merino sheep. High estimates of heritability of greasy fleece yield were also reported by Singh *et al.* (1984) in Russian Merino, and Singh

Table 2. Least-square means (±SE) for fleece quality characteristics of the Bharat Merino lambs

Effects		Staple length (cm)	Fibre diameter (microns)	Medullation (% age)
No. of lambs		1079	1314	1314
Population mean		3.32±0.07	18.89±0.15	4.39±0.49
C.V. (%)		33.76	15.05	203.09
Year of shearing		**	**	**
Season of shearing		**	*	ns
Spring		3.78[a]±0.06	19.15 [a]±0.11	4.78±0.37
Autumn		2.86 [b]±0.10	18.63 [b]±0.24	4.00±0.81
Sex of lamb **		**	ns	
Male		3.24 [a]±0.07	18.70 [a]±0.16	4.20±0.52
Female		3.40 [b]±0.07	19.08 [b]±0.17	4.58±0.57
Type of birth **		ns	ns	
Single		3.45 [a]±0.05	18.86±0.12	4.46±0.39
Twin		3.19 [b]±0.10	18.91±0.22	4.32±0.75
Lamb weight (kg)•		**	**	ns
3–mo wt	*6–mo wt*			
<15	<21	3.17 [a]±0.07	18.35 [a]±0.17	4.80±0.58
20	25	3.30 [a]±0.08	19.06 [b]±0.16	4.16±0.54
>20	>25	3.49 [b]±0.09	19.25 [b]±0.23	3.76±0.79

CV, Coefficient of variation; Means with similar superscripts within a column do not differ (P≤0.05) from one another. (i) 3–month body weight classes are for fibre diameter and medullation percentage. (ii) 6–month body weight classes are for staple length.* P <0.05; ** P<0.01; ns P>0.05.

and Dhillon (1992) in Avivastra sheep. Khan and Singh (1974) and Singh and Manuja (1995) also reported high estimates of heritability of fibre diameter and staple length.

The positive genetic association between greasy fleece weight and fibre diameter was undesirable. High and positive genetic correlation (0.93) between fibre diameter and medullation percentage was also reported by Singh and Dhillon (1992) in Avivastra sheep but the authors reported very low and positive (0.04) association between greasy fleece weight and fibre diameter. The genetic correlations among first six-monthly greasy fleece weight, medullation percentage and staple length had very high standard errors. Kushwaha *et al*. (1995) observed low and positive genetic association between greasy fleece and body weights in Avivastra breed of sheep. The undesirable association between greasy fleece weight and fibre diameter indicated the need for restricted selection index for an overall improvement of Bharat Merino sheep.

Phenotypic correlations indicated that heavier lambs produce heavier greasy fleece with coarser wool fibres and longer staple length. Any effort at environment level to improve growth of the lambs tend to improve the wool yield and staple length but deteriorate fibre diameter and medullation percentage due to antagonism among these traits.

SUMMARY

The contribution of genetic and phenotypic parameters for fleece traits in 3/4th bred 2425 Bharat Merino Lambs, sired by 154 rams over period of 1982–96 were evaluated. The year and season of shearing, sex of lamb, type of birth, age and weight of lamb contributed 8 to 42% of the phenotypic variability in the fleece traits. The least squares means for the first and second six monthly greasy fleece weights, staple length, fibre diameter and medullation percentage were 0.874±0.015 and 1.010±0.017 kg, 3.32±0.07 cm, 18.89±0.15 microns and 4.39±0.49% respectively. Correspondingly, the heritability estimates were 0.54±0.13,

Table 3. Estimates of heritabilities, genetic and phenotypic correlations among fleece traits and growth traits of the Bharat Merino sheep

Trait	GFY–1*	GFY–2**	Staple length	Fibre diameter	Medullation percentage	3–month weight	6–month weight	12–month weight
GFY–1	0.54±0.13	0.16±0.03[+] (0.19)	0.20±0.03[+] (0.12)	0.16±0.03[+] (–0.17)	0.12±0.03[+] (0.06)	0.35±0.03[+] (0.30)	0.41±0.03[+] (0.18)	-
GFY–2	0.13±0.18	0.31±0.09	-	-	-	-	0.32±0.03[+] (0.08)	0.39±0.03[+] (0.20)
Staple length	0.24±0.17	-	0.76±0.15	0.20±0.03[+] (0.79)	0.20±0.02[+] (0.34)	0.10±0.01[+] (0.46)	0.09±0.03[+] (0.46)	-
Fibre diameter	0.48±0.18[+]	-	–0.15±0.18	0.46±0.13	0.49±0.03[+] (0.45)	0.11±0.03[+] (0.05)	-	-
Medullation%	0.30±0.29	-	0.15±0.27	0.71±0.22[+]	0.15±0.10	–0.01±0.03 (–0.04)	-	-
3–month weight	0.48±0.20[+]	-	–0.21±0.22	0.23±0.25	0.11±0.39	-	-	-
6–month weight	0.64±0.14[+]	0.62±0.13[+]	–0.12±0.18	-	-	-	-	-
12–month weight	-	0.72±0.13[+]	-	-	-	-	-	-

Figures in parentheses are environmental correlations. Total observations, 750; No. of sires, 94; No. of progeny per sire (K), 7.5. * First six monthly greasy fleece yield. ** Second six monthly greasy fleece yield. The heritabilities, genetic and phenotypic correlations are along the diagonal, below the diagonal and above the diagonal, respectively. [+] The genetic and phenotypic correlations are significantly different from zero.

0.31±0.09, 0.76±0.15, 0.46±0.13 and 0.15±0.10 respectively. The estimates of genetic correlation among the fleece traits ranged from low to high in magnitude. The wool yield had desirable and significant genetic association with the body weight but undesirable association with the fibre diameter. These estimates revealed the scope for the genetic improvement of these traits through appropriate selection index.

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