Genetic and non-genetic factors affecting morphometry of Sirohi goats

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Abstract

Aim: The aim was to estimate genetic and non-genetic factors affecting morphometric traits of Sirohi goats under field condition.

Materials and Methods: The detailed information of all animals on body measurements at birth, 3, 6, 9, and 12 months of age was collected from farmer’s flock under field condition born during 2007-2013 to analyze the effect of genetic and non-genetic factors. The least squares maximum likelihood program was used to estimate genetic and non-genetic parameters affecting morphometric traits.

Results and Discussion: Effect of sire, cluster, year of birth, and sex was found to be highly significant (p<0.01) on all three morphometric traits, parity was highly significant (p<0.01) for body height (BH) and body girth (BG) at birth. The h² estimates for morphometric traits ranged among 0.528±0.163 to 0.709±0.144 for BH, 0.408±0.159 to 0.605±0.192 for body length (BL), and 0.503±0.197 to 0.695±0.161 for BG.

Conclusion: The effect of sire was highly significant (p<0.01) and also h² estimate of all morphometric traits were medium to high; therefore, it could be concluded on the basis of present findings that animals with higher body measurements at initial phases of growth will perform better with respect to even body weight traits at later stages of growth.

Keywords: correlation, genetic, morphometric traits, non-genetic and Sirohi.

Introduction

Goat substantially contributes to the rural economy and provide livelihood to the poor sections. The total goat population of the country is 135.17 million, and it constitutes 26.46% of total livestock population.

Rajasthan ranks the first in total goat population of the country, i.e., 16.03% [1]. Among various genotypes available the Sirohi is one of the principal and renowned breed of goats. This breed has derived its name from Sirohi district of Rajasthan [2]. The source of income from this breed depends mainly on meat and milk production. In meat producing animals like sheep and goats, external body measurements could be a reliable indicator of its future performance with respect to live body weights, if and only if a correlation has been identified among these traits of interest [3]. Growth traits, which are available early, are a very important economic trait and could serve as an indicator for improvement of the traits that appear at the later age due to the association of body weights, and body measurements with fiber production [4].

In the present study, an attempt was made to study genetic and non-genetic factors affecting the body measurements along with genetic parameters.

Materials and Methods

Data

The detailed information of 3551 kids (male-1768 and female-1783) born during 2007-2013 on body measurements at birth, 3, 6, 9, and 12 months of age was collected from farmer’s flock under field condition, which were maintained under All India Coordinated Research Project (AICRP) on Sirohi goats, Livestock Research Station (LRS), Vallabh Nagar, Udaipur, Rajasthan. Under this project, all Sirohi breeders were identified in the field. The study area (Figure-1) is located in western part of India and situated at 582 m above mean sea level on 24°35″ N latitude and 73°43″
E longitudes, which characterized with semi-arid climate with undulated topography having an average rainfall of 660 mm annually. Similarly, the temperature ranges from 2.3°C to 42.3°C. Breeding bucks properly tagged were reared and maintained at LRS under AICRP, Vallabhnagar during off breeding season and distributed to identified farmers during breeding season. Different bucks were rotated among farmers in different breeding seasons. The kids born out of such matings were tagged, and their pedigree records were maintained at LRS, Vallabhnagar. Animals were vaccinated against enterotoxaemia and peste des petits ruminants. The data were recorded on the same day for body weight and body measurements. The records were taken from birth up to 12 months of age at the interval of 3 months by the staff members of LRS. The data were classified into five clusters of three districts viz., (1) Vallabhnagar cluster of Udaipur district, (2) Railmagra, (3) Devgarh, (4) Nathdwara clusters of Rajasamand district, and (5) Bhadsoda cluster of Chittorgarh district, three seasons of birth viz., (1) rainy (July-October), (2) winter (November-February) and (3) summer (March-June), 6 years of birth from April month of the year up to March month of next calendar year, year 1 (2007-08), year 2 (2008-09), year 3 (2009-10), year 4 (2010-11), year 5 (2011-12), and year 6 (2012-13), five parity (1, 2, 3, 4, and ≥5), two types of birth:(1) single and (2) multiple and two sex:(1) Male and (2) female.

**Statistical methods**

The data on growth trait was analyzed through mixed model least-squares and maximum Likelihood Computer Program PC 2, Harvey [5]. To study the effect of various genetic and non-genetic factors on body measurements the statistical model used was as under:

\[ Y_{ijklmnop} = \mu + a_j + B_k + C_i + D_l + E_m + F_n + G_o + b (D_{ijklmnop} - \bar{D}W) + e_{ijklmnop} \]

Where,

- \( Y_{ijklmnop} \) = Performance record of the \( p \)th progeny of \( i \)th sire belonging to \( j \)th cluster, \( k \)th season of birth, \( l \)th year of birth, \( m \)th parity, \( n \)th type of birth and \( o \)th sex.
- \( \mu \) = Overall population mean
- \( a \) = Random effect of \( i \)th sire
- \( B \) = Fixed effect of \( j \)th cluster (\( j = 1, 2, 3, 4, 5 \))
- \( C \) = Fixed effect of \( k \)th season of birth (\( k = 1, 2, 3 \))
- \( D \) = Fixed effect of \( l \)th year of birth (\( l = 1, 2, 3, 4, 5, 6 \))
- \( E_m \) = Fixed effect of \( m \)th parity (\( m = 1,2,3,4, \geq 5 \))
- \( F_n \) = Fixed effect of \( n \)th type of birth (\( n = 1, 2 \))
- \( G_o \) = Fixed effect of \( o \)th sex (\( o = 1, 2 \))
- \( b (D_{ijklmnop} - \bar{D}W) \) = The regression of the trait on dam’s weight at kidding
- \( e_{ijklmnop} \) = Random error NID (0, \( \sigma^2 \))

Duncan’s multiple range test as modified by Kramer [6] was used to make pairwise comparison among the least-squares means.

**Estimation of heritability**

The heritability was estimated by sire component of variance-covariance obtained from the paternal half-sib analysis. The standard error of heritability was estimated as per Swiger et al. [7].

**Genetic and phenotypic correlations**

The genetic and phenotypic correlations among traits were calculated from the analysis of variance and covariance among sire groups.

**Results and Discussion**

The estimates of least-squares means of body height (BH), body length (BL) and body girth (BG) at birth, 3, 6, 9, and 12 months of ages are given in Tables 1-3, respectively.

**Effect of sire**

The effect of sire was found to be highly significant (\( p<0.01 \)) on all morphometric traits at birth, 3, 6, 9, and 12 months of age. The finding was in agreement with the observations of Kumar et al. [8] in Jamunapari goats and Karna et al. [9,10] in Cheghu goats. Tomar et al. [3] reported no significant effect of sire on the three morphometric traits.

Sire significantly affected the morphometric traits at all ages indicating the existence of additive genetic variability among these traits and significant influence of sire might be attributed to relative merits of the sires used.

**Effect of cluster**

The effect of the cluster was found to be highly significant (\( p<0.01 \)) on all morphometric traits at birth, 3, 6, 9, and 12 months of ages. Sharma et al. [11] observed highly significant (\( p<0.01 \)) effect of cluster on BH and BL at birth and 3 months of age in Sirohi goats, BG at 3 months of age. However, Patil et al. [12] observed highly significant (\( p<0.01 \)) effect on BG at 1 month of age, BH and BG at 6 months of age and BG at 9 months of age. Kharkar et al. [13] observed a significant effect on BL at birth. Gohain et al. [14] observed highly significant (\( p<0.01 \)) effect of cluster on BG and BH in Assam local goats. Kuralkar et al. [15] reported highly significant (\( p<0.01 \)) effect on all three measurements. Differences across clusters might be due to differences in grasses and herbage availability. Significantly (\( p<0.01 \)) higher mean body measurements were observed in Bhadsoda cluster as compared with remaining four clusters in all age groups except BL at birth.

**Effect of year**

The effect of year of birth was found to be highly significant (\( p<0.01 \)) on all morphometric traits at birth, 3, 6, 9, and 12 months of ages. Present findings are similar with Tomar et al. [3] except at birth in BH in Sirohi goats, Sharma et al. [11] observed highly
### Table 1: Least-squares means and SE for BH (cm) of Sirohi goat at different ages.

| Factors            | At birth | 3 months | 6 months | 9 months | 12 months |
|--------------------|----------|----------|----------|----------|----------|
| Overall mean (µ)   | 31.02±0.35 (3551) | 51.53±1.19 (3073) | 57.65±0.95 (2194) | 61.76±2.24 (1642) | 67.09±0.95 (1144) |
| Sire               | **       | **       | **       | **       | **       |
| Cluster            | **       | **       | **       | **       | **       |
| Vallabh Nagar      | 29.16±0.38a (278) | 50.54±1.23 (214) | 55.52±1.04 (123) | 59.10±2.30a (59) | 59.54±1.65a (36) |
| Railmagra           | 31.03±0.38b (650) | 47.35±1.22 (593) | 57.44±1.01 (504) | 60.71±2.27b (396) | 65.82±1.10c (229) |
| Devgarh            | 31.70±0.38c (1584) | 52.63±1.22a (1849) | 57.42±1.65c (914) | 61.62±2.27c (943) | 64.76±1.12b (715) |
| Nathdwara          | 29.38±0.61a (37) | 51.31±1.71b (15) | 53.42±1.65b (12) | 56.75±0.70a (3)  | 70.63±2.28a (241) |
| Bhadsoda           | 33.85±0.38d (1002) | 55.81±1.22d (812) | 64.47±1.03d (371) | 78.24±1.17d (164) | 78.38±1.23d (164) |
| Season             | **       | **       | **       | **       | **       |
| Rainy              | 30.95±0.35a (1303) | 51.18±1.19b (1171) | 57.64±0.96 (795) | 61.96±2.25a (507) | 67.61±0.96b (377) |
| Winter             | 30.96±0.35a (596) | 51.88±1.19a (1443) | 57.59±0.96 (1021) | 61.96±2.25a (829) | 66.99±0.95a (589) |
| Summer             | 31.16±0.36a (525) | 51.63±1.19b (459) | 57.71±0.97 (378) | 61.36±2.27a (306) | 66.66±0.98a (178) |
| Year of birth      | **       | **       | **       | **       | **       |
| 2007-08            | 32.16±0.38a (491) | 53.21±1.22b (453) | 59.40±1.00 (404) | 63.92±2.27a (350) | 62.28±1.03a (310) |
| 2008-09            | 31.53±0.37c (436) | 50.98±1.22b (412) | 56.17±1.00a (412) | 61.36±2.27a (412) | 65.74±1.03a (412) |
| 2009-10            | 30.38±0.36a (624) | 50.54±1.20a (394) | 56.42±0.97a (320) | 59.82±2.25a (320) | 66.44±0.99a (186) |
| 2010-2011          | 30.38±0.36a (531) | 51.25±1.20c (376) | 57.24±0.98b (308) | 61.24±2.26a (218) | 67.68±1.02c (218) |
| 2011-2012          | 30.91±0.36a (668) | 51.91±1.20b (406) | 58.90±0.98c (301) | 62.86±2.26c (221) | 69.31±1.02d (221) |
| 2012-2013          | 30.79±0.36a (651) | 51.29±1.21b (528) | 57.74±1.00e (202) | 61.37±2.32e (47)  | -                  |
| Parity             | **       | **       | **       | **       | **       |
| 1st                | 30.97±0.36a (278) | 51.43±1.20a (664) | 57.74±0.97 (507) | 61.88±2.25 (393) | 67.41±0.98 (276) |
| 2nd                | 31.06±0.35a (650) | 51.44±1.19a (589) | 57.82±0.96 (455) | 61.84±2.25 (348) | 67.18±0.97 (243) |
| 3rd                | 30.89±0.36a (1584) | 51.46±1.19a (395) | 57.51±0.96 (341) | 61.55±2.25 (220) | 67.25±0.97 (209) |
| 4th                | 30.99±0.36a (37) | 51.74±1.19b (461) | 57.76±0.97 (317) | 61.99±2.25 (218) | 66.77±0.98 (152) |
| ≥5th               | 31.20±0.35a (1002) | 51.58±1.19a (806) | 57.40±0.96 (504) | 61.55±2.25 (380) | 66.84±0.97 (253) |
| Type of birth      | **       | **       | **       | **       | **       |
| Single             | 32.12±0.35a (2080) | 52.58±1.19a (1842) | 58.70±0.96a (1386) | 62.46±2.24a (1049) | 67.74±0.95a (752) |
| Multiple           | 29.93±0.35a (1471) | 50.48±1.19a (1231) | 56.60±0.96a (808) | 61.06±2.25a (593) | 66.44±0.95a (392) |
| Sex                | **       | **       | **       | **       | **       |
| Male               | 31.41±0.35a (1768) | 52.49±1.19a (1536) | 58.51±0.96a (1023) | 62.68±2.24a (679) | 68.04±0.94a (372) |
| Female             | 30.64±0.35a (1783) | 50.57±1.19a (1537) | 56.78±0.96a (1171) | 60.84±2.24a (963) | 66.14±0.95a (772) |
| Regression on weight of dam at kidding | **       | **       | **       | **       | **       |
| Regression coefficient (b) (kg/kg) | 0.066±0.015 | 0.068±0.031 | 0.076±0.037 | 0.046±0.048 | 0.157±0.057 |

Number of observations are given in parentheses. Estimates with different superscripts differ significantly. **Highly significant (p<0.01), *Significant (p<0.05), NS=Non-significant, SE=Standard error, BH=Body height.

Significant (p<0.01) effect of cluster on all three morphometric traits at birth and 3 months of age in Sirohi goats and Patil et al. [12] at 1 and 3 months of age on all three morphometric traits in Sangamneri goats. Karna et al. [10] reported the significant effect on all three traits at 3 and 6 months of age in Cheggu goats.

Higher values of all three morphometric traits were observed at birth in initial 2 years (2007-2008 and 2008-2009) then it remain almost constant. The
BH declined up to 2nd year and then again remained unchanged. The BG continuously declined up to 6 and 9 months of age. The highest BL was observed in the 1st year of birth (2007-2008), whereas BH and BG in last year of birth (2012-2013). This might be due to the differences in climate, nutrition and management.

**Effect of season of birth**
Influence of season of birth was highly significant (p<0.01) on BH at 3 and 12 months of ages,
| Factors | Traits | At birth | 3 months | 6 months | 9 months | 12 months |
|---------|--------|---------|---------|---------|---------|---------|
| Overall mean | (µ) | 31.19±0.41 | 51.62±1.18 | 58.64±1.00 | 62.26±2.35 | 67.51±1.06 |
| Sire | ** | ** | ** | ** | ** | ** |
| Cluster | ** | ** | ** | ** | ** | ** |
| Vallabhnagar | 29.69±0.44 | 51.20±1.22 | 56.08±1.09 | 59.90±2.40 | 59.66±1.73 |
| Railmagra | 32.25±0.44 | 48.82±1.21 | 59.18±1.07 | 62.45±2.37 | 68.36±1.20 |
| Devgarh | 32.02±0.44 | 52.90±1.21 | 57.72±1.06 | 61.84±2.37 | 65.24±1.22 |
| Nathdwara | 29.03±0.66 | 50.34±1.70 | 56.81±1.77 | 57.43±1.35 | - |
| Bhdasoda | 32.98±0.43 | 54.84±1.21 | 63.43±1.08 | 69.71±2.38 | 76.77±1.26 |
| Season | ** | ** | ** | ** | ** |
| Rainy | 31.20±0.41 | 51.24±1.18 | 58.54±1.00 | 62.33±2.35 | 67.93±1.07 |
| Winter | 31.32±0.41 | 51.35±1.18 | 56.63±1.00 | 62.50±2.35 | 67.13±1.06 |
| Summer | 31.36±0.42 | 51.77±1.19 | 58.76±1.01 | 61.96±2.35 | 67.46±1.08 |
| Year of birth | ** | ** | ** | ** | ** |
| 2007-08 | 32.82±0.43 | 53.85±1.21 | 60.62±1.05 | 65.01±2.37 | 67.34±1.14 |
| 2008-09 | 31.95±0.43 | 51.31±1.21 | 57.80±1.05 | 62.58±2.37 | 66.02±1.13 |
| 2009-10 | 30.37±0.42 | 50.60±1.19 | 57.37±1.11 | 60.24±2.36 | 66.90±1.10 |
| 2010-2011 | 30.79±0.42 | 51.19±1.19 | 57.85±1.02 | 61.33±2.36 | 67.89±1.12 |
| 2011-2012 | 30.72±0.42 | 51.67±1.19 | 59.68±1.02 | 62.92±2.36 | 69.40±1.13 |
| 2012-2013 | 30.50±0.42 | 51.09±1.20 | 58.55±1.04 | 61.51±2.42 | - |
| Parity | 1<sup>st</sup> | 31.06±0.42 | 51.47±1.19 | 58.63±1.01 | 62.17±2.36 | 67.69±1.09 |
| 2<sup>nd</sup> | 31.22±0.42 | 51.44±1.18 | 58.73±1.01 | 62.31±2.35 | 67.64±1.08 |
| 3<sup>rd</sup> | 31.11±0.42 | 51.58±1.18 | 58.57±1.01 | 62.09±2.35 | 67.48±1.08 |
| 4<sup>th</sup> | 31.19±0.42 | 51.84±1.19 | 58.88±1.01 | 62.65±2.36 | 67.32±1.09 |
| ≥5<sup>th</sup> | 31.38±0.41 | 51.76±1.18 | 58.41±1.01 | 62.11±2.35 | 67.40±1.08 |
| Type of birth | Single | 32.27±0.41 | 52.70±1.18 | 59.67±1.00 | 62.89±2.35 | 68.25±1.06 |
| Multiple | 30.11±0.41 | 50.53±1.18 | 57.61±1.00 | 61.64±2.35 | 66.77±1.07 |
| Sex | Male | 31.58±0.41 | 52.55±1.18 | 59.52±1.00 | 63.18±2.35 | 68.46±1.07 |
| Female | 30.80±0.41 | 50.69±1.18 | 57.77±1.00 | 61.35±2.35 | 66.56±1.06 |

Regression on weight of dam at kidding:

| Regression coefficient (b) (kg/kg) | 0.039±0.015 | 0.071±0.031 | 0.037±0.041 | 0.008±0.048 | 0.153±0.058 |

Number of observations are given in parentheses. Estimates with different superscripts differ significantly. **Highly significant (p<0.01), *Significant (p<0.05). NS=Non-significant, SE=Standard error, BG=Body girth

significant at birth and 9 months of ages and non-significant at 6 months of age. Highly significant (p<0.01) effect was observed on BG at birth, 3 and 12 months of ages, also on BL at birth and 3 months of ages. Similar results were also observed by Pathodiya et al. [16] in Sirohi goats. However, Sharma et al. [11] reported significant (p<0.01) effect of season of birth on BH and BL at birth, highly significant (p<0.01) effect on all three morphometric traits at 3 months of age. Barhat [17] reported highly significant (p<0.01)
effect on all three morphometric traits in Marwari goats, Kharkar et al. [13] at 3 months on BL, 3 and 12 months BH and at birth and 12 months BG on Berari goats.

Summer born kids at birth have higher BH, BL and BG compared with rainy season and winter season. Kids born in rainy season attended maximum BH and BG.

Effect of sex of kids

Sex of kids had highly significant effect (p<0.01) on all three morphometric traits at birth, 3, 6, 9 and 12 months of ages. However, the male kids were larger to females one with regards to their BH, BL, and BG at all the ages. These results are in agreement with the findings of Pathodiya et al. [16], Sharma et al. [11] reported highly significant (p<0.01) effect of sex of kid on BL and BG at birth in Sirohi goats and Reotheia et al. [18] reported highly significant (p<0.01) effect of sex of kid on BH and BG at 3 months of age and all three morphometric traits at 6 and 9 months of age in Bakrevali goats. However, the non-significant effect of sex of kids on BH, BL and BG on all ages was observed by Kharkar et al. [13], whereas Kharkar et al. [19] significant effect on boy height at 12 months of age in Berari goats. Gohain et al. [14] observed highly significant (p<0.01) effect of sex of kid on all three morphometric traits in Assam local goats.

Effect of type of birth

The type of birth had highly significant effect (p<0.01) on all three morphometric traits at birth, 3, 6, 9, and 12 months of ages. These findings were in agreement to those of Tomar et al. [3] at birth, 3 and 6 months of age in Sangamneri goats and Patil et al. [12] at 1 and 3 months of age in Sirohi goats. Kharkar et al. [13], Pathodiya et al. [16] reported highly significant effect (p<0.01) of type of birth on all three morphometric traits at birth, significant effect (p<0.01) on BH at 3 months of age. However, non-significant effect of type of birth on BH, BL and BG on all ages was observed by Kharkar et al. [13] in Berari goats.

Single born kids were larger in BH, BL and BG than those born as multiple at all the ages. This might be due to availability of more nutrients to the single born kid than those born in multiple births during pre and postnatal life.

Effect of parity

The parity of dam had highly significant effect (p<0.01) on BH and BG at birth and at other ages non-significant effect of parity was observed. BL had non-significant effect of parity on all ages in the present study. Similar effect of dam’s parity on morphometric traits at all ages was reported by Nahardeka et al. [20] in Assam local goats. However, Pathodiya et al. [16] reported significant effect of parity of dam on all morphometric traits at birth in Sirohi goats.

Effect of dam’s weight at kidding

The regression of dam’s weight at kidding had significant effect on BH at birth, 3, 6 and 12 months of ages, BL at birth, 6 and 12 months of ages and BG at birth, 3 and 12 months of ages. However, Kumar et al. [8] reported non-significant effect of dam’s weight at kidding on all morphometric traits at 6, 9, and 12 months of ages in Jamunapari goats and Sharma et al. [11] also reported non-significant effect on all morphometric traits at birth and 3 months of age.

Genetic and phenotypic parameters for Morphometric traits at different ages

The results regarding estimated genetic and phenotypic parameters viz. heritability, genetic and phenotypic correlations of a population are presented in Tables 4-6.

Heritability

The heritability estimates for morphometric traits under study were of high magnitude. The heritability estimates for morphometric traits ranged among 0.528±0.163 to 0.709±0.144 for BH, 0.408±0.159 to 0.605±0.192 for BL, and 0.503±0.197 to 0.695±0.161 for BG. Higher estimates were also reported by Tomar et al. [3] at 3 and 6 months of age and Pathodiya et al. [16] at birth in Sirohi goats. On the other hand low heritability for BH and BL at 3 months and moderate heritability for morphometric traits at birth in Sirohi goats was reported by Tomar et al. [3]. The results indicated the presence of additive genetic variability and hence mass selection would be effective to improve these traits.

Genetic correlation

Estimates of genetic correlations between BHs at different ages ranged from 0.520±0.030 to 6-9BH to 0.775±0.014 for 9-12BH, between BLs at different ages ranged from 0.478±0.126 for BBL-6BL to 0.863±0.050 for 6-12BL and between BGS at different ages ranged from 0.508±0.061 for BBG-9BG to 0.900±0.044 for 6-12BG.

Phenotypic correlation

Phenotypic correlation is the association between phenotypic values of different traits measured on the same animal. It is a joint function of the genotype, and environment and interaction if any, between the two, but their relative contributions are varied. The estimates of phenotypic correlations between different morphometric traits at different ages are presented in Tables 4-6 and are discussed as follows.

Phenotypic correlations between BHs at different ages ranged from 0.333±0.026 for BBH-12BH to 0.741±0.013 for 9-12BH, between BLs at different ages ranged from 0.227±0.028 for BBL-6BL to 0.703±0.015 for 6-9BL and between BGS at different ages ranged from 0.340±0.026 for BBG-6BG to 0.668±0.017 for 9-12BG.
Table-6: Estimates of heritability (on diagonal), genetic correlation (above diagonal) and phenotypic correlation (below diagonal) among BG at different ages in Sirohi goats.

| Trait | BBG   | 3 BG  | 6 BG  | 9 BG  | 12 BG |
|-------|-------|-------|-------|-------|-------|
| BBG   | 0.693±0.130 | 0.621±0.059 | 0.533±0.102 | 0.636±0.080 | 0.767±0.074 |
| 3 BG  | 0.443±0.024 | 0.528±0.163 | 0.664±0.046 | 0.691±0.040 | 0.513±0.036 |
| 6 BG  | 0.354±0.026 | 0.658±0.017 | 0.709±0.144 | 0.520±0.030 | 0.664±0.049 |
| 9 BG  | 0.357±0.026 | 0.573±0.020 | 0.727±0.104 | 0.699±0.179 | 0.775±0.014 |
| 12 BG | 0.333±0.026 | 0.495±0.022 | 0.557±0.020 | 0.741±0.013 | 0.708±0.188 |

BBG=Body girth at birth, 3 BG=3 months body girth, 6 BG=6 months body girth, 9 BG=9 months body girth, 12 BG=12 months body height

Table-4: Estimates of heritability (on diagonal), genetic correlation (above diagonal) and phenotypic correlation (below diagonal) among BH at different ages in Sirohi goats.

| Trait | BBH   | 3 BH  | 6 BH  | 9 BH  | 12 BH |
|-------|-------|-------|-------|-------|-------|
| BBH   | 0.693±0.130 | 0.621±0.059 | 0.533±0.102 | 0.636±0.080 | 0.767±0.074 |
| 3 BH  | 0.443±0.024 | 0.528±0.163 | 0.664±0.046 | 0.691±0.040 | 0.513±0.036 |
| 6 BH  | 0.354±0.026 | 0.658±0.017 | 0.709±0.144 | 0.520±0.030 | 0.664±0.049 |
| 9 BH  | 0.357±0.026 | 0.573±0.020 | 0.727±0.104 | 0.699±0.179 | 0.775±0.014 |
| 12 BH | 0.333±0.026 | 0.495±0.022 | 0.557±0.020 | 0.741±0.013 | 0.708±0.188 |

BBH=Body height at birth, 3 BH=3 months body height, 6 BH=6 months body height, 9 BH=9 months body height, 12 BH=12 months body height

Table-5: Estimates of heritability (on diagonal), genetic correlation (above diagonal) and phenotypic correlation (below diagonal) among BL at different ages in Sirohi goats.

| Trait | BBL   | 3 BL  | 6 BL  | 9 BL  | 12 BL |
|-------|-------|-------|-------|-------|-------|
| BBL   | 0.568±0.137 | 0.584±0.069 | 0.478±0.126 | 0.576±0.109 | 0.679±0.090 |
| 3 BL  | 0.373±0.025 | 0.408±0.159 | 0.660±0.050 | 0.550±0.052 | 0.648±0.030 |
| 6 BL  | 0.227±0.028 | 0.555±0.020 | 0.789±0.150 | 0.731±0.028 | 0.863±0.050 |
| 9 BL  | 0.261±0.026 | 0.531±0.022 | 0.703±0.151 | 0.571±0.172 | 0.835±0.026 |
| 12 BL | 0.294±0.027 | 0.458±0.023 | 0.520±0.022 | 0.663±0.017 | 0.605±0.192 |

BBL=Body length at birth, 3 BL=3 months body length, 6 BL=6 months body length, 9 BL=9 months body length, 12 BL=12 months body length

Conclusion

The effect of sire was highly significant (p<0.01) and also h² estimate of all morphometric traits were medium to high; therefore, it could be concluded on the basis of present findings that animals with higher body measurements at initial phases of growth will perform better with respect to even body weight traits at later stages of growth. The estimates of phenotypic and genetic correlations were quite high in magnitude suggesting that improvement in BH would result in desired gain in body weight and body girth also.

Authors’ Contributions

SBSY and RKN designed the experiment. SDD conducted the study and analyzed the data. UP and GCG revised the manuscript. All authors read and approved the final manuscript.

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Competing Interests

The authors declare that they have no competing interests.

References

1. 19th Livestock Census. (2012) Available from: http://www.dahd.nic.in/dahd/statistics/livestock-census.aspx. Accessed on 24-05-2015.
2. Meel, U.K., Nagda, R.K., Sharma, S.K. and Rajawat, B.S. (2010) Growth performance of Sirohi goats under field conditions. Indian J. Small Rumin., 16(1): 246-248.
3. Tomar, A.K.S., Kumar, A., Mehta, B.S. and Jaishankar, J. (2001) Factors affecting early express body traits in Sirohi goats. Indian J. Anim. Sci., 71(3): 271-273.
4. Karna, D.K., Koul, G.L. and Bishit, G.S. (2001a) Pashmina yield and its association with morphometric traits in Indian cheghu goats. Small Rumin. Res., 41: 271-275.
5. Harvey, W.R. (1990) User’s Guide for LSMLMW, Mixed Model Least-Squares and Maximum Likelihood Computer Programme. Ohio State University, Columbus, Ohio, USA.
6. Kramer, C.R. (1957) Extension of multiple range tests to group correlated means. Biometrics, 13: 13-18.
7. Swiger, L.A., Harvey, W.R., Everson, D.O. and Gregory, K.E. (1964) The variance of interclass correlation involving group with one observation. Biometrics, 20: 818-826.
8. Kumar, S., Bhat, P.N., Bhat, P.P. and Palia, S.K. (1992) Genetic and non-genetic factors affecting body weights and measurements in Jamunapari goats. Indian J. Anim. Sci., 62(9): 894-897.
9. Karna, D.K., Koul, G.L. and Bishit, G.S. (2001b) Birth
10. Karna, D.K., Bisht, G.S. and Koul, G.L. (2005) Genetic and non-genetic factors affecting morphometry of cheghu goats. *Indian J. Small Rumin.*, 11(1): 62-64.

11. Sharma, M.C., Pathodiya, O.P., Tailor, S.P. and Mishra, S. (2010) Pre-weaning growth traits of Sirohi kids under farmer’s management system. *Indian J. Small Rumin.*, 16(1): 243-245.

12. Patil, B.S., Pachpute, S.T. and Dhage, S.A. (2013) Growth performance of Sangamneri goats under field conditions. *Indian J. Small Rumin.*, 192: 151-155.

13. Kharkar, K., Kuralkar, S.V., Kuralkar, P., Bankar, P.S., Chopade, M.M. and Hadole, K.A. (2014) Factors affecting body weight and morphometric characters of Berari goats. *Indian J. Small Rumin.*, 20(2): 112-114.

14. Gohain, M., Konwar, P. and Nahardeka, N. (2014) Influence of non-genetic factors on body weight and linear body measurements of Assam local goats. *Indian J. Small Rumin.*, 20(2): 115-117.

15. Kuralkar, S.V., Varma, N.V., Kharkar, K. and Kuralkar, P. (2013) Berari goats: Characterization, management, performance and population status. *Indian J. Anim. Sci.*, 83(12): 1292-1298.

16. Pathodiya, O.P., Gurjar, M.L., Sharma, M.C. and Khadda, B.S. (2004) Studies on birth weight and morphometry of Sirohi kids in farmers field. *Indian J. Small Rumin.*, 10(1): 74-76.

17. Barhat, N.K. (2005) Boy weight and measurements in Marwari goats. *Indian J. Anim. Sci.*, 75(11): 1323-1325.

18. Reothemia, A., Khan, A. and Suri, S. (2013) Morpho-metric traits of Bakerwali goats under migratory production system. *Indian Vet. J.*, 90(12): 22-25.

19. Kharkar, K., Kuralkar, S.V. and Kuralkar, P. (2014) Growth, production and reproduction performance of Berari goats in their native tract. *Indian J. Small Rumin.*, 20(1): 12-15.

20. Nahardeka, N., Das, D., Roy, T.C., Goswami, R.N., Das, G.C., Gopal, P.K. and Das, B. (2001) Studies on body weights of Assam local goats and their crosses with Beetal. *Indian Vet. J.*, 78(9): 811-814.

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