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Estimates of (co)variance components and genetic parameters for body weights and first greasy fleece weight in Malpura sheep

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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) and greasy fleece weight at first clip (GFW) for Malpura sheep. Data were collected over a period of 23 years (1985–2007) for economic traits of Malpura sheep maintained at the Central Sheep & Wool Research Institute, Avikanagar, Rajasthan, India. Analyses were carried out by restricted maximum likelihood procedures (REML), fitting six animal models with various combinations of direct and maternal effects. Direct heritability estimates for BWT, WWT, 6WT, 9WT, 12WT and GFW from the best model (maternal permanent environmental effect in addition to direct additive effect) were 0.19 ± 0.04, 0.18 ± 0.04, 0.27, 0.15 ± 0.04, 0.11 ± 0.04 and 0.30 ± 0.00, respectively. Maternal effects declined as the age of the animal increased. Maternal permanent environmental effects contributed 20% of the total phenotypic variation for BWT, 5% for WWT and 4% for GFW. A moderate rate of genetic progress seems possible in Malpura sheep flock for body weight traits and fleece weight by mass selection. Direct genetic correlations between body weight traits were positive and ranged from 0.40 between BWT and 6WT to 0.96 between 9WT and 12WT. Genetic correlations of GFW with body weights were 0.06, 0.49, 0.41, 0.19 and 0.15 from birth to 12WT. The moderately positive genetic correlation between 6WT and GFW suggests that genetic gain in the first greasy fleece weight will occur if selection is carried out for higher 6WT.

1. Introduction

Sheep production is the major occupation of rural people especially in the semi-arid region of India. Malpura sheep are one of the heaviest sheep breed in India, known for their adaptability to the harsh environment and potential for high meat production (Mishra, 2008). They are mainly reared for mutton production, as the earnings from the wool are of little market value mainly due to unavailability of good market followed by coarse texture of wool. Malpura sheep are widely distributed in the semi-arid region of Rajasthan, mostly in the Tonk, Jaipur and Sawai Madhopur districts. Malpura sheep are reared by small and marginal land holders who graze them on fallow land, crop residue and also take them on migration during periods when grazing resources are scarce.

Growth potential of lambs and fleece weight per clip are important traits in the Malpura sheep production. It is essential to have knowledge of genetic parameters for these economically important traits to formulate optimum breeding strategies for improved production. Traits recorded in early life are likely to be affected by maternal ability (Robison, 1981). Nasholm and Danell (1994) observed that when maternal genetic effects are important and not considered in the statistical model, heritability estimates are biased upward and the realized efficiency of selection is reduced when compared with the expected. 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 weight to maternal effects (Safari et al., 2005; Mandal et al., 2006a, 2006b;

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Bahreini Behzadi et al., 2007; Kushwaha et al., 2009). To understand the relationship between direct and maternal effects for economically important traits of the lamb is also essential for the formulation of optimum breeding plans and improving selection efficiency. Availability of the restricted maximum likelihood (REML) algorithms for fitting animal models has simplified the estimation of (co)variance components accounting for maternal effects. In sheep breeding programs, usually two or more traits are desired for optimum production. Estimates of genetic and phenotypic correlations among economically important traits are therefore necessary to understand the relationships among the traits and also to devise breeding strategies which include best combinations of the desired characters.

Many of the published genetic parameter estimates on Indian sheep breeds were derived from sire models that did not take into account the partitioning of the genetic variance into its direct and maternal components. Direct and maternal effects on body weights and fleece weight have been reported in Muzaffarnagri sheep Mandal et al. (2006a, 2006b) and Chokla sheep (Kushwaha et al., 2009), but are not available for other Indian sheep breeds. In the present study, estimates of the variance and (co)variance components owing to direct and maternal effects in Malpura sheep for various economic traits were obtained. Estimates of genetic, phenotypic and environmental correlations between body weight traits and fleece weight were also obtained to explore the possibility of better selection strategies for Malpura sheep.

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 six 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) and first greasy fleece weight (GFW). 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. The data structure, numbers of sires and dams, least squares means, standard deviation and coefficient of variation for each trait are summarized in Table 1. Data were collected over the years 1985 to 2007, which were divided into 5 periods: (1) 1985–1991, (2) 1992–1995, (3) 1996–1999, (4) 2000–2003 and (5) 2004–2007. Records were available from a total of 3145 lambs descended from 172 sires and 1044 dams. The flock was a closed type where 250 breeding females were maintained during each year. 10 to 15 sires were used for breeding every year. Males were selected for breeding on the basis of an index involving 6WT and GFW. Males were tested and selected on the basis of progeny performance. A sire was typically used for 2 years. Ewes were unselected. Ewes usually remained in the flock for 7 years and culling was done only on the basis of health and low production. Ewes lambed for first time at 2 to 2 1/2 years of age due to controlled breeding practices. Lambing was restricted to the spring (February–April) and autumn (September–October) seasons, where 30 and 70% of lambing took place, respectively. At lambing, both lambs and dams were weighed and the lambing date, sex and type of birth of each lamb were recorded.

Animals were treated in the same way in both seasons with respect to management and concentrate supplementation. Concentrate mixture was offered *ad-libidum* to suckling lambs from 15 days age until weaning (90 days). From three weeks of age until weaning, lambs were grazed separately from their dams for 3 h each morning and evening. In addition to 8–10 h grazing and dry fodder supplementation, 300 g of concentrate mixture was provided during the post-weaning period. The grazing area consisted of forestland with natural fodder trees like Khejri (*Prosopis cineraria*), Ardu (*Ailanthus* spp.), and Neem (*Azadirecta indica*). Bushes and surface vegetation, including the improved pastures of *Cenchrus ciliaris* were also available. Due to scarce grazing resources from March to June, the sheep were supplemented with hay of *Cenchrus*, Cowpea and Dolichos. Additionally pala leaves (*Zizyphus*) and fodder tree loppings were provided. This resulted in seasonal differences in growth patterns of the lambs. Lambs were weighed on exactly the target ages. Birth weight was taken within 24 h of birth, and 3, 6, 9 and 12 month weights were taken on exact dates. Shearing took place in September for lambs born during January to March and in March for lambs born during August to September. Immediately after shearing, greasy fleece weight was recorded.

2.2. Statistical methods

(Co)variance components were estimated by restricted maximum likelihood procedures (REML) using a derivative free algorithm fitting an animal model (DFREML; Meyer,

Table 1
Characteristics of the data structure for body weights and greasy fleece weight of Malpura sheep.

Trait	BWT	WWT	6WT	9WT	12 WT	GFW
No. of records	3145	2695	2508	2161	1810	2555
Sires with progeny records	172	169	164	159	158	166
Dams with progeny records	1044	980	948	860	766	957
Grand sires with progeny	226	214	217	217	210	222
Grand dams with progeny	669	615	611	563	505	638
Mean	3.04 kg	13.90 kg	20.79 kg	23.68 kg	27.05 kg	576.15 g
Standard deviation	0.48 kg	2.93 kg	3.91 kg	4.25 kg	4.20 kg	198.40 g
CV(%)	14.12	18.36	16.63	14.53	12.27	34.24