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Genetic and phenotypic parameter estimates of live weight and daily gain traits in Malpura sheep using Bayesian approach

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ABSTRACT

Estimates of (co)variance components and genetic parameters were calculated for birth weight (BWT), weaning weight (WWT), 6-month weight (6WT), 9-month weight (9WT), 12-month weight (12WT), average daily gain (ADG) from birth to weaning (ADG1), weaning to 6 months (ADG2) and 6–12 months (ADG3) for Malpura sheep. Data were collected over a period of 25 years (1985–2010) with records for economic traits on total of 4549 lambs descended from 234 sires and 1541 dams of Malpura sheep maintained at Central Sheep & Wool Research Institute, Avikanagar, Rajasthan, India. Analyses were carried out by Bayesian approach using Gibbs sampler Animal model. Total heritability estimates for BWT, WWT, 6WT, 9WT, 12WT, ADG1, ADG2 and ADG3 were 0.21, 0.15, 0.17, 0.11, 0.28, 0.15, 0.22 and 0.19, respectively. Maternal genetic effects contributed significantly for total variance in the traits except 12WT and ADG3. Maternal permanent environmental effects contributed 9% of the total phenotypic variation for BWT and thereafter declined significantly for all the traits. A moderate rate of genetic progress seems possible in the flock for live weight traits by mass selection. Direct genetic correlations between body weight traits were positive and high and ranged from 0.37 for WWT and 12WT to 0.96 between 9WT and 12WT. Genetic correlations between different daily gain traits were negative due to kin and contemporary competition effect. Results suggest that genetic progress in the growth traits can be achieved if the selection is carried out for higher 6-month weight.

1. Introduction

Sheep production has been the important source for sustainable livelihood of the rural folk in arid and semi arid region of India as it serves their various needs and provides an unceasing source of income round the year. Sheep has been reared for the mutton and wool production since ages, however, recently the trend has shifted more towards the enhanced mutton production, productivity and profitability. Malpura sheep is one amongst the heaviest sheep breed of India, widely distributed in the semi-arid region of Rajasthan, mostly Tonk, Jaipur and Sawai Madhopur districts.

As per the 17th livestock census (2007), Government of India, the total population of Malpura sheep is 375,336 (0.375 million). The sheep is known for its adaptability to the harsh environment and potential for high meat production (Gowane et al., 2010a). Malpura sheep is reared by

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small and marginal landholders who graze them on fallow land, crop residue and also take them on migration during period of scarcity. However, recently the phenomenon of migration has been restricted to a few pockets due to optimum rainfall in the region. Malpura sheep are mainly reared for mutton purpose, as the earnings from their coarse wool are of little market value. The Central Sheep & Wool Research Institute (CSWRI), Avikanagar is involved in genetic improvement and conservation of Malpura sheep since many years.

The growth potential of the lambs is very important in the sheep production. It is essential to have knowledge of genetic parameters for these economically important traits to formulate optimum breeding strategies for better production. Growth traits are influenced both by direct additive genetic effects and by maternal effects (Albuquerque and Meyer, 2001). In tropical breeds, maternal effects are often omitted during genetic evaluation due to data limitation (Wasike et al., 2009). When these effects are important, but omitted, the genetic parameters are biased upwards (Dodenhoff et al., 1999; Maniatis and Pollott, 2002) and selection efficiency is reduced. Thus for achieving optimum progress especially in growth traits, both direct and maternal components must be considered. Recently many studies have attributed most of the variation in lamb weights to maternal effects (Safari et al., 2005; Prakash et al., 2012). The genetic parameter estimates for this breed were obtained earlier by REML approach (Gowane et al., 2010b). However, the Bayesian approach has several practical advantages over the classical (REML) approach (Pretorius and van der Merwe, 2000) like, the estimates from the Bayesian approach for a variance are always positive and an interval estimate such as a highest posterior density region will not include negative values. Therefore, in the current study, major objective was to obtain the estimates using Gibbs sampler animal model. Bayesian approach is being used to validate the earlier results and to obtain accurate estimates for adopting better selection strategy.

2. Material and methods

2.1. Data

Data available for the analysis were collected from the breeding flock of Malpura sheep maintained at the Central Sheep & Wool Research Institute (CSWRI), Avikanagar. The eight different economic traits used for the analysis were birth weight (BWT), weaning weight (WWT), 6-month weight (6WT), 9-month weight (9WT), 12-month weight (12WT), average daily gain for pre-weaning period i.e. birth to 3 months (ADG1) and for post weaning period 3–6 months (ADG2) and from 6 to 12 months (ADG3). The sheep flock was maintained at the Central Sheep & Wool Research Institute (CSWRI), Avikanagar, located in the semi-arid region of Rajasthan, India at 75°28′E Longitude and 26°17′N Latitude at an altitude of 320 m above mean sea level. A flock of around 500 Malpura sheep was maintained under a semi-intensive management system, which was similar to the management of flocks by farmers. Average litter size of Malpura sheep at birth was 1.04. The sex ratio in the lambs (♂:♀) was 1:0.96. Characteristic of the data structure, least squares means, standard deviations, coefficient of variation for respective traits and effects of several non-genetic factors on each trait are summarized in Table 1. Data were collected over the years 1985–2010, which were further divided in to five periods [(1): 1985–1990, (2): 1991–1995, (3): 1996–2000, (4): 2001–2005, (5): 2005–2010] with records on total of 4549 lambs descended from 234 sires and 1541 dams. The flock was a closed type where 250 breeding females were maintained during each year. Nearly 1:30 sire to ewe ratio was maintained. Active selection was practiced for males. One sire was typically used for 2 years. For ewes, selection was relaxed. Ewes usually remained in the flock for 7 years and culling was only on the basis of health and low production. Ewes are bred for the first time at average 554 days (nearly 1.5 years) and lambed for first time at 722 days (nearly 2 years) of age due to controlled breeding practices. Lambing

Table 1
Characteristics of the data structure summary of statistics and significance of the source of variation for growth traits of Malpura sheep.

Trait[a]	BWT	WWT	6WT	9WT	12WT	ADG1	ADG2	ADG3
Data structure								
No. of records	4549	3848	3599	3071	2650	3848	3583	2593
Summary statistics								
Mean	3.05	14.53	21.24	24.36	27.77	127.20	87.91	36.64
Standard deviation	0.54	3.20	4.45	5.06	5.46	33.23	50.33	23.40
CV(%)	18.01	23.13	21.11	20.85	19.65	27.57	57.26	63.86
Effects[b]								
Sex	**	**	**	**	**	**	**	**
Period of birth	**	**	**	**	**	**	**	**
Season of birth	**	**	**	NS	**	**	**	*
Age of dam at lambing	**	**	*	*	NS	**	**	NS
Ewe weight (covariate)	**	**	**	**	**	**	NS	NS
R^2 (%)	24.6	10.9	22.5	24.8	33.6	22.8	12.4	5.8

[a] BWT, birth weight; WWT, weaning weight (90 days); 6WT, weight at six month; 9WT, weight at 9 months; 12WT, weight at 12 months; ADG1, average daily gain from birth to weaning; ADG2, average daily gain from 3 to 6 months; ADG3, average daily gain from 6 to 12 months.
[b] Indicates the significance of the source of variation.
* ($P < 0.05$).
** ($P < 0.01$)
NS, non-significant ($P > 0.05$).