*Indian Journal of Animal Sciences* **89**(9): 970–973, September 2019/Article
https://doi.org/10.56093/ijans.v89i9.93838

# Genetic and phenotypic parameters for growth traits of Sonadi sheep

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Received: 18 February 2019; Accepted: 25 February 2019

ABSTRACT

The aim of present study was to estimate the genetic and phenotypic parameters for growth traits of Sonadi sheep. Records of lambs were collected over a period of four years from Sonadi unit maintained at CVAS Navania (Rajasthan) under Mega Sheep Seed Project. Traits included for the study were birth weight (BWT), weight at three months (3MWT), weight at six months (6MWT), weight at nine months (9MWT) and weight at twelve months of age (12MWT). Low estimates of heritability were observed for weight at birth, three and twelve months of age. Lamb weight at six and nine months of age was moderately heritable and shows that these traits are less influenced by environmental effects; which make them effectively transmitted to the progeny. However, estimates of genetic parameter with high sampling error do not agree with empirical results. The direct maternal genetic correlation ($r_{am}$) was negative for all body weight except for twelve months body weight. A negative estimate of $\sigma_{am}$ resulted in increase in direct and maternal heritability pointing towards cross substitution effect in the partitioning of total variation. The high positive genotypic and phenotypic correlations between body weight at six months, nine months and twelve months of age indicates that selection for six months of traits will result in increase in nine and twelve months of body weight.

**Key words**: Correlation, Genetic, Heritability, Phenotypic, Sonadi sheep

Rajasthan with 9.08 million of sheep population (Livestock Census 2012) is the 3rd largest sheep rearing state (13.95% of total sheep of India) of the country. However, the inter census period (2007–12) showed 18.86% decline in sheep population of Rajasthan. The southern and eastern districts of Rajasthan are home tract of Malpura and Sonadi breeds known for triple purpose, i.e. milk, meat and wool production. Small and marginal farmers belonging to pastoralist community rear the Sonadi sheep for their livelihood in the region. According to breed survey 2013, the total population of Sonadi was estimated as 0.15 million including 14,237 breedable ram (Singh and Sharma 2017). Sonadi rams are not available in optimum number in the breeding tract due to crossbreeding with Marwari sheep. Keeping in view of the above economic consequences of Sonadi sheep, the present investigation was planned to estimate the genetic and phenotypic parameters for growth traits of Sonadi sheep.

## MATERIALS AND METHODS

The data on growth production records on Sonadi sheep maintained at Mega Sheep Seed Project coordinating Sonadi sheep unit, CVAS Navania, pertaining to period 2014–17, were utilized for the present study. Record of 519 animals (258 females and 261 males) spread over a period of 4 years (2014 to 2017) comprised the material for this study. The lambing pattern revealed that the lambing occurred throughout the year. However most of the lambing was observed between September and February with maximum in December. On the basis of prevailing lambing pattern, lambing season was categorized into two seasons as major (November to February) and minor (July to October) lambing season. Data were categorized into four categories for years. The data related to gender of lamb was classified according to male and female. The Data were analyzed using one data set namely body weight. The influence of various non-genetic factors, i.e. period, sex and season of lambing on different growth performance traits and to overcome the problem of non-orthogonality of effects due to unequal and disproportionate sub-class frequencies, least square technique (SPSS 14.0) was employed. Variance and (co)variance components for additive direct and maternal direct effect were estimated by restricted maximum likelihood procedures (REML) using derivative free algorithm fitting an animal model for growth traits. The analysis was worked out by the WOMBAT approach (Meyer 2007). Univariate animal models were fitted to estimate (co)variance components for all the traits. The direct maternal correlation ($r_{am}$) was computed as the ratio of the estimates of direct maternal covariance ($\sigma_{am}$) to the product of the square roots of estimates of $\sigma^2_a$ and $\sigma^2_m$. The total

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heritability ($h^2_t$), was also be calculated for all traits (Willham 1972).

## RESULTS AND DISCUSSION

*Environmental effect:* Season of lambing showed non-significant effect on weaning and post weaning weight except birth (P<0.001) and six months (P<0.05) body weight (Table 1). Generally, lamb born during minor lambing season (July-October) showed higher body weight (4–6%) than lamb born in major season (November-February). Period of lambing showed a conspicuous variation among body weight of Sonadi sheep born in various period. Three months weight (3MWT), six months weight (6MWT) and nine months weight (9MWT) showed a constant increasing trend over the period. The sex of lamb had highly significant (P<0.001) effect on body weight at all stages. Male lambs were heavier (4-24%) than female at all development stages. It was observed that difference between weight of male and female lambs were increased with increase in age.

The estimates of body weight at various ages in accordance with the findings of Jain *et al.* (1998). The findings of present study about effect of non-genetic factors of body weight were in partial or full agreement with the findings of many other workers. Most of the environment factors had significant effect on body weight at various age in the present study. Body weight among lambs born in different periods and seasons suggest that growth of lambs may be attributed to differences in environmental conditions such as availability of grazing and feeding stuffs in different years and seasons. Higher birth weight may be due to the availability of favourable environment to the developing fetus when good quality grasses are available during July to October. The difference in body weight between male and female with the advancement of age might be due to the increasing difference in endocrine system. These sex differences are consistent with the results from other investigations (Karmaker *et al.* 2018).

*Genetic effect:* On the basis of log L values, maternal genetic and permanent effect model with correlated direct and maternal genetic ($\sigma am \neq 0$) component can be considered as the best fit model for explaining the variance and covariance components of all body weight traits. The direct heritability was recorded as low estimate for BW, 3MWT and 12MWT and moderate estimate for 6MWT and 9MWT. As clearly demonstrated by estimates of maternal heritability ($m^2$), birth weight was primarily determined by maternal effect. However, 12 months body weight also showed 3% influence by maternal genotype. While maternal genetic effect did not showed any influence on 3MWT, 6WT and 9WT. Permanent maternal effect was estimated and found to be non-estimable on all growth traits except birth weight due to low number of progenies. Direct maternal covariance was found as negative estimates amounting 18, 28 and 24% of total variance for 3MWT, 6MWT and 9MWT. The repeatability of ewe performance ($t_m$) was observed in magnitude as low for all growth traits. The total heritability ($h_t^2$) was estimated as low estimate for 6MWT and high estimate for 12 MWT.

Birth weight (BWT) and weight at weaning age (3MWT) showed positive and high estimates of genetic correlation and moderate estimates of phenotypic correlation (Table 3). While low and non-significant genetic and phenotypic correlations were estimated between birth weight and post weaning weight at later age. The genetic and phenotypic correlations of birth weight were positive and showed significant association with weaning weight of sheep. Whereas post weaning weight did not show any significant association with birth weight. The high positive genetic and phenotypic correlations between body weight at six months, nine months and twelve months of age indicates that selection for six months of traits will result in increase in nine and twelve months of body weight.

Similar to the present findings, moderate estimate of direct heritability for six months body weight was reported by Prince *et al.* (2010) in Avikalin sheep. Lower estimate of heritability at birth and three months of age indicated

Table 1. Season, period and sex wise least squares means and standard errors of growth traits of Sonadi sheep

| Effect | BWT | 3MWT | 6 MWT | 9MWT | 12MWT |
|---|---|---|---|---|---|
| N | 519 | 373 | 257 | 179 | 145 |
| μ | 3.07±0.02 | 11.32±0.19 | 16.42±0.25 | 19.46±0.34 | 23.23±0.40 |
| *Season* | *** | NS | * | NS | NS |
| Major Season (Nov.–Feb.) | 3.01±0.03 (306) | 11.23±0.30 (207) | 15.94±0.56 (123) | 19.12±0.53 (94) | 22.73±0.56 (82) |
| Minor Season (July–Oct.) | 3.13±0.04 (213) | 11.41±0.33 (166) | 16.89±0.40 (134) | 19.80±0.57 (85) | 23.73±0.64 (63) |
| *Period* | NS | *** | *** | *** | NS |
| 2014–15 | 3.01±0.03 (187) | 6.73±0.25 (106) | 12.82±0.36 (90) | 17.78±0.43 (84) | 23.23±0.49 (73) |
| 2015–16 | 3.11±0.03 (162) | 12.37±0.22 (138) | 17.30±0.35 (94) | 19.46±0.45 (73) | 22.57±0.49 (69) |
| 2016–17 | 3.10±0.03 (155) | 11.74±0.23 (123) | 16.42±0.43 (73) | 23.10±0.87 (22) | 24.59±2.39 (3) |
| 2017–18 | 3.06±0.11 (15) | 14.43±1.06 (6) | – | – | – |
| *Sex* | *** | *** | *** | *** | *** |
| Male | 3.13±0.03 (261) | 11.72±0.31 (187) | 17.24±0.48 (122) | 21.07±0.54 (83) | 25.72±0.64 (65) |
| Female | 3.01±0.03 (258) | 10.91±0.32 (186) | 15.59±0.48 (135) | 17.85±0.54 (96) | 20.74±0.56 (80) |
| CV | 14.70 | 33.99 | 26.39 | 24.22 | 21.25 |

**Highly significant (P≤0.01); *Significant (P≤0.05); NS, Non-significant.

Table 2. Estimates of variance components and heritability ($h^2$±SE) for body weight

| Item | BW | 3MWT | 6MWT | 9MWT | 12MWT |
|---|---|---|---|---|---|
| Total no of records | 519 | 373 | 257 | 179 | 145 |
| Sire with progeny record | 34 | 32 | 30 | 25 | 24 |
| Dams with progeny record | 309 | 248 | 194 | 146 | 122 |
| Average no of progeny per dam | 1.02 | 1.04 | 1.10 | 1.15 | 1.19 |
| Additive variance ($\sigma^2_a$) | 0.023 | 1.428 | 4.422 | 7.241 | 4.037 |
| Maternal variance ($\sigma^2_{m)}$ | 0.028 | 0.960 | 2.481 | 9.625 | 0.578 |
| $\sigma_{am}$ | 0.025 | –1.171 | –3.311 | –8.348 | 1.527 |
| $\sigma^2_c$ | 0.001 | 0.001 | 0.001 | 0.005 | 0.001 |
| $\sigma^2_e$ | 0.120 | 5.127 | 8.274 | 7.051 | 11.166 |
| $\sigma^2_p$ | 0.148 | 6.347 | 11.867 | 15.575 | 17.309 |
| $h^2$ | 0.16±0.12 | 0.23±0.19 | 0.37±0.24 | 0.47±0.29 | 0.23±0.27 |
| $m^2$ | 0.19±0.43 | 0.15±0.46 | NE | 0.62±NE | 0.03±NE |
| $r_{am}$ | –0.98 | –0.99 | NE | –1.00 | 1.00±NE |
| $c^2$ | 0.007±0.28 | NE | NE | NE | NE |
| $h^2_T$ | NE | NE | 0.10 | NE | 0.38 |
| tm | –0.25 | 0.02 | 0.09 | 0.19 | 0.16 |
| Log L | 213.18 | –540.50 | -450.51 | –337.24 | –282.43 |

Table 3. Genetic (above diagonal) and Phenotypic (below diagonal) correlation among body weight

| Parameter | BW | 3MW | 6 MWT | 9MWT | 12MWT |
|---|---|---|---|---|---|
| BW | – | 0.97± 0.01*** | 0.15± 0.07 | 0.11± 0.39 | –0.01± 0.47 |
| 3MW | 0.31± 0.04*** | – | –0.98± 0.24** | 0.09± 0.80 | –0.26± NE |
| 6 MWT | 0.11± 0.06 | 0.45± 0.04*** | – | 0.99± 0.02*** | 0.98± NE |
| 9 MWT | –0.05± 0.08 | 0.51± 0.06 | 0.55± 0.06** | – | 0.99± 0.35* |
| 12 MWT | 0.00± 0.09 | 0.50± 0.06*** | 0.48±* 0.11 | 0.76± 0.03*** | – |

that the major part of the variation in body weight was governed by environmental factors. Therefore, efficient management of lambs is a key to enhance the body weight at weaning months of age. Estimates of sampling errors are higher due to low number of progenies. A negative estimate of $\sigma_{am}$ resulted in negative genetic correlation $r_{am}$ between direct and maternal genetic effect inflated in direct and maternal heritability pointing towards cross substitution effect in the partitioning of total variation when estimating highly correlated parameters. Non-significant large negative genetic correlation between direct and maternal genetic effects on growth traits may be due to the presence of antagonistic environmental effects in progeny and dam. Similar to the present study, Meyer (1992) also observed large negative estimates of $\sigma_{am}$ for weaning weight for Hereford and Zebu cross cattle and genetic correlation between direct and maternal genetic effects ($r_{am}$) was estimated in magnitude as large to moderate for weaning weight (–0.59 and –0.78) negative and somewhat smaller for yearling weight (–0.48 and –0.39).

High sampling error of variance and covariance component was observed for all traits. It may be due to small number of animals and low number of progeny per family. Average number of progeny per dam was very low. Similar to the present findings, Mayer (1992) observed that sampling error of variance components was influenced by number of families, number of dam per sire and number of progeny per dam.

The results obtained in this study have demonstrated the importance of non-genetic factors as source of variation in body weight. Most of the non-genetic factors influenced the body weight of sheep therefore measures to be taken for standardizing the management of flock for sustainable growth. Lamb weight at six and nine months of age was moderately heritable. However, estimates of genetic parameter with high sampling error do not agree with empirical results. During genetic evaluation, family size and number of progeny should be considered for low sampling error in dataset. A high estimate of genetic and phenotypic correlation between weights at post weaning age indicates that selection on the basis of six months of age would result in increase in body weight at later age.

## ACKNOWLEDGEMENTS

Authors acknowledge the financial and technical support provided by the Director and Project Coordinator, Mega Sheep Seed Project, CSWRI for execution of the project. Timely suggestions and help extended by the Dean PGIVER and CVAS Navania for research are gratefully acknowledged.

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