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ESTIMATION OF HERITABILITY AND REPEATABILITY OF BIRTH WEIGHT OF RAMBOUILLET LAMBS

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Data on birth weight records of 450 Rambouillet lambs sired by 16 rams of the same breed, recorded from 1978 to 1985 were used to calculate heritability. Average birth weights were 3.49 ± 0.05, 3.26 ± 0.05 and 3.38 ± 0.04 kg for male, female separately and for both combined. There was significant difference in birth weights between years and sexes. Heritability was calculated by 5 different methods, namely paternal halfsib correlation, intrasire regression of offspring on dams, regression of offspring on mid parents, regression of offspring on dam and regression of offspring on sire. The calculated heritability values were 0.034 ± 0.162, 0.0194 ± 0.104, 0.017 ± 0.060, 0.040 ± 0.10 and 0.050 ± 0.070. Repeatability of birth weight was 0.0355 ± 0.915. Paternal halfsib correlation yielded higher value of heritability than other methods. Low value of heritability indicated that birth weight of lambs was significantly affected by environment than by genetic factors.

INTRODUCTION

Mutton production from sheep largely depends upon birth weight and weaning weight. It has been shown that a positive relationship exists between birth weight and weaning weight in sheep (Singh *et al*,. 1984; Nawaz *et al*., 1985). An improvement in birth weight is highly desireable. It is well established that birth weight influences the survival and growth of an individual and survival rate is higher in heavier lambs than those of lighter ones at birth. Birth weight is greatly influenced by various genetic and environmental factors. The fraction of the phenotypic variance which is due to heredity is known as heritability. Heritability and repeatability of productive traits needs to be known for effective selection and culling programme. Heritability of trait is not a constant one but it varies from beed to breed and from place to place due to genetic and environmental variations. The present study was made to estimate heritability and

repeatability of birth weight and environmental and sex effect on the trait in Rambouillet lambs at Livestock Experiment Station, Jaba.

MATERIALS AND METHODS

Birth weight records of 450 Rambouillet lambs alongwith their dams and sires were obtained from Livestock Experiment Station, Jaba, District Mansehra. They were progney of 16 sires used over a period of eight years (1978-1985). The number of lambs born alongwith their mean birth weights for both sexes during the period under study are given in Table 1.

Table 1. *Yearwise variation in birth weight of lambs (kg)*

Year	Male		Female		Overall	
	No.	Av. birth weight ± SE	No.	Av. birth weight ± SE	No.	Av. birth weight ± SE
1978	23	2.96 ± 0.13	30	2.77 ± 0.11	53	2.85 ± 0.09
1979	15	2.96 ± 0.21	15	2.75 ± 0.17	30	2.86 ± 0.13
1980	16	3.23 ± 0.08	19	3.13 ± 0.08	35	3.18 ± 0.05
1981	36	3.46 ± 0.12	18	3.47 ± 0.14	54	3.47 ± 0.09
1982	24	3.34 ± 0.12	32	3.18 ± 0.09	56	3.25 ± 0.07
1983	18	3.67 ± 0.13	24	3.42 ± 0.15	42	3.53 ± 0.11
1984	36	3.81 ± 0.13	42	3.52 ± 0.10	78	3.66 ± 0.08
1985	53	3.75 ± 0.12	49	3.46 ± 0.10	102	3.61 ± 0.09
Total :	221	3.49 ± 0.05	229	3.26 ± 0.05	450	3.38 ± 0.04

Statistical procedure

Data on birth weights were analysed for variation due to year of lambing and sex by assuming the following model :

$X_{ij} = \mu + Y_i S_j + (YS)_{ij} + \epsilon_{ij}$

where μ is the overall mean

Y_i is the effect of ith year

S_j is the effect of jth sex

$(YS)_{ij}$ is the year X sex interaction

ϵ_{ij} is the error term which is NID (o, σ^2)

Data were analysed by the method of unweighted means using two way classification to obtain differences due to year, sex and their interaction.

The heritability estimates were calculated by five different methods namely,

I. Paternal halfsib correlation
II. Intrasire regression of offspring on dam
III. Regression of offspring on mid parents
IV. Regression of offspring on dam
V. Regression of offspring on sire

The data for intrasire regression comprised of 448 pairs which were progney of 14 sire.

Repeatability of birth weight of 321 lambs which were a progney of 96 dams was also calculated. Regression coefficients of birth weights of lambs with birth weights of their sires and dams were also calculated.

RESULTS AND DISCUSSION

The average birth weight of Rambouillet lambs born during 1978-85 was 3.49 ± 0.05, 3.26 ± 0.05 and 3.38 ± 0.04 kg, for male, female separately and for both combined, respectively. It wos found that male progeny was significantly heavier than female.

The analysis of variance of birth weight data revealed that differences between sex and year of lambing were significant (Table 2).

Table 2. *Analysis of variance for birth weight of Rambouillet lambs*

Source of variation	Degree of freedom	Mean squares	F. ratio
Between years	7	0.992	8.3**
Between sexes	1	0.686	5.7*
Year X sex	7	0.027	0.227NS
Error	434	0.11927	
Total	449		

NS = Non-significant.
* = Significant ($P<0.5$).
** = Significant ($P<0.01$).

Significant yearly differences for birth weight reflected variation in managemental practices or environmental changes. Findings of this study are in

agreement with Duflapurkar *et al.* (1976) and Raman *et al.* (1979) who reported a significant differences between year of lambing and sexes.

Heritability Estimates

Paternal halfsib correlation : The estimates of heritability obtained by method of paternal halfsib correlation were 0.48 ± 0.261, 0.345 ± 0.212 and 0.334 ± 0.162 for male, female and overall progeny, respectively. Table 3 shows variation among offspring on sire group for overall progeny.

Table 3. *Analysis of variance showing variation among offspring on sire group*

Source of varition	Degree of freedom	Sum of squares	Mean squares	Expected mean spuare
Between sires	15	128.94	8.60	$\sigma^2w + 26.02\ \sigma^2_s$
Within sires	434	1108.57	2.55	σ^2w

$$K_1 = \frac{1}{S-1}\left(\frac{I.-\Sigma ni^2}{n.}\right)$$

$$\sigma^2 = 0.2325$$

$$\sigma^2w = 2.55$$

$$t = \frac{0.2325}{2.55 + 0.2325} = 0.0835$$

$$h^2 = 4t = 0.334$$

$$SE\ (h^2) = \sqrt{\frac{4/2\ (n. - 1)\ \ (1-t)^2\ \ 1 + (K - 1)\ t}{K_1^2\ (n.-s)\ \ (s-1)}}$$

$$SE\ (h^2) = 0.162$$

The above estimates are in complete agreement with the results obtained by Singh *et al.* (1984), who reported the heritability of birth weight as 0.31 and 0.33 and 0.34 in Targhee, Soviet Merino and Awassi lambs, respectively, whereas Bhadula and Bhat (1980) reported heritability of birth weight of Corriedale lambs, as 0.38 ± 0.56 which is also close to these results. Difference between heritability of male and female is probably due to significant difference between birth weights of both sexes.

Intrasire regression of offsprings on dam : The variation due to sire was removed to find the sum of crossproducts from data of offsprings and their dams on

intrasire basis. The regression coefficient of offspring on dam was —0.00972, which yielded an estimate of —0.0194 ± 0.104. These findings are in agreement with the results reported by Bucher *et al.* (1964). Estimate of heritability by method of intrasire regression of offsprings on dams is presented in Table 4.

Table 4. *Estimation of heritability by method of intrasire regression of offsprings on dams*

Source of variation	Degree of freedom	Sum of products		
		Dam x x	Dam X Progeny XZ	Progeny ZZ
Between sires	14		Not needed	Not needed
Between dams within sires	434	942.64	-9.166	1108.578
Total	447	981.25		1237.098

$$b = \frac{-9.166}{942.64} = -0.00972$$

$$h^2 = 2b = -0.01944$$

$$Sb = \frac{1108.508 - \frac{-9.166}{942.64}}{(448-14-1)\ (942.64)}$$

$$Sb = \sqrt{0.00271606} = 0.0521$$

$$SE\ (h^2) = 2Sb = 0.1042$$

Regression of offsprings on mid parent : Heritability of birth weight was calculated by averaging the birth weights of sires and dams for each offspring (Table 6). The estimates thus obtained are 0.093 ± 0.091, -0.026 ± 0.079 and 0.017 ±0.060 for male, female and overall progeny, respectively.

Table 5. *Regression coefficients of birth weights of progeny on birth weights of sire dam and mid parents*

Sex	Progeny Vs sire	Progeny Vs dam	Progeny Vs mid parent value
Male	0.054	0.038	0.093
Female	0 007	—0.035	—0.026
Overall	0.025	—0.020	0.017

Regression of offsprings on parents : Regression of birth weights of offsprings on sire was 0.025 which yielded the heritability estimate as 0.050 ± 0.068. whereas heritability was -0.040 ± 0.106 when calculated from regression of offsprings on dam. Low values of heritability by above mentioned methods are due to the fact that small population of Rambouillet have been kept at Jaba Sheep Farm since 1957 which is long enough for an appreciable amount of fixation to have taken place. Moreover, variable conditions which are evident from significant yearly variation of the data reduced the heritability.

Negative values of heritability in the methods of intrasire regression of offspring on dam and regression of offspring on dam my be attributed that the variation due to sire was removed in which covariance is least likely to be augmented by an environmental component, whereas these metnods were more liable to give too high estimates on account of maternal effects and environmental sources of covariance. These could introduce a bias difficult to overcome by statistical procedures.

Rej eatability :

Repeatability of birth weight of 321 lambs of 96 dams was 0.0357 ± 0.0915 as shown in Table 6.

Table 6. *Analysis of variance of data on repeatability*

Source of variation	Degree of fredom	Sum of squares	Mean squares
Correction term		$\frac{(2382)^2}{321} = 17675.77$	
Dams	95	294.60	3.10
Individual	225	721.63	2.76
Total	329		

$MS_w = \sigma^2 = 3.10$

$MS_s = \sigma_r^2 = 2.76$

$K = \frac{1}{N-1} \frac{(m. - mk)}{m.}$

Where N is the total number of dams

m. is the total number offsprings
mk is the offsprings of kth dam

$K_1 = 3.339$

$\sigma^2_w = MS_E$

$\sigma^2_w = \frac{MS_w - MS_E}{K_1}$

$\sigma^2_w = 0.10$

$R = \frac{\sigma^2_w}{\sigma^2_w + \sigma^2_E} = 0.03558$

Standard error of $R = \sqrt{\frac{2\,(m.-1)\,(1-R)^2\,[1 + (K_1-1)\,R]^2}{K^2 1 \quad (m.-N)\,(N-1)}} = 0.0915$

$R = 0.03558 \pm 0.0915$

The genetic model shows that σ^2_w estimates all the genetic variance, plus a portion of the environmental variance.

The component σ^2_w estimates all the genetic variance and the portion of the environmental variacce. Since genetic variance was low, the repeatability was also low. The heritability for birth weight was low, indicating no effective improvement with mass selection. Heritability can be increased only by reducing the environmental variation through attention to the technique of rearing management and avoiding in breeding.

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