HERITABILITY ESTIMATES FOR VARIOUS PERFORMANCE TRAITS OF NILI-RAVI BUFFALOES

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INTRODUCTION
There are two breeds of buffaloes in Pakistan i.e. Nili-Ravi and Kundi. The former is one of the best dairy buffaloes in the world. They are the main dairy animals in Pakistan and supply about 75 percent of the milk produced in the country. These animals produce good quantity of milk, however, late age at first calving and long calving intervals of these animals result in reduced reproductive efficiency, calf crop and milk yield on lifetime basis. This indicates a need for the improvement of genetic merit of these buffaloes. The estimates of genetic parameters i.e. heritability and repeatability of different production and reproduction traits and genetic correlations among them are needed for the formulation of effective breeding plans and for estimation of breeding values. Salah-ud-Din (1989), Akhtar et al. (1990) and Khan et al. (1996) estimated heritability (h²) values for various performance traits of Nili-Ravi buffaloes but the methodology then used is outdated now. Best linear unbiased prediction procedure (BLUP) using animal model is now considered the method of choice for the estimation of breeding values of animals. It is considered more appropriate to use the estimates of genetic parameters from the same model as is used for the genetic evaluation of animals. Thus the present study was planned to compute h² estimates of different production and reproduction traits of Nili-Ravi buffaloes using the latest available analytical procedure.

MATERIALS AND METHODS
Pedigree and performance records (N=3197) of 1322 Nili-Ravi buffaloes maintained at Livestock Experiment Station, Bahadarnagar, Pakistan during the period 1954 to 1998 were utilized for the estimation of heritability (h²) of 305-day Milk Yield (305-d MY), Lactation Length (LL), Dry Period (DP), Age at First Calving (AFC), Service Period (SP) and Calving Interval (CI). Only normal and complete records of the buffaloes were included in the analysis. Incomplete lactation showing any abnormality were not used. Lactation records of less than 150 days were also not included in the analysis. Keeping in view the climatic data, the year of birth / calving / service was divided into following seasons: Winter, December to January; Spring, February to April; Hot dry, May to June; Hot humid, July to September; Autumn, October to November. The various fixed effects observed to be significant sources of variation for different performance traits were fitted in the following model for the estimation of h². For total 305-d MY and total lactation MY, the effect of lactation number was included in addition to the effect of year of calving and LL (covariate). The effects included for other performance traits were: year and season of calving and lactation number for LL, year of calving for DP, year and season of service and lactation number for SP, season of service for gestation period and year and season of calving and lactation number for CI.
The $h^2$ values were estimated by using restricted maximum likelihood (REML) procedure as proposed by Patterson and Thompson (1971) fitting an individual animal model. The derivative-free restricted maximum likelihood (DFREML) set of computer programmes (Meyer, 1998) was used for the analysis. All of the available pedigree information was included in the analysis in an attempt to minimise the bias due to selection and non-random mating. The convergence criterion (variance of function values -2 log likelihood) for various genetic parameters was $1 \times 10^{-8}$. The $h^2$ estimates were computed by assuming the following mixed model:

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

where, $Y_{ijk}$ is the measurement of a particular trait; $\mu$ is the population mean; $A_i$ is the random additive genetic effect of $i$th animal with mean zero and variance $\sigma^2_A$; $F_j$ is the fixed effects observed to be significant from the initial analyses and $e_{ijk}$ is the random error with mean zero and variance $\sigma^2_E$. Phenotypic variance ($\sigma^2_P$) was assumed to be the sum of additive genetic variance ($\sigma^2_A$) and the residual variance ($\sigma^2_E$). The $h^2$ was calculated as $\sigma^2_A / \sigma^2_P$.

**RESULTS AND DISCUSSION**

The $h^2$ estimates for various performance traits as obtained from the animal model analysis have been presented in Table 1. They have been discussed in the following under separate headings:

<table>
<thead>
<tr>
<th>Traits</th>
<th>N° sires</th>
<th>N° records</th>
<th>N° animals</th>
<th>N° pedigree</th>
<th>$h^2 \pm$ s.e.</th>
</tr>
</thead>
<tbody>
<tr>
<td>305d milk yield</td>
<td>51</td>
<td>3141</td>
<td>1308</td>
<td>1678</td>
<td>0.10±0.01</td>
</tr>
<tr>
<td>Lactation length</td>
<td>52</td>
<td>3197</td>
<td>1322</td>
<td>1678</td>
<td>0.11±0.06</td>
</tr>
<tr>
<td>Dry period</td>
<td>46</td>
<td>1991</td>
<td>901</td>
<td>1676</td>
<td>0.07±0.14</td>
</tr>
<tr>
<td>Age at first calving</td>
<td>50</td>
<td>1183</td>
<td>1183</td>
<td>1677</td>
<td>0.003±0.01</td>
</tr>
<tr>
<td>Service period</td>
<td>51</td>
<td>2470</td>
<td>1122</td>
<td>1678</td>
<td>0.06±0.03</td>
</tr>
<tr>
<td>Calving interval</td>
<td>48</td>
<td>1797</td>
<td>829</td>
<td>1676</td>
<td>0.04±0.05</td>
</tr>
</tbody>
</table>

$N°$ Numbers, $h^2 \pm$ s.e.: Heritabilities ± Standard Error

**Milk Yield.** The $h^2$ estimates for 305-day MY was 0.10±0.01 (Table 1). The estimate of $h^2$ as obtained in the present study was in agreement with the $h^2$ estimate (0.05) reported by Mourad et al. (1993) in Egyptian buffaloes for this trait. However, this estimate is lower than those of Velea et al. (1991), Pilla and Moioli (1992) and Tiwana et al. (1994) in Romanian (0.35), Italian (0.27) and Indian Murrah (0.44) buffaloes, respectively.

**Lactation Length.** The $h^2$ estimate for LL was 0.11±0.06 (Table 1). The finding of the present study regarding the estimate of $h^2$ for LL was substantiated from the findings of Gogoi et al. (1984) and Tailor et al. (1992) who reported $h^2$ estimates of 0.09 (Murrah) and 0.16 (Surti) for this trait, respectively. The $h^2$ estimates for LL (all records) reported by Juma et al. (1994) and Tonhati et al. (1997) were zero (Iraqi buffaloes) and 0.01 (Murrah), respectively, which were
lower than that observed in the present study. However, the $h^2$ estimates as reported by Metry et al. (1994) and Tiwana et al. (1994) for LL (all records) were relatively very high than the present estimate. The values of $h^2$ as found by these workers were 0.28 (Egyptian) and 0.36 (Murrah), respectively.

**Dry Period.** The estimate of $h^2$ for DP was 0.07±0.14 (Table 1). The estimate of $h^2$ for DP in the present study was in agreement with the results of some other workers (Marques et al., 1994; Tiwana et al., 1994 and Dutt and Taneja, 1995) who reported the $h^2$ estimates for DP in different breeds of buffaloes ranging from 0.07 to 0.10. However, Juma et al. (1994) reported a relatively higher $h^2$ value for DP in Iraqi buffaloes. The data of 282 buffaloes consisting of 842 lactation records collected during the period 1967 to 1988 at the Misan Animal Breeding Station, Iraq were analysed. The $h^2$ estimate was calculated to be 0.18.

**Age At First Calving.** The $h^2$ estimate for AFC was 0.003±0.01 (Table 1). Very low estimate of $h^2$ for AFC had also been reported in the literature. The value reported by Juma et al. (1994) was 0.01 in Iraqi buffaloes. The present estimate of $h^2$ was, however, lower than those of Salah-ud-Din (1989), Chakravarty and Rathi (1989), Dahama et al. (1991), Dutt and Taneja (1995), Khan et al. (1996) and Tonhati et al. (1997) who reported the $h^2$ estimates of AFC ranging from 0.20 to 0.45 in various breeds of buffaloes.

**Service Period.** The estimate of $h^2$ for SP in the present study was computed to be 0.06±0.03 (Table 1). It was in agreement with the findings of Tiwana et al. (1994). The breeding records of 270 Murrah buffaloes collected over a period of 18 years were analysed. The $h^2$ of SP was reported to be 0.07. Metry et al. (1994) also reported a very low $h^2$ value (zero) for SP in Egyptian buffaloes.

**Calving Interval.** The estimate of $h^2$ for CI was 0.04±0.05 (Table 1). It was in line with the findings of Metry et al. (1994), where $h^2$ of CI was reported to be 0.02. It was also in agreement with the results obtained from many other studies (Salerno, 1960; Alim, 1978 and Vikkram and Desai, 1979). The estimates of $h^2$ for CI as obtained by these workers ranged from 0.04 to 0.06 in different breeds of buffaloes. Slightly higher estimates of $h^2$ (0.10 to 0.13) for CI as compared to the present study had also been reported by some other workers (Vankov, 1991; Juma et al., 1994 and Tonhati et al., 1997) in various breeds of buffaloes. However, the estimate of $h^2$ for CI as reported by Tiwana et al.(1994) was found to be the highest (0.30) ever reported in the literature.

**CONCLUSION**

In the present study the estimates of $h^2$ for various production traits were all unusually low and ranged from 0.001 to 0.11. Similar trend (0.003 to 0.06) was observed for the reproduction traits. However, all these estimates are within the range of the estimates published world wide. The low estimates of $h^2$ suggested that additive gene action is not very important for these traits and thus genetic progress through selection within the herd will be slow. The low values further suggested that variation in performance traits was completely due to environmental influences. Therefore, for example, reduction in length of dry period could be achieved with better feeding and better management practices.
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