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Environmental and genetic effects on growth traits of Chokla sheep

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ABSTRACT

Data on 1810 Chokla sheep, maintained at the Central Sheep and Wool Research Institute (CSWRI), Avikanagar, Rajasthan, collected for a period of 21 years (1980 through 2000) were used to study growth traits and genetic control. The average weights at birth, 3, 6, 9 and 12 months of age were 2.73±0.04, 12.74±0.22, 16.71±0.26, 18.20±0.26 and 21.81±0.35 kg, respectively. Significant effects associated with the period of birth, parity of dam, season of birth and sex of lambs were observed on body weight at different stages of growth. Sire of the lamb contributed significantly on all body weights under study. There were marked periodic differences in the different growth traits of lambs. The lambs born in the dam's third and later parities were significantly heavier to those born in first or second parities. Season of birth had significant effect on body weights at 3, 9 and 12 months of age. Males were heavier than females at almost all stages of growth and the sex differences tended to increase with age. The heritabilities of body weights at birth and at 3, 6, 9 and 12 months of age were high in magnitude, ranging from 0.32 to 0.48, which indicate the ample scope of improvement of these traits by selection. The medium (0.17±0.16) to high (0.89±0.05) genetic correlation among the body weights at different stages in this study suggest that selection for increased early growth traits will lead to genetic improvement in the subsequent development of body weights.

Key words: Genetic analysis, Growth traits, Genetic parameters, Sheep

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 present study was undertaken to identify various factors (viz. period of birth, parity of dam, season of birth and sex of lamb) influencing growth traits and to estimate the genetic and phenotypic parameters of these traits in Chokla sheep.

MATERIALS AND METHODS

Breeding flock and its management: 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 wool of this breed is heterogeneous in quality and is finer than the wool of any other carpet wool producing sheep breeds in the country. Generally the animals were maintained under semi-intensive system of feeding management where they are allowed to graze for 10–12 h on natural pasture with supplementation of some amount of concentrate depending upon the status and age category of the animals. Normally, rotational grazing system was followed. Controlled mating was practised in the flock. Majority of the ewes (more than 80%) were bred during autumn (August-September), the main breeding season and some ewes were bred in spring breeding season (March-April), off breeding season. Heat detection of ewes was done with teaser ram in the morning and evening during the breeding season. The ewes in heat were mated in the morning with selected sires. Generally, one breeding ram was allowed to mate 25 to 30 ewes and used for 2 years. At birth, each lamb was weighed and identified by metal ear tag. Weaning of lambs was generally done at 90 days. Shearing of animal was done twice in a year, i.e. in March–April and September–October. Animals were vaccinated against PPR, enterotoxaemia, FMD etc. The detailed descriptions of this breed along with distribution and production performance were described by Kushwaha *et al.* (1997).

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Data: Data on 1810 lambs of Chokla sheep, maintained at the Central Sheep and Wool Research Institute (CSWRI), Avikanagar, Rajasthan, India, under the All India Coordinated Research Project (AICRP) on Sheep Improvement (later on, AICRP was renamed as Network Project on sheep improvement since 1990) for a period of 21 years (1980 to 2000) were used for the present study. The body weights at different ages (i.e. at birth, 3, 6, 9 and 12 month) were recorded and classified according to period of birth, season of birth, parity of dam and sex of lamb. The years of lambing were divided into 11 periods, each comprising 2 years except last period, based on the use of a different ram for breeding during each period. Each year of lambing was also divided into 2 seasons, i.e. S–1 (January-February) and S–2 (August-Sept.).

Statistical analyses: Data were analyzed using a mixed model least-squares analysis for fitting constants (Harvey 1990) including all main effects and interactions. In the final model, all non-significant interactions were ignored, which is as follows:

$$Y_{ijklmn} = \mu + S_i + P_j + A_k + S_l + E_m + e_{ijklmn,}$$

where, Y_{ijklmn} is the record for the nth lamb, S_i is the effect of the ith sire, P_j is the effect of the jth period of birth, A_k is the effect of the kth parity of dam, S_l is the effect of the lth season of birth, E_m is the effect of the mth sex of lamb and e_{ijklmn} is the residual error element.

The genetic parameters of various growth traits were estimated by the paternal half-sib method. The comparison of different sub-groups mean was made by Duncan's Multiple Range Test (DMRT) as described by Kramer (1957).

RESULTS AND DISCUSSION

Body weights at different ages: The average weight of Chokla lamb at birth, 3, 6, 9 and 12 month of age were 2.73±0.04, 12.74±0.22, 16.71±0.26, 18.20±0.26 and 21.81±0.35 kg, respectively (Table 1). The overall least-squares means for lamb weights observed at the different ages in this breed were similar with the findings of Nehra and Singh (2006) but lower than the results of Reddy *et al.* (2009). The sires of lambs had significant (P<0.01) influence on all the body weights in the present study. Similar significant sire effects on body weights were observed by Mandal *et al.* (2003) in various sheep breeds. The significant effect of sire on all these traits studied indicated that superior rams could be used effectively for improvement of these traits. 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

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

Effects	No. of obs.	Birth weight (kg)	No. of obs.	3 m weight (kg)	No. of obs.	6 m weight (kg)	No. of obs.	9 m weight (kg)	No. of obs.	12 m weight (kg)
Overall	1810	2.73±0.04	1501	12.74±0.22	1304	16.71±0.26	1132	18.20±0.26	920	21.81±0.35
Period of birth										
P–1	69	2.10±0.28^{a}	64	14.54±1.53^{de}	55	15.00±1.79 ^{a}	47	17.96±2.02 ^{abcd}	37	20.41±2.50 ^{ab}
P–2	48	2.32±0.24^{a}	43	13.99±1.33^{cde}	36	14.99±1.49 ^{a}	33	16.92±1.80 ^{abc}	31	21.58±2.27 ^{abc}
P–3	84	2.79±0.16^{bc}	74	13.36±0.93^{cde}	62	14.71±1.23 ^{a}	50	17.08±1.26 ^{abc}	43	18.71±1.61 ^{a}
P–4	95	2.59±0.14^{ab}	84	12.77±0.82^{bcd}	68	16.84±1.10 ^{ab}	60	18.15±1.13 ^{bcd}	56	21.63±1.49 ^{abc}
P–5	149	2.87±0.13^{cd}	113	14.54±0.76^{de}	76	21.82±1.01 ^{d}	64	21.53±1.04 ^{d}	60	26.24±1.39 ^{d}
P–6	188	2.96±0.12^{cd}	171	15.53±0.66^{e}	148	20.88±0.85 ^{cd}	122	20.93±0.87 ^{d}	63	26.21±1.66 ^{cd}
P–7	175	3.20±0.12^{d}	147	12.41±0.69^{bc}	117	19.02±0.88 ^{bc}	100	19.92±0.91 ^{cd}	83	25.05±1.21 ^{bcd}
P–8	207	2.79±0.14^{bcd}	158	10.65±0.82^{ab}	141	16.76±1.02 ^{ab}	110	16.26±1.04 ^{ab}	92	19.68±1.42 ^{a}
P–9	323	2.84±0.15^{bcd}	235	10.17±0.86^{a}	206	16.17±1.07 ^{a}	187	14.91±1.10 ^{a}	157	17.77±1.47 ^{a}
P–10	336	2.91±0.15^{cd}	303	11.48±0.89^{abc}	294	16.57±1.11 ^{ab}	263	17.07±1.14 ^{abc}	207	19.57±1.51 ^{a}
P–11	136	2.63±0.17^{ab}	109	10.74±0.97^{ab}	101	17.11±1.21 ^{ab}	96	19.44±1.23 ^{cd}	91	21.07±1.60 ^{ab}
Parity of dam										
1	565	2.38±0.04^{a}	420	11.75±0.24^{a}	334	15.86±0.29^{a}	279	17.49±0.29^{a}	219	21.39±0.39 ^{a}
2	465	2.65±0.04^{b}	387	12.62±0.24^{b}	347	16.80±0.28^{b}	292	18.07±0.29^{ab}	235	21.83±0.38 ^{a}
3	334	2.79±0.04^{c}	297	12.88±0.25^{bc}	261	16.83±0.31^{b}	232	18.58±0.30^{b}	187	22.01±0.40 ^{a}
4	225	2.87±0.05^{c}	196	12.94±0.28^{bc}	178	16.75±0.33^{b}	163	18.15±0.33^{ab}	135	21.64±0.43 ^{a}
5	140	2.86±0.05^{c}	128	13.58±0.31^{c}	116	17.19±0.37^{b}	104	18.25±0.37^{ab}	88	21.90±0.47 ^{a}
6 or > 6	81	2.81±0.06^{c}	73	12.71±0.37^{bc}	68	16.86±0.45^{b}	62	17.97±0.44^{c}	56	22.10±0.54 ^{a}
Sex of lamb										
Male	897	2.78±0.04 ^{a}	736	13.17±0.23 ^{a}	637	17.74±0.27 ^{a}	545	19.65±0.27 ^{a}	410	23.92±0.37 ^{a}
Female	913	2.67±0.04 ^{b}	765	12.32±0.23 ^{b}	667	15.69±0.27 ^{b}	587	16.75±0.27 ^{b}	510	19.70±0.36 ^{b}
Season of birth										
Jan-Feb	562	2.72±0.03 ^{a}	1317	11.97±0.21 ^{a}	1149	16.48±0.24 ^{a}	1020	18.69±0.23 ^{a}	1835	22.31±0.32 ^{a}
Aug-Sep	248	2.74±0.04 ^{a}	184	13.52±0.28 ^{b}	155	16.94±0.36 ^{a}	112	17.70±0.35 ^{b}	85	21.31±0.46 ^{b}

Means with different superscripts differed significantly (P<0.05) from each other.

Table 2. Estimates of heritability (diagonal), genetic correlations (below diagonal) and phenotypic correlations (above diagonal) of growth traits of Chokla sheep

Traits/parameter	Birth wt.	3 M BW	6 M BW	9 M BW	12 M BW
Birth wt.	0.36±0.07(1810)	0.44	0.28	0.32	0.30
3 M BW	0.66±0.12	0.43±0.09(1501)	0.69	0.55	0.51
6 M BW	0.26±0.18	0.68±0.10	0.37±0.09(1304)	0.68	0.61
9 M BW	0.28±0.18	0.37±0.16	0.51±0.15	0.32±0.09(1132)	0.80
12 M BW	0.17±0.16	0.23±0.17	0.46±0.15	0.89±0.05	0.48±0.11(920)

Figures in parentheses indicate number of observations.

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 and environmental conditions etc. The parity of dam contributed significantly ($P<0.01$) for all growth traits of lamb except weight at 12 months of age (Table 1). The lambs born in third or later parities were heavier except at birth than the lambs of younger ewes. Similarly, Mandal *et al.* (2003) found significant effect of parity of dam on different body weights of Muzaffarnagari lamb. The low birth weight of lambs in younger ewes may be due to the existence of relative competition between the still growing ewes and the developing foetus for nutrients/ food. Season of birth had significant effect on weights of lambs at 3, 9 and 12 months of age. 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). The significant effect of the season of birth on 9 and 12 months body weight may be due to those lambs born in August-September passing through a period with a favorable climate during January to April when the grazing of good quality was available. Male lambs achieved significantly ($P<0.01$) higher body weights at all stages of growth than their female counterparts (Table 1). The increase in the ratio of male to female body weight as the lambs became older and their body weights increased, probably arises from the increasing differences in the endocrine system between males and females (Swenson and Reece 1993). These sex differences are consistent with results from other investigations (Waghmode *et al.* 2008, Reddy *et al.* 2009).

Genetic and phenotypic parameters

The genetic and phenotypic correlations and heritability estimates for growth traits are presented in Table 2. The heritability of body weights tended to increase with increasing age from birth to weaning and subsequent weights except for that at 9 months of age. The heritabilities of body weights at birth and at 3, 6, 9 and 12 months of age observed in this study were high (0.32–0.48) in magnitude, as compared to the estimates of Nehra and Singh (2006), which indicate ample scope of improvement of these traits by selection. Both the phenotypic (0.44) and genetic (0.67) correlation (0.67) of birth weight with weaning weight was moderately high in magnitude, but the correlation of birth weight with body weights at subsequent ages ranged from low to medium and positive (0.17 to 0.32). The phenotypic correlations of weaning weight with 6, 9 and 12 months body weight were also significant and high (0.51 to 0.69) but declined steadily at later stages. The genetic correlations of weaning weight with the body weights at subsequent ages showed a similar trend. The 6-and 9-month body weights had significant, high positive phenotypic and genetic correlations with their subsequent body weights and these correlations were statistically significant ($P<0.01$). The moderately medium to high genetic correlations between birth weight and weaning weight, and of weaning weight with 6, 9 and 12 months body weight in this study indicates that selection for increased birth weight in the sheep will also result in genetic improvement in the subsequent development of body weights.

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.

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