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Estimation of genetic parameters and trends in performance traits of Rambouillet sheep

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ABSTRACT

Genetic parameters and trends are very important to know about the genetic gain and effectiveness of the selection. The present study was conducted on 8,872 records of Rambouillet sheep maintained at Government Sheep Breeding and Research Farm, Reasi, Jammu, Jammu and Kashmir, India over a period of 20 years from 1996 to 2015. The performance traits studied in the present investigation were birth weight (BW), weaning weight (WW), nine-month body weight (9BW), twelve month body weight or yearling weight (YW) and annual wool production (AWP). Heritability, genetic correlations and genetic trends were estimated. Estimates of heritability ranged from medium (0.192 for AWP) to very high (0.720 for 9BW). The highest genetic and phenotypic correlations were obtained between 9BW and YW indicating that early selection on the basis of 9BW will improve the YW simultaneously. AWP had negative genetic correlations with all other traits except for WW. The genetic trends over the years were positive for BW and WW; and negative for 9BW, YW and AWP. The phenotypic trends for all the performance traits in the present study were negative. The effect of genetic trend was non-significant for all the traits. The R^2 value was very low to medium. The phenotypic trends over the years were negative for all the traits except for YW. The genetic and phenotypic trends of the present study indicate that environment plays an important role in controlling different performance traits of Rambouillet sheep.

Keywords: Heritability, India, Performance traits, Rambouillet sheep, Trends

Rambouillet is well known breed due to its excellence in maternal ability. It is one of the largest fine wool breed adaptable to wide variety of arid range conditions. Early growth traits are important factors influencing profitability in any meat producing enterprise. Production traits are the main criterion for selection of animals (Gupta *et al.* 2015). Information about the phenotypic and genetic parameters of various economic traits is essential for selection strategies for higher productivity and efficient management practices (Zaffer *et al.* 2018). Estimates of genetic parameters are necessary to determine the selection method to be used, to estimate the maximum genetic gain that can be achieved and to obtain correct estimates of breeding values (Lobo *et al.* 2009). Studying the genetic variance of important traits and covariance between traits is considered an important step in the planning and implementation of any successful selection or breeding program that aims to improve the genetic gain of animals. Information on heritability is essential for planning efficient breeding programmes, and for prediction of response to selection (Falconer and Mackay 1996).

The genetic trends express the outcome of a given genetic improvement program in a herd in terms of the rate of change in performance level of the herd per unit of time which is commonly referred to as 'trends' of performance level of the herd. The evaluation of genetic trend gives an indication of genetic direction of the rate of genetic improvement from the time of application of the breeding program. The reliable estimates of genetic trends, i.e. the annual rate of the genetic change allows comparison of expected and realized genetic change in the experimental situations and assessment of progress in a particular trait. Trends estimation illustrates how much the selection was effective. Therefore, the present study was undertaken with the objective to estimate the genetic parameters and genetic trends for performance traits in Rambouillet sheep.

MATERIALS AND METHODS

Source of data: The data of 8,872 Rambouillet sheep pertaining to different performance traits were collected for present study from history sheets maintained at Government Sheep Breeding and Research Farm, Reasi, Jammu, Jammu and Kashmir, India over a period of 20 years from 1996 to 2015. Birth weight of lambs born during night was recorded in the early hours of next morning and those born

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during day were weighed 1-2 h after birth.

Location of farm: The Government Sheep Breeding and Research Farm, Reasi, is one of the six sheep breeding farms of Jammu province, located 80 km on north-east of Jammu and lies between 33°05" N latitude and 74°5" E longitude. Reasi shares its boundaries with Udhampur district in south, Ramban district in east, Shopian district of Kashmir in north and Rajouri district in west. The Reasi farm is spread over a total area of 418 acres with a surrounding of abundant green vegetation. The temperature ranges from 5°C to 45°C in winter to summer season, respectively.

Management of farm: The farm follows semi-migratory production system. The sheep are reared at highland pastures (6000-8000 ft. above Mean sea level) at Zaban/ Banihal during summer months (May to September). At alpine pastures, sheep are kept open and allowed to graze during day time for 12 h without any supplementary feeding.

Data analysis: Performance traits included in the study were birth weight (BW), weaning weight (WW), nine-month body weight (9BW), twelve month body weight or yearling weight (YW) and annual wool production (AWP). Weaning in the herd is generally performed at the same time and it is in between 4-6 months. All the traits under present study were normalized. Paternal half sib correlation method (Becker 1975) was used to estimate the heritability of different characters and their genetic correlations. Performance records of progenies of 90 Rambouillet sheep were analyzed. The sires with five or more than five progeny were included for the estimation of heritability. The progeny group size of the sires ranged from 5 to 83. The data adjusted for significant effects of non-genetic factors were used for estimation of heritability.

Genetic and phenotypic correlations: The genetic and phenotypic correlations among different traits were calculated from the analysis of variance and covariance among ram groups as given by Becker (1975).

The standard error of phenotypic correlations was obtained according to formula given by Panse and Sukhatme (1961). The statistical significance of correlations was tested by 't' test as given by Snedecor and Cochran (1967).

Estimation of genetic trends: The method of estimation of genetic trend was based on the comparison of mean performance of paternal half sibs in different years. The genetic trends were calculated by regression of average predicted breeding values versus the animal's birth year/ period.

RESULTS AND DISCUSSION

Estimation of genetic parameters: The estimates for genetic parameters of different performance traits of Rambouilet sheep are presented in Table 1. The estimates of heritability ranged from 0.192±0.051 for AWP to 0.720±0.158 for 9BW.

Similar estimate of heritability for BW and lower estimate of heritability were reported in Rambouillet sheep by Anamika *et al.* (2020). Higher estimates of heritability for BW, WW and YW were reported in Dorper crossbred sheep (Chakraborty *et al.* 2015 and 2016). Gupta *et al.* (2015) reported higher estimates for BW, WW and GFW in Rambouillet crossbred sheep in India. Zaffer *et al.* (2015) reported higher estimates of heritability BW, WW and YW, whereas, lower estimate of heritability for AWP in Dorper crossbred sheep. Latifi and Mohammadi (2018) and Jawasreh *et al.* (2018) reported higher estimates of heritability for BW and lower estimates of heritability for WW in Iranian Afshari sheep and Awassi lambs, respectively. Zaffer *et al.* (2018) reported lower estimates of heritability for BW, WW, YW and AWP in Rambouillet sheep.

The heritability estimates of all traits under study were medium to very high indicating that most of the variations in these traits were due to additive gene action. These traits could be improved through selection and proper breeding strategies.

The estimates of genetic and phenotypic correlations among performance traits in Rambouillet sheep are presented in Table 1. Genetic correlations were positive between all the traits under the study except for AWP. The genetic correlations ranged from -0.084±0.152 (BW and AWP) to 0.984±0.05 (9BW and YW). Jawasreh *et al.* (2018) reported positive and significant genetic and phenotypic correlations in Jordan Awassi lambs. The findings of positive genetic correlations between different body weight traits were in agreement with Chakraborty *et al.* (2015) in Dorper crossbred sheep. Contrary to the present findings, negative genetic correlations between body weight traits were also reported by Zaffer *et al.* (2015 and 2018) and Anamika *et al.* (2020) in Dorper crossbred and Rambouillet sheep. Similar to the present study, Zaffer *et al.* (2015 and 2018) also reported negative genetic correlations for most of the body weight traits with wool

Table 1. Estimates of heritability, genetic and phenotypic correlations for performance traits in Rambouillet sheep

Particular	BW	WW	9BW	YW	AWP
BW	0.225±0.123	0.060±0.143	0.675±0.067	0.698±0.062	-0.084±0.152
WW	-0.018±0.021	0.254±0.058	0.109±0.136	0.139±0.133	0.304±0.173
9BW	0.248**±0.021	-0.022±0.021	0.720±0.158	0.984±0.05	-0.004±0.145
YW	0.349**±0.020	-0.031±0.021	0.762**±0.014	0.602±0.055	-0.036±0.143
AWP	-0.032±0.021	0.023±0.021	0.063**±0.021	0.006±0.021	0.192±0.051

Figures above diagonal are estimates of genetic correlations; Figures along the diagonal are estimates of heritability; Figures below the diagonal are estimates of phenotypic correlations; *, P<0.05; **, P<0.01.

production. Gupta *et al.* (2015) reported positive genetic correlations between BW and WW with wool weight in Rambouillet crossbred sheep.

The positive genetic correlations of BW with WW, 9BW and YW indicate that selection on the basis of BW will improve the WW, 9BW and YW and there is same genetic basis for these traits. The negative genetic correlation of BW with AWP suggests that selection on the basis of BW will not improve the AWP and these traits cannot be put in same selection index except for restricted selection index. The very high genetic correlation between 9BW and YW suggests that 9BW can be used as selection criterion for YW to reduce the generation interval.

The significant phenotypic correlations were obtained between BW and 9BW; BW and YW; 9BW and YW and 9BW and AWP. The phenotypic correlations ranged from -0.032±0.021 between BW and AWP to 0.762±0.014 between 9BW and YW. Similarly, Chakraborty *et al.* (2015) also reported the highest phenotypic correlations between 9BW and YW in Dorper crossbred sheep. Similarly, negative phenotypic correlation between BW and WW in Rambouillet crossbred sheep was also reported (Gupta *et al.* 2015). Contrary to the present findings, positive phenotypic correlations of WW with BW and YW were reported in Dorper crossbred sheep (Chakraborty *et al.* 2015) and Rambouillet sheep (Anamika *et al.* 2020).

Genetic and phenotypic trends for performance traits in Rambouillet sheep: To estimate the genetic trends, breeding values (BV) for different performance traits were calculated. The breeding values of BW, WW, 9BW, YW and AWP ranged from 2.64 to 3.64 kg, 19.61 to 23.98 kg, 23.52 to 30.68 kg, 27.07 to 35.54 kg and 1.03 to 1.52 kg, respectively.

The genetic trend for different performance traits are mentioned in Table 2. Positive genetic trends were reported for BW and WW in Rambouillet sheep. The genetic trend for birth weight (BW) was positive (0.0041±0.0018 kg/year) and non-significant over the period under study and there was very low genetic improvement in birth weight. The estimate of phenotypic trend of BW was found to be negative (-0.008 kg/year).

The genetic trends for 9BW, YW and AWP were negative, although the values were non-significant. The phenotypic trends were negative for all the traits under present study barring exception for YW, where positive phenotypic trend was estimated. Phenotypic trends were negative as due to natural calamities in 2014, there was huge loss of natural pasture and grazing areas which affected the performance traits badly. Due to environmental factors, the overall phenotypic trends were negative. Similar to the present findings, positive trends were reported for BW and WW and negative trends for wool production in Bharat Merino sheep (Mallick *et al.* 2016). Yadav *et al.* (2018) also reported negative genetic trends for YW and greasy fleece weight and phenotypic trends for BW, WW and fleece weight, respectively in Munjal sheep.

Similar to the present findings, non-significant trends were reported for WW and AWP in Bharat Merino sheep (Mallick *et al.* 2016). Genetic trends for BW and WW were significant for all population in Awassi sheep (Jawasreh *et al.* 2018). In contrast to present study, significant genetic trend was reported for YW in Madras Red sheep (Balasubramanyam 2012) and significant genetic trend for BW in Bharat Merino sheep (Mallick *et al.* 2016).

The higher genetic and phenotypic trends for BW, WW, 9BW and YW were reported by Arora *et al.* (2010) in Malpura sheep. For AWP, Arora *et al.* (2010) reported higher genetic trend but lower phenotypic trend compared to present findings in Malpura sheep.

The regression fit for genetic trend (R^2) values ranged from 0.95% to 48.4%. The maximum R^2 value was obtained for BW followed by 9BW, WW, AWP and YW. Lower R^2 value for BW and higher R^2 value for WW were reported in Doyogena sheep in Southern Ethiopia (Habtegiorgis *et al.* 2020). On the contrary, Mallick *et al.* (2016) reported higher R^2 values for BW, WW and fleece weight in Bharat Merino sheep.

Genetic trend in farm varied a lot for different performance traits of Rambouillet sheep. The non-significant effect of genetic trends indicates that there was decrease of predicted breeding values mean which was due to selection of rams with low breeding value or the high rate of inbreeding in the farm. The low genetic and phenotypic trends in the farm indicate that the ongoing breeding programmes for Rambouillet sheep in the farm were not effective and it should be reviewed. The poor accuracy with which breeding values have been predicted may be another reason for low trends for different performance traits of Rambouillet sheep. The estimates of phenotypic trends were low and negative for all the traits except YW indicating that there was no phenotypic gain over the period of study. This may be due to the lack of good quality and quantity of fodders and other environment and

Table 2. Estimates of genetic and phenotypic trends for some of the performance traits in Rambouillet sheep

Particular	ΔG (kg/year)	SE	Effect	R^2 (%)	Phenotypic trends (kg/year)
BW	0.0041	0.0018	NS	48.4	-0.008
WW	0.3553	0.149	NS	17.5	-0.002
9BW	-0.0420	0.010	NS	23.9	-0.002
YW	-0.0029	0.0244	NS	0.95	0.006
AWP	-0.0007	0.0008	NS	6.61	-0.006

ΔG, Genetic gain; R^2, Regression fit for genetic trend; SE, Standard error.

managemental practices in the farm.

The negative trends can be improved by exchanging or importing good quality of ram from other herds and with proper record maintaining and management practises. The genetic and phenotypic trends of the present study indicate environment plays an important role in controlling different performance traits of Rambouillet sheep.

It can be concluded from the present study that 9BW can be used as selection criterion as 9BW had high h^2, high genetic correlations with BW, WW and YW and positive significant phenotypic correlations with BW, 9BW and AWP and highly significant product moment correlations with other traits. The results indicate that selection on the basis of 9BW may be effective to improve the other traits at an early age. Therefore, more genetic gain can be obtained by applying selection for 9BW. The genetic trends were found to be non-significant for all the traits which may be due to inbreeding in the farm. Introduction of good quality of Rambouillet rams in the farm from other herds or importing would be helpful to improve the performance traits; along with maintaining records (i.e. rate inbreeding should be estimated regularly and it should be checked) and improving management practises.

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