



Evaluation of genetic and phenotypic parameters growth traits in organized flock of Chokla sheep of Rajasthan

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Received: 18 September 2017; Accepted: 15 April 2019

Key words: Chokla sheep, Genetic and non-genetic factors, Genetic and phenotypic parameters, Growth traits, Rajasthan

Several non-genetic factors affect growth traits and directly obscure recognition of the genetic potential of animals. The effect of various factors like year of birth, season of birth, type of management and sex of animal on lamb growth of various wool breeds of sheep, has been studied (Mandal *et al.* 2003, Reddy *et al.* 2009). The Chokla sheep, comparatively fine carpet wool producing type sheep among the Indian sheep breeds, is hardy and well adapted to the arid and semi-arid regions of Rajasthan and also best suited for the region where migration is common practice. The present study was undertaken to identify various factors (period of birth, dam's age at lambing, and season of birth and sex of lamb) influencing growth traits and to estimate the genetic and phenotypic parameters of these traits in Chokla sheep.

The overall least-squares means were 2.79 ± 0.015 , 12.68 ± 0.119 , 19.02 ± 0.0152 , 20.91 ± 0.194 and 23.89 ± 0.199 kg at birth, 3, 6, 9 and 12 months of age, respectively (Table 1). The overall least-squares means were 109.97 ± 1.242 , 70.67 ± 1.082 and 29.66 ± 0.879 g/day at 0–3, 3–6 and 6–12 months of age, respectively (Table 2). The random effect of sire was observed to be highly significant ($P \leq 0.01$) on all growth traits which indicated that sire selection for these traits can bring further genetic improvement in the flock. Arora *et al.* (1999) in Avikalin and Malpura sheep, Tomar *et al.* (2000) in Bharat Merino sheep and Gohil (2010) in Marwari sheep also observed significant effect of sire on all growth traits. Gohil (2010) reported significant effect of sire on average daily gain in Marwari sheep. The fixed effect of sex of lamb was highly significant ($P \leq 0.01$) on all growth traits except 12 months body weight. Male lambs were heavier than female lambs on all ages. This was also corroborated by Narula *et al.* (2010), Dass *et al.* (2008) and Gohil (2010) in Marwari sheep. These differences are

mainly due to anabolic effect of androgen which causes higher growth in males. Due to the impact of this hormone, males became more aggressive for feeding resulting in higher feed intake and consequently higher body weight compared to females (Singh and Dhillon 1992, Chopra *et al.* 2010).

The fixed effect of period was highly significant ($P \leq 0.01$) on all growth traits except birth weight. Period of birth was also highly significant ($P < 0.01$) in respect of lamb weights at all developmental stages in this study. The present findings corroborated with the results of Sivakumar *et al.* (2006) and Reddy *et al.* (2009) who obtained significant effect of period/year of birth on body weights of sheep. The body weight differences among lambs born in different periods in our study may be attributed to differences in management, selection of rams, genetic improvement in breed performance over the period and environmental conditions etc.

The fixed effect of dam's age was highly significant ($P \leq 0.01$) on birth weight, 3 months weight and ADG3 and non-significant for 6, 9, 12 months body weights, ADG1 and ADG2. In general, it has been observed that dam's age, i.e. from 4 to 5 years and 5 to 6 years of age were giving significantly higher body weights of lambs at birth and this effect continued in all the growth traits in advanced age as a carryover maternal and permanent environmental effect. Younger and older dams were giving birth to lower body weight lambs and also resulted in lower growth rate of those lambs in later stages too. Dixit *et al.* (*loc.cit.*) reported effect of age of ewe at birth and post weaning ADG less significant, whereas it was found to be highly significant on all other traits in Bharat merino sheep. Negi *et al.* (1987) in Gaddi sheep found the non-significant effect dam age on growth traits. Singh and Dhillon (1992) in Avivastra lambs reported significant effect of dam age on growth traits, which is similar to our study.

The fixed effect of season was highly significant ($P \leq 0.01$) on all growth traits and non-significant for 12 month body weight. The significant effect of season of birth on body weights was also reported in different breeds of sheep (Kumar *et al.* 2007, Reddy *et al.* 2009). Lambs born

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Table 1. Least-squares means along with standard errors of different body weights in Chokla sheep

Effect	No. of obs.	BWT	No. of obs.	3WT	No. of obs.	6WT	No. of obs.	9WT	No. of obs.	12WT
Overall mean (μ)	3714	2.79 $\pm$ 0.015	3177	12.68 $\pm$ 0.119	2838	19.02 $\pm$ 0.015	2421	20.91 $\pm$ 0.194		23.89 $\pm$ 0.199 (2102)
Sire		**		**		**		**		**
Period	NS	NS		**		**		**		**
P1 (1994–1996)	411	2.71 $\pm$ 0.053	313	12.34 $\pm$ 0.356 ^c	306	17.52 $\pm$ 0.486 ^b	237	17.83 $\pm$ 0.547 ^a	228	21.10 $\pm$ 0.728 ^b
P2 (1997–1999)	524	2.74 $\pm$ 0.045	407	11.58 $\pm$ 0.291 ^a	409	16.44 $\pm$ 0.404 ^a	358	18.05 $\pm$ 0.429 ^a	289	20.09 $\pm$ 0.644 ^a
P3 (2000–2002)	570	2.79 $\pm$ 0.050	494	11.97 $\pm$ 0.315 ^b	477	17.64 $\pm$ 0.432 ^b	461	20.26 $\pm$ 0.444 ^c	342	21.61 $\pm$ 0.716 ^b
P4 (2003–2005)	589	2.75 $\pm$ 0.052	510	11.85 $\pm$ 0.313 ^{ab}	475	18.08 $\pm$ 0.434 ^c	427	19.32 $\pm$ 0.458 ^b	356	24.42 $\pm$ 0.782 ^c
P5 (2006–2008)	637	2.89 $\pm$ 0.056	594	13.85 $\pm$ 0.357 ^d	570	19.64 $\pm$ 0.491 ^d	486	22.12 $\pm$ 0.58 ^d	333	25.34 $\pm$ 0.736 ^d
P6 (2009–2011)	983	2.87 $\pm$ 0.069	859	14.51 $\pm$ 0.418 ^c	601	24.82 $\pm$ 0.627 ^e	452	27.87 $\pm$ 0.651 ^e	454	30.78 $\pm$ 0.849 ^e
Sex		**		**		**		**		NS
Male	1860	2.85 $\pm$ 0.017	1585	13.12 $\pm$ 0.127	1389	20.26 $\pm$ 0.165	1147	22.48 $\pm$ 0.205	1073	23.94 $\pm$ 0.216
Female	1854	2.74 $\pm$ 0.017	1592	12.24 $\pm$ 0.127	1449	17.79 $\pm$ 0.165	1274	19.33 $\pm$ 0.204	1029	23.84 $\pm$ 0.220
Season		**		**		**		**		**
May–October	854	2.83 $\pm$ 0.021	734	13.46 $\pm$ 0.148	541	19.32 $\pm$ 0.201		21.20 $\pm$ 0.241 (353)		23.50 $\pm$ 0.277 (326)
November–April	2860	2.76 $\pm$ 0.016	2443	11.90 $\pm$ 0.120	2297	18.73 $\pm$ 0.151	2068	20.61 $\pm$ 0.190	1776	24.28 $\pm$ 0.191
Dam's age		**		**		NS		NS		NS
1 (<2 year)	441	2.58 $\pm$ 0.027 ^a	353	12.35 $\pm$ 0.179 ^a	273	18.84 $\pm$ 0.254	231	20.71 $\pm$ 0.279	204	24.04 $\pm$ 0.342
2 (2–3 year)	854	2.64 $\pm$ 0.021 ^b	694	12.50 $\pm$ 0.148 ^a	606	18.90 $\pm$ 0.198	505	20.85 $\pm$ 0.233	473	23.85 $\pm$ 0.263
3 (3–4 year)	735	2.82 $\pm$ 0.021 ^c	628	12.68 $\pm$ 0.149 ^{ab}	574	19.02 $\pm$ 0.198	494	20.76 $\pm$ 0.231	435	23.74 $\pm$ 0.263
4 (4–5 year)	609	2.88 $\pm$ 0.023 ^d	540	12.64 $\pm$ 0.154 ^{ab}	495	19.02 $\pm$ 0.205	416	20.95 $\pm$ 0.238	355	23.71 $\pm$ 0.278
5 (5–6 year)	480	2.94 $\pm$ 0.025 ^e	432	13.03 $\pm$ 0.163 ^{bc}	407	19.33 $\pm$ 0.218	357	21.32 $\pm$ 0.247	292	23.93 $\pm$ 0.297
6 >6 year)	595	2.90 $\pm$ 0.023 ^{de}	530	12.89 $\pm$ 0.156 ^{bc}	483	19.03 $\pm$ 0.209	418	20.85 $\pm$ 0.240	530	24.04 $\pm$ 0.284
Dam's weight at lambing		**		**		**		**		*
Regression coefficient (kg/kg)		0.062 $\pm$ 0.0024		0.25 $\pm$ 0.0144		0.252 $\pm$ 0.021		0.227 $\pm$ 0.0204		0.062 $\pm$ 0.0282

Number of observations are given in parenthesis. Figure with different superscripts differ significantly BWT, birth weight; 3WT, weaning weight; 6WT, 6-month weight 9WT, month weight; 12WT, 12-month weight **-Highly significant ($P \leq 0.01$); *-Significant ($P \leq 0.05$); NS-Non-significant.

Table 2. Least-squares mean ($\pm$ SE) of for main effects on average daily gain (g) during different of age in Chokla lambs

Effect	No. of obs.	ADG1 (0–3 months)	No. of obs.	ADG2 (3–6 months)	No. of obs.	ADG3 (6–12 months)
Overall mean (μ)	3156	109.97 $\pm$ 1.242	2648	70.67 $\pm$ 1.082	1783	29.66 $\pm$.879
Sire		**		**		**
Period		**		**		**
P1 (1994–1996)	312	106.34 $\pm$ 1.766 ^b	267	61.49 $\pm$ 3.790 ^b	147	25.19 $\pm$ 3.062 ^a
P2 (1997–1999)	397	99.91 $\pm$ 3.099 ^a	348	55.73 $\pm$ 3.047 ^a	254	25.67 $\pm$ 2.724 ^a
P3 (2000–2002)	490	103.21 $\pm$ 3.326 ^b	464	61.96 $\pm$ 3.175 ^b	331	31.27 $\pm$ 3.013 ^c
P4 (2003–2005)	505	100.92 $\pm$ 3.304 ^{ab}	443	67.16 $\pm$ 3.264 ^c	270	34.16 $\pm$ 3.273 ^d
P5 (2006–2008)	594	120.86 $\pm$ 3.770 ^c	532	63.26 $\pm$ 3.644 ^b	397	28.91 $\pm$ 3.134 ^b
P6 (2009–2011)	858	128.55 $\pm$ 4.417 ^d	594	114.39 $\pm$ 4.498 ^d	(384)	32.78 $\pm$ 3.101 ^{cd}
Sex		**		**		**
Male	1578	114.19 $\pm$ 1.329	1306	78.84 $\pm$ 1.172	774	32.94 $\pm$ 0.935
Female	1578	105.75 $\pm$ 1.329	1342	62.49 $\pm$ 1.183	1009	26.38 $\pm$ 0.926
Season		**		**		**
May–October	732	118.26 $\pm$ 1.554	478	66.01 $\pm$ 1.466	225	25.91 $\pm$ 1.136
November–April	2424	101.68 $\pm$ 1.260	2170	75.32 $\pm$ 1.067	1558	33.41 $\pm$.844
Dam's age		NS		NS		**
1 (<2 year)	352	108.84 $\pm$ 1.879	261	71.04 $\pm$ 1.814	169	32.00 $\pm$ 1.287 ^c
2 (2–3 year)	693	109.47 $\pm$ 1.555	572	71.46 $\pm$ 1.416	356	29.01 $\pm$ 1.080 ^{ab}
3 (3–4 year)	623	109.83 $\pm$ 1.565	532	70.25 $\pm$ 1.421	315	28.83 $\pm$ 1.060 ^{ab}
4 (4–5 year)	532	108.75 $\pm$ 1.620	460	71.53 $\pm$ 1.472	315	29.59 $\pm$ 1.082 ^{ab}
5 (5–6 year)	430	111.94 $\pm$ 1.722	375	70.95 $\pm$ 1.569	260	30.74 $\pm$ 1.144 ^{bc}
6 (>6 year)	526	110.96 $\pm$ 1.640	448	68.76 $\pm$ 1.502	337	27.79 $\pm$ 1.080 ^a
Dam's weight at lambing		**		NS		NS
Regression coefficient (kg/kg)		2.226 $\pm$ 0.1519		0.107 $\pm$ 0.1489		–034 $\pm$ 0.0983

Number of observations are given in parenthesis. Figure with different superscripts differ significantly. **Highly significant ($P \leq 0.01$); *Significant ($P \leq 0.05$); NS, Non-significant.

Table 3. Estimates of heritability (on diagonal), genetic correlation (above diagonal) and phenotypic correlation (below diagonal) among body weights (kg) average daily gains (g/day) at different ages in Chokla sheep

Traits/ parameter	BWT	3 WT	6 WT	9 WT	12 WT	ADG1	ADG2	ADG3
BWT	0.231±0.030	0.242±0.111	0.565±0.103	0.030±0.116	0.065±0.124	0.072±0.122	-0.270±0.190	-0.252±0.143
3 WT	0.321±0.017	0.139±0.029	0.855±0.062	0.383±0.121	0.437±0.121	0.977±0.006	0.017±0.218	-0.181±0.178
6 WT	0.279±0.029	0.753±0.008	0.068±0.024	0.667±0.092	0.573±0.183	0.831±0.068	0.462±0.196	0.081±0.229
9 WT	0.265±0.021	0.591±0.014	0.806±0.007	0.175±0.033	0.847±0.041	0.367±0.122	0.637±0.137	0.589±0.146
12 WT	0.255±0.023	0.538±0.017	0.715±0.011	0.818±0.008	0.183±0.039	0.534±0.024	0.709±0.131	0.721±0.102
ADG1	0.160±0.019	0.985±0.001	0.737±0.009	0.564±0.015	0.184±0.037	0.137±0.029	0.065±0.026	-0.088±0.183
ADG2	0.046±0.020	0.058±0.020	0.694±0.010	0.557±0.015	0.492±0.018	0.141±0.029	0.059±0.023	0.322±0.251
ADG3	0.040±0.025	-0.206±0.025	-0.271±0.023	0.101±0.025	0.548±0.018	0.-0.22±0.025	-0.132±0.025	0.131±0.037

in May–October grew well up to 3 months of age and attained highest weight. This might be due to a favorable climate when the grazing of good quality was available.

The effect of dam's weight as a covariate was highly significant ($P \leq 0.01$) on birth, 3, 6, 9 months body weights and ADG1 and significant ($P \leq 0.05$) on 12 months body weights and non-significant for ADG2 and ADG3. This suggests that heavier dams during pregnancy and lambing delivered heavier lambs. Weaning weight and pre-weaning average daily gain of these lambs was also higher probably due to good body condition of dams, better nutrition, better mothering ability and favourable uterine environment prior to lambing (Dass *et al.* 2008, Gohil 2010). Therefore these non-genetic factors should be considered while evaluating performance and planning genetic improvement.

The genetic and phenotypic correlations and heritability estimates for growth traits are presented in Table 3. The heritabilities of body weights at birth and at 3, 6, 9 and 12 months of age observed in this study were moderate (0.088–0.231), as compared to the estimates of Nehra and Singh (2006), which indicate ample scope of improvement of these traits by selection. The heritabilities of average daily gains observed in this study were low to medium (0.059–0.137). Estimates of genetic correlations between body weights with weights at subsequent ages were positive and ranged from 0.065 to 0.885, and average daily gains during different phase ranged from -0.088 to 0.322. Estimates for phenotypic correlations between body weights with weights at subsequent ages ranged from 0.255 to 0.818, and average daily gains during different phase ranged from -0.22 to 0.141. Both the phenotypic (0.753) and genetic correlation (0.855) of 3 months weight with 3 months weight was high. The present study revealed that different environments affect significantly the growth traits of Chokla sheep. The high heritabilities of body weights and high genetic correlation among the body weights at different stages suggest that selection for increased early growth traits will lead to genetic improvement in the subsequent development of body weights.

SUMMARY

The sire effect was highly significant ($P \leq 0.01$) on all growth traits. The sex effect of lamb was highly significant

($P \leq 0.01$) on all growth traits but non-significant on 12 months body weight, period effect was highly significant ($P \leq 0.01$) on all growth traits but non-significant on birth weight. The effect of dam's age was highly significant ($P \leq 0.01$) on birth weight, 3 months weight, ADG3 and non-significant effect for 6, 9, 12 months body weights, ADG1 and ADG2. The effect of season of birth was highly significant ($P \leq 0.01$) on all growth traits but non-significant effect for 12 months body weights. The effect of dam's weight as a covariate was highly significant ($P \leq 0.01$) on birth, 3, 6, 9 months body weights and ADG1 and significant ($P \leq 0.05$) on 12 months body weights and non-significant for ADG2 and ADG3. The heritability estimates from WOMBAT (animal model 1) method for body weights and average daily gains were low to medium. Estimates of genetic correlations between body weights with weights at subsequent ages were positive and ranged from 0.065 to 0.885, and average daily gains during different phase ranged from -0.088 to 0.322. Estimates for phenotypic correlations between body weights with weights at subsequent ages ranged from 0.255 to 0.818, and average daily gains during different phase ranged from -0.22 to 0.141.

ACKNOWLEDGEMENTS

Authors thank the Director, Central Sheep and Wool Research Institute, Avikanagar; Head, Arid Region Campus, Central Sheep and Wool Research Institute, Bikaner; Vice-Chancellor, Rajasthan University of Veterinary and Animal Sciences, Bikaner and Dean, College of Veterinary and Animal Science, Bikaner for providing the facilities for the execution of work.

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