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HEREDITARY VARIATION IN REPRODUCTIVE TRAITS OF SAHIWAL CATTLE

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Data on 900 halfsibs from 34 sires and 556 daughter-dam pairs of 28 sires were analysed for the estimation of the heritability of age at first calving in Sahiwal cows. Heritability estimates calculated by halfsib analysis and intrasire regression of daughters on dams techniques were 0.80 ± 0.19 and 0.08 ± 0.10, respectively. First lactation length averaged 308 ± 3 days and had 0.39 ± 0.12 and 0.26 ± 0.05 as the heritability estimates by halfsib and intrasire regression analyses, respectively. The two methods of heritability estimation had presented negative values for heritability of first dry period. Analysis by intraclass correlation indicated that first calving interval had low heritability (0.08 ± 0.06), whereas the same estimate by intrasire regression of daughters on dams method was found to be -0.06 ± 0.05. These results suggested that in this herd, age at first calving and lactation duration were partially under the genetic control, but most of the observed variations in dry period and calving interval were due to environmental influences.

INTRODUCTION

Pakistan possesses some of the finest dairy breeds of tropical cattle, but these animals are slow to mature, have higher age at first calving and long calving intervals. This renders dairying uneconomical by increasing the unproductive life of the milch animal. A substantial part of this unproductive life can be reduced if the relative role of heredity and environment in the expression of these characteristics is known. The measure of hereditary variation is the estimate of heritability which refers to the fraction of variance attributable to the average effects of genes. In tropical cattle, the age at first calving was moderately affected by the genetic constitution of the individual (Singh and Desai, 1961; Singh and Sundaresan, 1969; Singh and Prasad, 1969). However, the studies by Singh (1957) and Amble *et al.* (1958) indicated that this character was little under the genetic control. Heritability estimates equivalent to zero for the calving interval had been reported in many studies (Singh, 1958; Singh and Desai, 1961; Dadlani and Chandiramani, 1968), but some other investigations showed that this trait had moderate to high estimates of transmitting ability (Kushwaha, 1965; Amble *et al.* 1967; Singh and Sundaresan,

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1969). The present investigation was a follow up study for the estimation of the genetic causes of variability in age at first calving, calving interval and its components, namely, lactation length and dry period in a herd of Sahiwal cattle maintained for a period of 41 years.

MATERIALS AND METHODS

Data on the pedigree and calving records of Sahiwal cows kept at Allahdad Cattle Farm, Jahanian, Multan for the years 1926 to 1966 were used for the estimation of heritability of various reproductive traits. Heritability estimates of age at first calving, first lactation length, first dry period and first calving interval were worked out by the methods of halfsib analysis and intrasire regression of daughters on dams.

(a) *Halfsib Analysis.* In this method, each observed value was regarded as having the components described by the model :

$$Y_{ij} = u + S_i + e_{ij}$$

where

i = 1, 2, ... s (number of sires),
j = 1, 2, ... ni (number of daughters of *ith* sire),
Y_{ij} is the observation of *jth* daughter of *ith* sire,
u is the population mean,
S_i is the effect of *ith* sire,
e_{ij} is the random error associated with the record of *jth* daughter of *ith* sire.

It was also assumed that mean deviation due to sire was equal to zero and the errors were distributed normally and independently with mean zero and variance σ^2_w.

The analysis of variance model described by Kempthorne (1957) was followed and components of variance were worked out. The intraclass correlation (t) was worked out from these components and the heritability estimate (h^2) was obtained by multiplying 't' value by a factor 4.

The standard error of the heritability based on 't' was worked out using the formula described by Swiger *et al.* (1964).

(b) *Intrasire Regression of Daughters on Dams.* The computational procedure described by Becker (1967) was used for working out heritability

by intrasire regression of daughters on dams which is based on the following model:

$$Y_{ijk} = S_i + \beta\,(X_{ij} - \bar{x}..) + e_{ijk}$$

where

Y_{ijk} is record of k*th* daughter of the i*th* sire mated to j*th* dam,
S_i is the effect due to i*th* sire,
β is the regression of daughters on dams,
X_{ij} is the recordof j*th* dam mated to i*th* sire,
$\bar{x}..$ is the mean of the dams mated to all sires included in the data,
e_{ijk} is the random error associated with the observation of k*th* daughter of i*th* sire mated to j*th* dam.

Heritability by this method was obtained by multiplying the regression coefficient by the factor 2. The standard error of heritability was also worked out by using the formula described by Becker (1967).

RESULTS AND DISCUSSION

1. Age at First Calving

The data on 900 halfsibs from 34 sires and 556 daughter-dam pairs of 28 sires were available for the estimation of the heritability of age at first calving. The average age at first calving was calculated to be 1465±7 days.

(a) *Halfsib analysis.* Heritability calculated by analysis of variance and intraclass correlation technique was 0.80±0.19 (Table 1). This very high estimate alongwith low standard error indicated that in this herd much of the variation in age at first calving was due to the additive gene action. It suggested that age at first calving could be reduced through selective breeding.

TABLE 1. *Heritability estimates of reproductive traits by halfsib analysis*

Character	No. of sires	No. of daughters	Average of the trait (days)	Heritability estimate
Age at 1st calving	34	900	1465 ± 7	0.80 ±0.19
1st lactation length	34	870	308 ± 3	0.39 ±0.12
1st dry period	34	795	182 ± 5	-- 0.09 ±0.02
1st calving interval	34	795	491 ± 5	0.80±0.06

The estimates obtained by Singh (1957) and Singh and Desai (1961) by this method of analysis were much lower than the present estimate. This might be due to breed and certain environmental differences.

(b) *Intrasire Regression of Daughters on Dams.* Average age at first calving based on 556 daughter-dam pairs of 28 sires was 1467±10 and 1456±8 days among the daughtes and dams, respectively. The heritability by this method was 0.08±0.10 (Table 2), which is surprisingly low as compared to halfsib method and also from most of the other studies.

TABLE 2. *Heritability estimates of reproductive traits by intrasire regression analysis*

Character	No. of sires	No. of daughter-dam pairs	Av. of daughters (days)	Av. of dams (days)	Intrasire regression (b)	Heritability estimate
Age at 1st calving	28	556	1467±10	1456±8	0.04	0.08±0.10
1st lactation length	31	617	307±3	315±3	0.13	0.26±0.05
1st dry period	31	543	185±6	177±5	−0.05	−0.10±0.05
1st calving interval	31	543	494±6	493±5	−0.03	−0.06±0.05

Amble *et al.* (1958), Singh and Desai (1961), Singh and Sundaresan (1969), and Singh and Prasad (1969) have reported heritability of age at first calving above 0.30. Although similar estimates by Amble *et al.* (1958) and Dudlani *et al.* (1969) among the Red Sindhi and Hariana cattle were low, yet were higher than the present estimate. The estimates reported by Amble *et al.* (1958) and Singh (1958) were in close agreement with the present study and did not differ from zero among the Red Sindhi and Tharparkar breeds of cattle. The lower estimate obtained by this method as compared to the halfsib analysis might be due to the non-orthogonal distribution of the records of the dams with their daughters.

2. First Lactation Length

The first lactation length averaged 308±3 days for 870 halfsibs of 34 sires (Table 1). Average lactation length calculated from 617 daughter-dam pairs

of 31 sires was 307±3 and 315±3 days for daughters and dams, respectively (Table 2).

(a) *Halfsib Analysis.* Heritability of first lactation length based on this technique was 0.39±0.12 (Table 1). The present estimate was high compared with those reported by Shukla and Prasad (1970), and Balaine *et al.* (1970) who obtained – 0.54±0.07 and 0.21, respectively as the estimate of heritability of first lactation length by halfsib method. The present estimate was, however, very low than that reported by Dadlani *et al.* (1969). They estimated 0.86 as the heritability of first lactation length in Hariana cows.

(b) *Intrasire Regression of Daughters on Dams.* The intrasire regression of daughters on dams using 617 pairs of 31 sires was 0.13. This estimate when multiplied by 2 provided the heritability as 0.26±0.05 (Table 2).

The heritability estimates for first lactation length obtained in this study by both the methods suggested that this character is partially under the genetic control. Hence, cows with lactation duration of 305 days can be have through selective breeding coupled with better feeding and management.

3. First Dry Period

The first dry period based on 795 daughters of 34 sires was 182±5 days (Table 1). The analysis of the 543 daughter-dam pairs of 31 sires revealed that the daughters and dams had 185±6 and 177±5 days as the first dry period. The heritability estimate obtained by halfsib correlation method was–0.09± 0.02 (Table 1). The same estimate obtained by intrasire regression of daughters on dams technique was —0.10±0.05 (Table 2).

Both the methods of heritability estimation had presented negative values for heritability of first dry period. These values are very low compared with those reported by Singh *et al.* (1969) and Dadlani *et al.* (1969), who found 0.20 and 0.32 as the estimate of heritability for first dry period by the halfsib correlation method. This discrepency might be due to the differences in genetic and environmental conditions such as differential management and feeding practices. The estimates of heritability for dry period suggested that this trait among the Sahiwal cows entirely depends upon the environments. Judicial feeding and managemental practices would enable the breeders to curtail the dry period from over 180 days to a desirable length of 60 days.

4. First Calving Interval

Data on 795 daughters of 34 sires indicated that the average first calving interval was 491±5 days (Table 1).

(a) *Halfsib Analysis.* The heritability of first calving interval by this method was 0.08 ± 0.06 as is shown in Table 1. This estimate was very low as compared with that reported by Dadlani *et al.* (1969). They reported 0.20 as the heritability of first calving interval among the Hariana cattle.

(b) *Intrasire Regression of Daughters on Dams.* The heritability of first calving interval by this method of analysis was found to be -0.06 ± 0.05 (Table 2). This estimate indicated heritability of calving interval as zero. The present estimate was in close agreement with those reported by Amble *et al.* (1958) and Singh (1958). They had reported negative values for heritability in Red Sindhi and Tharparker breeds of cattle. Amble *et al.* (1958, 1967) and Dadlani and Chandiramani (1968) also reported very low estimates of heritability for calving interval in Red Sindhi, Tharparker, Kangayam and Hariana breeds of cattle. The estimates given by these workers were, however, higher than that obtained in the present study. Moderate estimates of heritability for this trait were given by Amble *et al.* (1958, 1967), Singh and Sundaresan (1969) and Dadlani *et al.* (1969). The estimates by these workers varied from 0.20 to 0.38 for various breeds of this subcontinent. High estimates of heritability by the method of intrasire regression of daughters on dam have been reported by Amble *et al.* (1967) in Gir and Kankrej breeds of Indian cattle. These differences may again be attributed to the feeding and other managemental practices carried out on the various farms.

The lower estimate of heritability for calving interval obtained by the method of halfsib correlation and an estimate of almost zero by the intrasire regression of daughters on dams indicated that most of the observed variations in calving interval were due to environmental influences. A great reduction in calving interval therefore can be brought in by improving the environmental conditions whether temporary or permanent in nature.

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