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Research Article

Heritability Estimates of Post-Weaning Performance Traits in Hissardale Sheep in Pakistan

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Abstract: Data obtained from 5260 birth records of 1179 Hissardale sheep maintained at the Livestock Experiment Station, Jahangirabad, in the district of Khanewal during 1978-1995 were analyzed. The objective was to evaluate the performance and to estimate the heritability of Hissardale sheep in Pakistan. Mean 180-day, 270-day, and yearling weights were 23.5 ± 3.31 kg, 25.7 ± 3.49 kg, and 30.7 ± 3.83 kg, respectively. Mean greasy fleece weight was 3.6 ± 0.57 kg. Post-weaning mean daily weight gain was 45 ± 0.02 g. Mean weight at first service was 38.9 ± 4.9 kg. The number of services per conception averaged 1.23 ± 0.40. The sire model using PROC MIXED in SAS was used to estimate heritability. Heritability estimates for 180-day, 270-day, and yearling weights were 0.09 ± 0.03, 0.17 ± 0.04, and 0.15 ± 0.04, respectively. The heritability estimate of post-weaning average daily gain was low (0.06 ± 0.03). The heritability for greasy fleece weight was also very low (0.02 ± 0.02). Low estimates of heritability indicated the presence of less additive genetic variance and large environmental variance. Hence, improvement in the traits through selection may be limited.

Key Words: Heritability estimates, post-weaning growth, Hissardale sheep, Pakistan

Introduction

An increase in the profitability of lamb production is dependent upon reducing input costs and/or increasing production output. Genetic improvement of traits can be increased with knowledge of their genetic parameters (1). Hissardale is a fine wool breed developed in Hissar, India during the 1930s by crossing Merino with a local carpet wool sheep known as Bikaneri. The animals of this breed are large and have a white body coat. The average adult male weighs 60 kg, while females weigh 50 kg. The average wool yield per head per annum is 4.5 kg, with a fiber diameter of 25.0 µm (2-4). All breed improvement programs are based on effective utilization of genetic variations among the animals. It is, therefore, imperative to estimate heritability for predicting response to selection. The influence of environmental factors on different performance traits in Hissardale sheep from the same data has been reported (2,3). Knowledge of heritability estimates is helpful in determining the method of selection to be adopted, in choosing an efficient system, and in estimating the genetic gains. Analysis of the data for Hissardale sheep was envisaged with the objective to evaluate performance and to estimate heritability of post-weaning growth traits in Hissardale sheep in Pakistan. The information thus generated would be helpful in developing future breeding plans for the conservation and genetic improvement of Hissardale sheep in Pakistan.

Materials and Methods

Pedigree and performance data on the Hissardale flock maintained at the Livestock Experiment Station of Jahangirabad, in the district of Khanewal, Pakistan, collected during 1978-1995 were analyzed. The information collected included individual's identity, and its

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sire, dam, date of birth, date of lambing, sex, type of birth, body weight at different ages (180, 270, and 365 days), weight at breeding, weight at lambing, and greasy fleece weight (autumn and spring combined). The performance traits examined in the present study were 180-day weight, 270-day weight, yearling weight (365-day), post-weaning average daily gain, weight at service, weight at first lambing, and number of services per conception.

Prior to data analysis several edits were performed to remove the outliers. The following edit criteria were used for different performance traits: weight at first service between 23 and 60 kg; number of services per conception > 3; greasy fleece weight between 1.0 and 6.0 kg per annum. The ranges selected were close to the population mean ± 3 SD. Data with any recorded abnormalities were excluded from analysis. The heritability for every economic trait was estimated using paternal half-sib analysis. The variance components for estimates of heritability were obtained from the following model:

$$Y_{ijk} = \mu + S_i + F_j + e_{ijk}$$

where Y_{ijk} is the measurement of a particular trait, μ is the population mean, S_i is random effect of ith sire with a mean of zero and variance σ_S^2, F_j is fixed effects observed to be significant (3), and ε_{ijk} is random error with a mean of zero and variance σ_e^2. Analysis of variance was run for all the performance traits using the sire model and PROC MIXED in SAS (5).

Results

Data on 5260 lambings spread over a period of 15 years were used for the present study. The twining rate in this flock was 19%. The male-female sex ratio was 52.5:47.5. Mean birth and weaning weights in this flock were 4.0 ± 0.51 kg and 19.6 ± 0.11 kg, respectively. Mean post-weaning weight at 180, 270, and 365 days (yearling) was 23.5 ± 3.31 kg, 25.8 ± 3.49 kg, and 30.7 ± 3.83 kg, respectively. Mean post-weaning daily gain was 45 ± 0.02 g. Mean yearly fleece weight in the flock was 3.60 ± 0.57 kg. Mean fleece weights of ewes shorn during autumn and spring were 1.77 ± 0.30 kg and 1.83 ± 0.32 kg, respectively. Mean age and weight at first service of the ewes in this flock were 593.3 ± 265.87 days and 38.9 ± 4.90 kg, while mean age and weight at first lambing were 747 ± 266 days and 39.84 ± 4.9 kg. Mean number of services per conception was 1.23. The lambing rate was observed to be 0.77% (Table 1). Data were also analyzed to estimate the heritability of various traits. The estimates thus obtained are summarized in Table 2. The data on 180- and 270-day weight of 2630 lambs from the progeny of 124 rams were analyzed for the estimation of heritability, which suggested heritability estimates of 0.09 ± 0.04 and 0.17 ± 0.04, respectively.

Table 1. Mean values of some performance traits in Hissardale sheep.

Trait	n	Mean	SD
180-day weight (kg)	2630	23.5	3.31
270-day weight (kg)	2630	25.7	3.49
Yearling weight (kg)	2630	30.7	3.83
Autumn fleece weight (kg)	3285	1.7	0.30
Spring fleece weight (kg)	3285	1.8	0.32
Post-weaning daily gain (g)	2630	45	0.02
Age at first service (days)	946	593.3	266.0
Weight at first service	945	38.9	4.90
Age at first lambing (days)	946	746.9	265.96
Weight at first lambing (kg)	945	39.8	4.94
Greasy fleece weight (kg)	3285	3.6	0.57
Number of services per conception	3298	1.23	0.40
Lambing rate (percent)	945	0.77	0.53

Table 2. Heritability estimates of post-weaning traits in Hissardale sheep.

Trait	Rams (n)	Half-sibs (n)	Estimate ± SE
180-day weight (kg)	124	2630	0.09 ± 0.03
270-day weight (kg)	124	2630	0.17 ± 0.04
Yearling weight (kg)	124	2630	0.15 ± 0.04
Post-weaning daily gain (g)	124	2630	0.06 ± 0.03
Age at first service (days)	78	874	0.44 ± 0.11
Weight at first service (kg)	78	945	0.07 ± 0.07
Age at first lambing (days)	78	874	0.44 ± 0.11
Weight at first lambing (kg)	78	945	0.10 ± 0.07
Greasy fleece weight (kg)	80	3285	0.02 ± 0.02
Number of services per conception	80	3298	0.01 ± 0.01

The analysis of 2630 half-sibs from 124 rams produced a heritability estimate of 0.06 ± 0.03 for post-weaning daily gain.

Discussion

The estimates of heritability obtained in the present study are in agreement with Carrillo and Segura (6), who reported heritability estimates of average daily gain of 0.11 ± 0.03 for PB breed and 0.15 ± 0.08 for BB breed. Qureshi and Ghaffar (7) analyzed data on 16,470 birth records of 141 rams mated with 5311 Kajli ewes and reported a heritability estimate for post-weaning average daily gain of 0.05 ± 0.06. On the other hand, some researchers reported higher estimates of heritability for post-weaning average daily gain in various sheep breeds. Badenhorst et al. (8) reported a heritability estimate of post-weaning average daily gain of 0.22 ± 0.07 in Afrino sheep. Greef et al. (9) used 24 sets of full-sibs to estimate the heritability of post-weaning average daily gain by least squares and regression methods. It was reported that the heritability estimates based on these 2 methods were 0.40 and 0.39, respectively. Jurado et al. (10) found a heritability estimate for post-weaning average daily gain of 0.15 in Merino sheep. The estimate of heritability of yearling weight by paternal half-sib correlation was 0.15 ± 0.04, which was based on 2636 half-sibs from 124 rams. The estimate of heritability for yearling weight obtained in the present study is in agreement with Mani and Rodricks (11), who reported a heritability estimate of 0.16 ± 0.15 in the Merino Nilgiri breed. Nonetheless, the estimates reported in previous studies (8,12) are higher than those of the present study. Yamaki and Sagae (12) used least square procedures and reported heritability as 0.66 ± 0.22 in different breeds.

Data on 945 ewes from 78 rams in the present study were analyzed for the estimation of heritability of weight at first service and were found to be 0.07 ± 0.07. This estimate of heritability of weight at first service was close to the results of a previous study by Qureshi and Ghaffar (7), who reported a heritability estimate of weight at first service of 0.12 ± 0.04. Other researchers reported much higher estimates of heritability for this trait, which were not in line with the findings of the present study (13,14). The half-sib analysis performed in the present study indicated that the heritability of weight at first lambing was 0.10 ± 0.07. This estimate was computed from 845 half-sibs from 78 rams. The analysis of 3285 shearings from the offspring of 80 rams revealed that the heritability of greasy fleece weight was 0.02 ± 0.02. The estimate of heritability of greasy fleece weight obtained in the present study (0.02 ± 0.02) is in line with previous findings (7,15,16). These researchers reported heritability of greasy fleece weight ranging from 0.04 to 0.19 in different breeds of sheep; however, many others reported the heritability of greasy fleece weight much higher than the present estimate. Cloete et al. (17) estimated genetic parameters for increased clean fleece weight involving South African Merinos. Direct additive heritability estimates were 0.29 ± 0.02 for clean fleece weight and 0.68 ± 0.02 for clean yield. Kumar and Tomar (18) analyzed data from Corriedale sheep and the

heritability of fleece weight based on dam-offspring regression was reported to be 0.24 ± 0.12. Hanford et al. (19) reported direct heritability estimates from single-trait analyses of 0.53 for fleece weight for the Columbia breed and 0.54 for fleece weight for the Targhee breed. Krajinovic et al. (20) used half-sib analysis in Tsigai sheep and reported that the heritability of fleece weight was 0.67 ± 0.09. The estimate of heritability for the number of services per conception was 0.02 ± 0.02, which was based on 3298 half-sibs from 80 rams.

The low estimate of heritability for the number of services per conception obtained in the present study is principally in agreement with the estimate of heritability for the number of services per conception in temperate dairy cattle previously reported by Pou et al. (21) and Everett et al. (22), indicating estimates of 0.07 and 0.05, respectively. On the basis of these low estimates of heritability for the number of services per conception it was reported that selection for improvement in breeding efficiency may not be very effective (21). It was further stated that unless a flock is subjected to a scientifically controlled investigation of reproductive performance, breeding records on any sheep flock are by-products (22). These records cannot be considered complete lifetime histories of the reproductive efficiency of the animals with all animals being subjected to uniform breeding conditions and examinations; however, such data would be extremely desirable for an investigation of this nature.

The low estimates of heritability for various performance traits obtained in the present study indicate that, in this flock, much of the variation in traits were due to non-additive genetic effects or environmental factors, and that selection on the basis of an individual's own phenotype may not be very effective. The low estimates also suggest that there was a weak correlation between genotype and phenotype for various traits in this flock, and that if superior individuals had been used their offspring would not have been as good as when the heritability was high, and that the variation due to additive gene action was probably small. In order to make progress in selection, much more attention must be paid to the performance of collateral relatives and progeny. The difference in the findings of the present study and those of other investigations might be due to breed, as well as the environmental conditions under which the various flocks were maintained. These differences might also be due to the method of estimation. Low estimates of heritability require the use of special methods of selection and mating to achieve greater improvement in a flock. Better recording methods and improvement through feeding and management are the likely possibilities.

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