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**Garima Choudhary**
Department of Animal Genetics and Breeding, College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India

**U Pannu**
Department of Animal Genetics and Breeding, College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India

**GC Gahlot**
Department of Animal Genetics and Breeding, College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India

**Corresponding Author:**
**Garima Choudhary**
Department of Animal Genetics and Breeding, College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India

# Efficiency of sire evaluation for milk production by incorporating auxiliary traits in Tharparkar cattle

**Garima Choudhary, U Pannu and GC Gahlot**

**Abstract**
The present investigation was conducted to study the efficiency of sire's breeding values by incorporating auxiliary traits with first lactation milk yield (FLMY). Age at first calving (AFC), first service period (FSP), first calving interval (FCI), first dry period (FDP) and first lactation length (FLL) were considered as auxiliary traits. The data for the present investigation were obtained from Records of 91 cows maintained at Livestock Research Station, Beechwal, Bikaner, over 15 years (2002 to 2016). Sires were evaluated for first lactation milk yield by simple daughter's average method ($\bar{D}$), Contemporary comparison method (CC), least-squares method (LSM), best linear unbiased prediction (BLUP) and by incorporating auxiliary trait. The results revealed that LSM method of sire evaluation was more efficient than all other methods for FLMY. When auxiliary traits were used with FLMY for sire evaluation the error variance was very high for all auxiliary traits. Among the sire indexes incorporating auxiliary traits, the lowest error variance was found when FDP was considered as auxiliary trait. This indicated that considering one auxiliary trait along with first lactation milk yield may not be very effective criteria for ranking sires for FLMY in comparison to any other sire evaluation method. The rank correlation among auxiliary sire indices ranged from 0.98 to 1, indicating similar ranking of sire for breeding values of milk production in all the auxiliary sire indices.

**Keywords:** Tharparkar cattle, auxiliary trait, sire evaluation

## Introduction
Identifying the best breeding animals is the first step towards successful selection programme. Better and effective breed improvement programme always need an accurate sire evaluation. The majority of genetic improvement comes through sires because of favorable differential and higher selection intensity. Therefore, the success of any breeding strategy depends on the identification of genetically superior sires and their maximum utilization. Most of the sire evaluation methods which are now in use are based on daughter's milk production only and accuracy of such methods depend on the number of progeny available. In Indian conditions, reliable estimates of breeding values by progeny testing of sires could not be obtained because the estimates are based on small number of daughter's record.

Selection based on daughter's milk production only will bring about faster improvement in milk production but may improve economic value of animals at slower rate. The traits of economic importance are correlated to each other due to both genetic and environmental causes. Each trait contributes information that may have value in predicting other traits of interest. Since under Indian conditions the number of daughters per sire being small, combination of other traits along with milk production may improve the accuracy and efficiency of sire evaluation. Therefore, it seems desirable to use one or more associated traits in conjunction with milk yield record of daughters for progeny testing [1].

The breeding value of the sires for milk yield depends on the phenotypic value of its progeny's milk yield as well as other correlated traits [2]. Considering this principle, Narain, 1985[2] proposed a sire index method for milk production using auxiliary traits such as age at first calving, first calving interval, and first lactation length with milk yield of daughters. It is inferred that use of auxiliary traits reduces the number of progeny required to attain a pre-assigned level of accuracy in comparison with sire evaluation based on milk yield only. This investigation was conducted to examine the effectiveness of estimation of sire breeding values for first lactation milk yield using commonly used sire evaluation methods and by use of auxiliary traits. The efficiency and accuracy for estimation of sire's breeding values by various

sire evaluation methods was compared in this study which revealed that using one auxiliary trait with lactation yield for sire evaluation the accuracy of the progeny test is always increased. The maximum gain in accuracy is found when the phenotypic and additive genetic correlations between the main and the auxiliary traits are of opposite signs.

## Materials and Methods

In the present investigation, 91 first lactation records of Tharparkar cows, progeny of 10 bulls (with 3 or more daughters), and spread over 15 years (2002 to 2016) at LRS, Beechwal, and Bikaner were used to evaluate sires. The sires were evaluated on the basis of first lactation milk yield using four prevalent sire evaluation methods, *viz*. simple daughter's average method [3], Contemporary comparison method [4], least-squares method [5] and best linear unbiased prediction [6]. Sire's breeding values for lactation milk yield were also calculated using one auxiliary trait along with milk yield of daughters. Age at first calving (AFC), first service period (FSP), first calving interval (FCI), first dry period (FDP) and first lactation length (FLL) were considered as auxiliary traits. The heritability, genetic and phenotypic correlation among traits were estimated using paternal half-sib correlation method [7].

Narain's method of sire index [2] for milk production corrected for auxiliary trait was used. The relationship between the breeding value of sire and the average phenotypic value of progeny for (K+l) characters (milk yield and K auxiliary traits) can be expressed as:

$$E[G_{(y)}] = b_o\bar{D}_{(y)} + \Sigma b_i\bar{D}_{(xi)}$$

Where,

$E[G_{(y)}]$ is the expected breeding value of a sire for lactation milk yield;

$\bar{D}_{(y)}$ is the sire's daughter average lactation milk yield;

$\bar{D}_{(X)}$ is sire's daughter average for $i^{th}$ auxiliary trait;

$b_o$ and $b_i$ (i=1,...k) are constants and are estimated by maximising the multiple correlation coefficient between the breeding value of sire and its expectation on the basis of daughters milk yield and auxiliary traits.

The effectiveness of different sire evaluation methods was judged by using the various criteria like error variance, coefficient of determination ($R^2$) and rank correlations. The sire evaluation method with lowest error variance was considered as the most efficient and appropriate.

## Results and Discussion

The estimates of heritabilities ($h^2$), genetic ($r_g$) and phenotypic ($r_p$) correlation between various first lactation traits are presented in table 1. The breeding value of first lactation milk yield of Tharparkar sires were estimated by various sire evaluation methods as described in materials and methods. Average breeding values, range of breeding value and relative efficiency of various sire evaluation methods are presented in table 2. Range of breeding values as well as error variance was higher in auxiliary sire evaluation methods in comparison to other methods. The lowest range of breeding values was found in case of BLUP method. The higher ranges of breeding value in auxiliary sire indices indicated that the auxiliary sire indices discriminate better among sires.

The results (table 2) showed that least squares method had lowest error variance and, therefore, it was considered to be the most efficient method out of all the methods. The results obtained in the present investigation were similar to the results of Sahana and Gurnani (1999) [1], Mukherjee (2005) [8], Banik and Gandhi (2006) [9], Singh and Singh (2011) [10] and Singh (2015) [11] as, they also reported LSM method as the most efficient method of sire evaluation.

When auxiliary traits were used along with the milk yield of daughter's, the error variance, in all the cases, was higher than BLUP, LSM, CC and $\bar{D}$ methods of sire evaluation for first lactation yield. Among the sire indexes incorporating auxiliary traits, the lowest error variance was found when FDP was considered as auxiliary trait and the highest error variance was observed when AFC was considered as auxiliary trait along with first lactation yield. The present results are in conformity to those reported by Sahana and Gurnani (1999) [1] and Dahiya (2002) except that magnitude of error was considerably higher. However, Sahana and Gurnani (1999) reported the lowest error variance with first service period and highest error variance with first dry period as auxiliary trait along with milk yield and Dahiya (2002) [12] reported lowest error variance when age at first calving was used as auxiliary trait and highest error variance when first lactation length was used as auxiliary trait along with milk yield.

The rank correlation between sire evaluations methods are presented in table 3. Rank correlation between LSM and BLUP method of sire evaluation for all the first lactation production and reproduction traits under study was found to be high (> 0.92). It indicated that ranking of sires by LSM and BLUP maintains a high consistency with each other. Inclusion of one auxiliary trait for estimation of breeding value had decreased rank correlation with breeding value estimated by other sire evaluation methods ($\bar{D}$, CC, LSM and BLUP) being low to medium in magnitude. It is indicative about that use of auxiliary trait to rank sires for first lactation milk yield is not of much practical importance as ranking of sires considerably altered. The estimates of rank correlation among various auxiliary sire indices were near unity ranging from 0.98 to 1.0. The rank correlation indicated that all the auxiliary indices used in the study had ranked the sires similarly.

**Table 1:** Heritability, genotypic and phenotypic correlation with their SE of different first lactation traits in Tharparkar cattle

| | AFC | FSP | FCI | FDP | FLL | FLMY |
|---|---|---|---|---|---|---|
| AFC | 0.52±0.070 | 0.21±0.298 | -0.74±0.132** | -0.51±0.170** | -0.01±0.242 | 0.19±0.248 |
| FSP | 0.19±0.109 | 0.12±0.166 | 0.63±0.581** | 0.01±0.749 | 0.45±0.633** | -0.29±0.767** |
| FCI | 0.12±0.110 | 0.29±0.106** | 0.18±0.232 | 0.15±0.689 | 0.37±0.643** | 0.64±0.470** |
| FDP | 0.12±0.110 | 0.19±0.970 | 0.09±0.110 | 0.04±0.030 | -0.32±0.523** | 0.56±0.425** |
| FLL | 0.24±0.102* | 0.33±0.105** | 0.17±0.109 | -0.08±0.110 | 0.33±0.288 | 0.77±0.266** |
| FLMY | 0.19±0.103 | 0.24±0.107 | 0.16±0.110 | -0.27±0.107* | 0.58±0.086** | 0.40±0.394 |

(Values at the diagonal are heritability estimates, and values above and below the diagonal are genotypic and phenotypic correlations, respectively). ** - Highly significant (P≤ 0.01); * - Significant (*P*≤0.05).

**Table 2:** Average, range of sire's breeding values and relative efficiency of various methods of sire evaluation for FLMY in Tharparkar cattle.

| Method | Average breeding value | Range of breeding value | Error variances | Relative efficiency |
|---|---|---|---|---|
| $\bar{D}$ | 1849.1 | 695 | 61352.77 | 14.59 |
| CC | 1836.17 | 850.4 | 59532.53 | 15.04 |
| LSM | 1858.65 | 342.6 | 8952.17 | 100.00 |
| BLUP | 1860.03 | 319.52 | 9729.79 | 92.01 |
| AFC | 1615.51 | 1980.92 | 442839.24 | 2.02 |
| FSP | 1527.47 | 1899.32 | 402754.82 | 2.22 |
| FCI | 1610.65 | 1906.12 | 414193.83 | 2.16 |
| FDP | 1527.50 | 1256.35 | 237498.90 | 3.77 |
| FLL | 1580.47 | 1954.8 | 421271.71 | 2.13 |

**Table 3:** Rank correlations among sire breeding value for FLMY by different methods.

| Method | | CC | LSM | BLUP | Auxiliary traits | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | AFC | FSP | FCI | FLL | FDP |
| $\bar{D}$ | | 0.76 | 0.87 | 0.88 | 0.39 | 0.38 | 0.38 | 0.39 | 0.39 |
| CC | | | 0.87 | 0.79 | 0.65 | 0.64 | 0.64 | 0.65 | 0.62 |
| LSM | | | | 0.98 | 0.54 | 0.52 | 0.52 | 0.54 | 0.56 |
| BLUP | | | | | 0.42 | 0.38 | 0.38 | 0.42 | 0.44 |
| Auxiliary traits | AFC | | | | | 0.99 | 0.99 | 1 | 0.98 |
| | FSP | | | | | | 1 | 0.99 | 0.99 |
| | FCI | | | | | | | 0.99 | 0.99 |
| | FLL | | | | | | | | 0.98 |

## Conclusions

1. The estimated breeding values of sires by different methods of sire evaluation revealed that least-squares method is more accurate and efficient as it showed smaller error variance in comparison to all other methods.
2. This study indicated that considering one auxiliary trait along with first lactation milk yield may not be a very effective criteria for ranking sires for FLMY in comparison to any other sire evaluation method.

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