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Genetic evaluation of growth and reproduction traits of Deccani sheep under organized farm

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Abstract
The data corrected for significant non-genetic factors from 397 Deccani female lambs, born between 2011 and 2019, were utilized for estimating heritability, genetic, and phenotypic correlations of growth and reproductive traits. These lambs were maintained at the Network Project on Sheep Improvement, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India. The heritability estimates for various traits were as follows: birth weight (W0) 0.17±0.05, three-month body weight (W3) 0.23±0.03, six-month body weight (W6) 0.28±0.06, nine-month body weight (W9) 0.22±0.03, twelve-month body weight (W12) 0.21±0.01, age at first lambing (AFL) 0.15±0.01, service period (SP) 0.16±0.01, and lambing interval (LI) 0.16±0.02. The heritability observed for various growth traits and reproductive traits is low to medium. The moderate heritability estimates for growth traits, except for birth weight, indicate the presence of genetic variability within the flock, suggesting that these traits can be effectively improved through selection. The low heritability estimates for reproductive traits may be attributed to the significant influence of environmental effects and the limited variability between breeding rams. The positive and significant association amongst growth traits and negative and significant association amongst growth and reproduction traits indicate that the early stage body weights especially body weight at weaning stage can be considered for selection of animals to enhance the growth and reproduction traits.

Keywords: Body weights, reproductive traits, heritability, genetic and phenotypic correlation

Introduction
Sheep production is a crucial source of sustainable livelihood for rural communities in the arid and semi-arid regions of India, meeting various needs and providing a consistent source of income throughout the year. Historically, sheep have been reared for both mutton and wool production. However, recent trends have shifted towards enhanced mutton production, productivity, and profitability. The Deccani sheep is a prominent mutton breed in India, predominantly found in the eastern part of Maharashtra and the neighboring regions of Andhra Pradesh and Karnataka. In Maharashtra, this breed is widely distributed across several districts, including Nasik, Pune, Ahmednagar, Kolhapur, Solapur and Aurangabad.

The overall efficiency of a sheep breed is assessed not only based on meat and fiber production but also on growth and reproductive performance. Lamb growth is a key indicator of economic viability. Body weight provides insight into the future performance of lambs, aiding sheep growers in ration computation, medication dosing, determining the appropriate age for breeding, assessing marketable slaughter weight, and evaluating animals at specific ages. Reproductive performance significantly influences the profitability of sheep enterprises. Genetic improvement in both growth rate and reproductive traits is crucial for increasing lamb meat production (Dickerson, 1978) [3]. The potential for genetic improvement of a trait is largely determined by its heritability and genetic correlation with other traits. Therefore, information on genetic and phenotypic parameters of the flock is essential. This study was undertaken to estimate the heritability, genetic, and phenotypic correlations among growth and reproductive traits of Deccani sheep.

Materials and Methods

The data analyzed in the present study pertained to 397 female lambs born between 2011 and 2019 at the Network Project on Sheep Improvement, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India. The measured traits included birth weight (W0), three-month body weight (W3), six-month body weight (W6), nine-month body weight (W9), twelve-month body weight (W12), age at first lambing (AFL), service period (SP), and lambing interval (LI).

The data were corrected for significant effects of the period and season of birth by fitting least squares constants. Rams with fewer than five progenies were excluded from the analysis. Estimates of heritability, as well as genetic and phenotypic correlations, were computed from sire components of variance and covariance using the LSMLMW and MIXMDL computer programs (PC-2) as described by Harvey (1990) [5].

Results and Discussion

The heritability estimates for birth weight (W1), body weight at three months (W3), six months (W6), nine months (W9), and twelve months (W12) were 0.17±0.05, 0.23±0.03, 0.28±0.06, 0.22±0.03, and 0.21±0.01, respectively. These values suggest a moderate level of heritability for most growth traits, as summarized in Table 1. These findings indicate significant genetic variability within the flock, implying that selective breeding could effectively improve these traits. Kesbi *et al.* (2008) [7] similarly reported comparable heritability estimates for body weights at different stages of growth in Mehraban sheep.

The heritability estimates for age at first lambing (AFL), service period (SP), and lambing interval (LI) were determined to be 0.15±0.01, 0.16±0.01, and 0.16±0.02, respectively. These relatively low estimates suggest that environmental factors may have a greater proportional influence on these reproductive traits compared to genetic factors. Additionally, the variability observed between breeding rams appears to be limited. Similar heritability estimates for age at first lambing (AFL), service period (SP), and lambing interval (LI) were previously reported in Munjal sheep by Umeel *et al.* (2018) [13], in Magra sheep by Chander (2012) [2], and in Rambouillet sheep by Khan *et al.* (2017) [10], respectively.

The genetic correlations among all measured body weights were consistently high, positive, and statistically significant, ranging from 0.44±0.27 to 0.96±0.26. This indicates strong genetic relationships between body weights at different ages. Similar ranges of genetic correlations were previously reported in Malpura sheep by Gowane *et al.* (2010) [4], in Marwari sheep by Singh *et al.* (2016) [12] and Kannojia *et al.* (2016) [6], and in Deccani sheep by Bangar *et al.* (2017) [1]. The high genetic correlations observed between body weight at three months and subsequent ages suggest that selecting individuals based on their weight at three months could effectively enhance genetic progress in future generations.

The genotypic correlations between age at first lambing with service period and lambing interval, and between service period and lambing interval, were highly positive and significant, with values of 0.95±0.05**, 0.99±0.04**, and 0.95±0.07**, respectively. These findings indicate strong genetic relationships between these reproductive traits. Similar positive genetic correlations between age at first lambing and lambing interval were previously reported in Multibreed meat sheep by Lobo *et al.* (2009) [9] and in Harnali sheep by Lali *et al.* (2016). However, Khan *et al.* (2017) [10] observed a negative genetic correlation between age at first lambing and lambing interval in Rambouillet sheep.

The birth weight had positive and significant genetic correlation with age at first lambing 0.75±0.39** and noticed negative correlation with service period (-0.77±0.51**) and lambing interval (-0.87±0.44**). Weaning weight had found to be negatively correlated with the reproductive traits like age at first lambing, service period, and lambing interval as -0.77±0.18**, -0.91±0.46** and -0.78±0.4**, respectively. There is negative correlation of six month weight with the reproductive traits age at first lambing, service period and lambing interval as -0.03±0.15, -0.32±0.14** and -0.04±0.94, respectively. Nine month weight reported positive correlation with the reproductive traits age at first lambing, service period and lambing interval as 0.3±0.03**, 0.04±0.02, and 0.34±0.18**, respectively. Twelve months weight has positive correlation with the reproductive traits age at first lambing, service period and lambing interval as 0.4±0.05**, 0.18±0.33**, and 0.38±0.15**.

Among the growth traits, the phenotypic correlations between three months body weight and the weights at six, nine, and twelve months were highly positive and statistically significant. This positive correlation suggests that animals with higher body weights at three months are likely to exhibit greater weights at subsequent ages. Similarly, six months body weight showed a highly positive and significant phenotypic correlation with weights at nine and twelve months. Additionally, a highly positive and significant phenotypic correlation was observed between nine months body weight and twelve months body weight. These findings are consistent with previous studies in Nali and Marwari sheep by Sharma *et al.* (2003) [11] and in Marwari and Deccani sheep by Kannojia *et al.* (2016) [6] and Bangar *et al.* (2017) [1], respectively. The strong and positive phenotypic correlations of weaning weight with weights at later stages suggest that early-stage selection could effectively improve these traits. Regarding reproductive traits, the phenotypic correlation between age at first lambing and lambing interval was low but positive. Similar findings of a low and positive phenotypic correlation between age at first lambing and lambing interval were also reported in Harnali sheep by Lalit *et al.* (2016) [8]. Furthermore, the phenotypic correlation between lambing interval and service period was highly positive and significant.

Among the growth and reproduction traits, the phenotypic correlation between body weights at three, six, nine and twelve months with age at first lambing found to be significant and negative, which indicate that heavier female lambs at weaning or later stages of age results in earlier lambing.

Table 1: Genetic and phenotypic correlations (genetic-above diagonal and phenotypic-below diagonal) among growth and reproductive traits.

Traits	W0	W3	W6	W9	W12	AFL	SP	LI
W0	0.17±0.05	0.80±0.23**	0.49±0.21**	0.70±0.25**	0.61±.18**	0.75±0.39**	-0.77±0.51**	-0.87±0.44**
W3	0.15±0.03**	0.23±0.03	0.84±0.22**	0.96±0.26**	0.70±0.28**	-0.77±0.18**	-0.91±0.46**	-0.78±0.40**
W6	0.06±0.04	0.59±0.03**	0.28±0.06	0.73±0.15**	0.44±0.27**	-0.03±0.15	-0.32±0.14**	-0.04±0.94
W9	0.07±0.03	0.42±0.03**	0.67±0.02**	0.22±0.03	0.75±0.39**	0.30±0.03**	0.04±0.02	0.34±0.18**
W12	0.03±0.03	0.37±0.04**	0.59±0.03**	0.62±0.03**	0.21±0.01	0.40±0.05**	0.18±0.33**	0.38±0.15**
AFL	0.06±0.04	-0.10±0.04*	-0.17±0.05**	-0.34±0.04**	-0.61±0.03**	0.15±0.01	0.95±0.05**	0.99±0.04**
SP	0.03±0.04	0.09±0.04*	0.02±0.05	0.03±0.05	0.05±0.05	0.08±0.04	0.16±0.01	0.95±0.07**
LI	0.04±0.04	0.08±0.04	0.02±0.05	0.03±0.05	0.05±0.05	0.07±0.05	0.99±0.01**	0.16±0.02

**=p<0.01 and * = p<0.05

Conclusions

The moderate heritability estimates observed for body weights, excluding birth weight, indicate substantial genetic variability within the flock, suggesting potential improvements through selective breeding. In contrast, the low heritability estimates for age at first lambing, service period, and lambing interval likely stem from greater environmental influences and reduced variability among breeding rams. The positive and significant correlations among growth traits, along with the negative and significant associations between growth and reproduction traits, underscore the potential value of selecting animals based on early-stage body weights, particularly at the weaning stage, to enhance both growth and reproductive traits.

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Conflict of Interest

Not available

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