# Sire Evaluation Methods Using First Lactation Traits in Cross Bred Jersey Cattle

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Journal of Livestock Science (ISSN online 2277-6214) 16: 671-677
Received on 6/4/25; Accepted on 12/12/25; Published on 15/12/25
doi. 10.33259/JLivestSci.2025.671-677

**Abstract:**

The data collected from the history sheets of 1200 progeny maintained under field progeny testing programme belonging to 20 Jersey crossbred sires were utilized to evaluate breeding values of sires for actual and predicted first lactation 305 days milk yield traits by using least squares method (LSM), best linear unbiased prediction (BLUP) and restricted maximum likelihood (REML) methods. The average breeding value for actual first lactation 305 days milk yield was found to be 2550.82 kg by LSM, 2568.77 kg by BLUP and 2484.18 kg by REML methods. The average breeding value for predicted first lactation 305days milk yield was found to be 2602.90 kg by LSM, 2607.87 kg by BLUP and 2411.62 kg by REML methods. The efficiency, accuracy and stability of different sire evaluation methods were compared to judge their effectiveness. The REML was most efficient and accurate method of sire evaluation based on low error variance and high coefficient of determination. However, LSM and BLUP methods were most stable among all the methods having low coefficient of variation. The rank correlations between the sires and product moment correlations among the estimated breeding values of sires for actual and predicted FL305DMY traits revealed high degree of similarity of REML with BLUP method. Hence, REML method was found to be most effective method of sire evaluation followed by LSM and BLUP methods for sire evaluation of Jersey crossbred cattle under field progeny testing programme.

**Key Words:** BLUP, Jersey crossbreds, Least squares, Progeny testing, and Sire evaluation

# Introduction

For any successful breeding programme identification of genetically superior sires is the most important thing, since the contribution of sire path is higher than the dam path for overall genetic improvement of a trait. Progeny testing is a breeding programme where the genetic information on an animal for selection comes from the performance of its progeny and is possible in cattle breeds having large population size. Selection of superior sires is the quickest path to genetic improvement, with maximum accuracy is the utmost importance for any breed improvement programme, as sires are easily and rapidly disseminated in various herds under Progeny Testing Programme (Kumar et al., 2017).

Sire evaluation is one of the most important criteria of breed improvement program which involves the estimation of breeding value of the bulls on the basis of their daughters first lactation 305-day milk yield (Senbeta et al., 2021; Shashikant et al., 2024). The accuracy of estimating the breeding value of an animal is the major factor that affects the genetic progress due to selection (Abbas et al., 2016). There are several methods of sire evaluation viz., Simple daughters average index, Least squares method (LSM), Simple regressed least squares (SRLS), Best linear unbiased prediction (BLUP), Derivative free restricted maximum likelihood (DFREML) and Restricted maximum likelihood (REML) for single as well as multiple traits models, which were studied and compared by different researchers (Banik and Gandhi, 2010; Dongre and Gandhi, 2014; Bajetha et al., 2015a and Lodhi et al., 2016a, Amol., 2023).

Sire evaluation methods will be compared to assess accuracy, stability and efficacy by utilizing standard error of the estimates, coefficient of variation and coefficient of determination. Spearman's rank correlation among ranks and product moment correlation among estimates of sire merit were used to judge the relative efficiency of different methods of sire evaluation. The most efficient method had the lowest error variance. Higher the coefficients of determination ($R^2$) from fitting a model, higher is the accuracy. The sire evaluation method, which retains the coefficient of variation (CV %) of the population near to coefficient of variation of unadjusted data was the most stable method (Singh and Singh, 2016).

The present research work was undertaken with the objective to estimate breeding value of Jersey crossbred sires from their daughters' first lactation milk yield records (FLMY) by using different sire evaluation methods viz., Least squares method (LSM), Best linear unbiased prediction (BLUP) and Restricted maximum likelihood (REML) method.

# Materials and Methods

Data for the present investigation were collected from history cum pedigree sheets and milk yield registers of 1200 Jersey crossbred daughters sired by 20 Jersey crossbred bulls maintained over a period of 5 years (2013-2018) by selected farmers under progeny testing programme in Chittoor district, Andhra Pradesh. Only the sires having records on at least five daughters were included in the present study. The records of only those animals with known pedigree and normal lactation were considered. The lactation records of less than 100 days were considered as abnormal and were not included in the analysis. A total of 1200 individual monthly test day milk records of first lactation milk yield (FLMY)of Jersey crossbred cows were collected from $5^{th}$ to $305^{th}$ day of lactation period to generate information on actual and predicted first lactation milk yield. Culling, abortions, stillbirths and other pathological conditions which affected the lactation yield were considered as abnormalities and hence such records were excluded from analysis. The records of animals with less than 300 kg of milk production or less than 100 days of lactation length were also eliminated. The records of animal with known pedigree and normal lactation were considered for this study.

The standard lactation milk yield records of animals under PTP were calculated using the Test Interval Method (A4) described at Section 2.1.5.1 of the International Agreement of Recording Practices published by International Committee for Animal Recording (ICAR, 2012). The records of animals with above 100 days of lactation length were standardized to 305 days of milk yield by using USDA-DHIA standardized correction factor (Thomas and Sastry, 2007). In the present study the sires each having at least five daughters milk yield records and each sire with at least 3 records in each Herd-Year-Season group were only considered. Therefore, first lactation milk yield lactation records of daughters of 20 sires distributed over 27 mandals of Chittoor were utilized for estimating breeding value of sires.

**Classification of periods**

The data were grouped into different classes based on village clusters (herds) and season/year of calving. The total of 27 mandals were placed into 2 groups, as Eastern and Western regions, which varied in climatic conditions and resources availability and test sires were distributed randomly to mandals under these regions. The data were classified according to the year of calving into three periods viz., period 1(2015-2016), period 2 (2016-2017) and period 3 (2017-2018) whereas, year of birth into three periods viz., period 1 (2013-2014), period 2 (2014-2015) and period 3 (2015-2016.) Each year was divided into three seasons namely winter (November-February), summer (March-June) and Rainy (July-October) i.e., S1, S2 and S3, respectively.

**Statistical Analysis**

Jersey crossbred sires were evaluated based on 305 days first lactation milk yield of daughters using three methods of sire evaluation, viz. Least Squares Method (LSM Harvey,1987), Best Linear Unbiased Prediction (BLUP Henderson,1973) and Restricted Maximum Likelihood Method (REML Meyer, 2007) by using univariate mixed model, including sire and animal as random effects and herd, year and season as fixed effects. The effectiveness of different sire evaluation methods

was judged by using the various criteria like error variance, coefficient of determination ($R^2$), coefficient of variation (CV %), rank correlation and product moment correlation. The sire evaluation method with lowest error variance was considered the most efficient method. The spearman's rank correlations and product moment correlations between the breeding values of sires derived for the traits used to judge the effectiveness of the methods.

## Statistical model

### Least-squares method (LSM)

Sire was treated as random effect and other non-genetic factors (season, period and herd) were taken as fixed effects in statistical model is $Y_{ij} = \mu + S_i + e_{ij}$., ($Y_{ij} = j^{th}$ dependent single trait of daughter of $i^{th}$ sire., $\mu$ = Population means., $S_i$ = Effect of $i^{th}$ sire and $e_{ij}$ = Random error assumed to be distributed normally and independently with mean zero and constant variance i.e. NID (0, $\sigma^2_e$).

### Best Linear Unbiased Prediction (BLUP) method

In the present study the BLUP evaluations were obtained by using Harvey software under Univariate animal model and the matrix notation of the model is Y = Xb + Za +e., (Y = Observational matrix of traits., b = Vector of fixed effects., a = Vector of random sire effects., X and Z= Design matrices for fixed and random effects, respectively and e = Vector of random residual effects).

### Restricted Maximum Likelihood method (REML)

In the matrix notation, the mathematical model of REML can be written as: $Y_{ijk} = X_{bi} + Z_{ui} + e_{ijk}$., ($Y_{ijk} = k^{th}$ observation of $j^{th}$ random effect of $i^{th}$ fixed effect., $b_i$ = Vector of observation of fixed effect i.e. Season, Period., $u_i$ = Vector of additive genetic effect (Random effect/Sire effect)., X = Design matrix/Incident matrix of fixed effect., Z = Design matrix/Incident matrix of random effect and $e_{ijk}$ = Vector of residual errors).

# Results and Discussions

### Estimation of breeding value of sires for first lactation milk yield traits by various sire evaluation methods

### Actual and Predicted - First lactation 305 days milk yield

The maximum breeding value was found by restricted maximum likelihood method (2865.38 kg), followed by least squares (2826.43 kg) and best linear unbiased prediction (2725.74 kg) methods. Divya et al. (2014) noticed similar results of maximum breeding value by restricted maximum likelihood method of sire evaluation.

The highest difference between maximum and minimum breeding values was found (1262.18 kg) by restricted maximum likelihood method, indicated that REML method discriminated the bulls to the highest extent as compared to other methods, which was in conformity with the findings of Dash et al. (2014) in Holstein Friesian crossbred cattle.

The lowest difference between maximum and minimum breeding values was 513.39 kg observed by best linear unbiased prediction method, which shows that BLUP method has small genetic variations among the tested bulls in comparison to other methods. Satish (2015) noticed similar results with a difference of 510.48 kg between these two extreme values by using best linear unbiased prediction method.

The results revealed that breeding values for predicted first lactation milk yield (305days) ranged from 2354.28 to 2858.70kg, 2459.77 to 2750.02kg and 1986.82 to 2837.92kg in LSM, BLUP and REML, respectively and highest estimated breeding value was observed by least squares method (Table 1), which was in consonance with the findings Singh and Singh (2016a) and Ambhore et al. (2018). The results showed that 17.68% of higher genetic superiority and 17.61% of lower genetic superiority than average breeding value was observed by restricted maximum likelihood method (Table 2).

The highest difference between maximum and minimum breeding values was found by restricted maximum likelihood method (851.10kg), indicated that REML method discriminated amongst the bulls to the high extent as compared to other methods, which was in conformity with the findings of Dash et al. (2014) in Holstein Friesian crossbred cattle.

The lowest difference between maximum and minimum breeding values was 290.25 kg recorded by best linear unbiased prediction method, which shows that BLUP method has small genetic variations among the tested bulls in comparison to other methods. Almost similar results were reported using BLUP method by Berhanu (2008) in Holstein Friesian and Jersey cattle with a difference of 304.80 kg respectively. These findings of lowest genetic variations by BLUP method were coincided with results of Ratna Rao (1993) in Holstein Friesian and Jersey cattle.

The average breeding value of 20 Jersey crossbred sires with five or more daughters were estimated for actual first lactation 305 days milk yield estimated by different methods was found to be 2550.82 kg (LSM), 2568.77 kg (BLUP) and 2484.18 kg (REML). Whereas, the average breeding value for predicted first lactation 305 days milk yield estimated by different methods was found to be 2602.90 kg (LSM), 2607.87 kg (BLUP) and 2411.62 kg (REML), respectively, which were lower than Dhanraj et al. (2022) (Table 2).

The accuracy and effectiveness of three different sire evaluation methods used in this study for the estimation of breeding values of sires was judged through error variance, coefficient of determination and coefficient of variation

**Table 1: Breeding value estimates for actual and predicted first lactation (305 days) milk yield using different sire evaluation methods in Jersey crossbred sires**.

| Sire ID | Actual first lactation (305days) milk yield | | | Predicted first lactation (305 days) milk yield | | |
|---|---|---|---|---|---|---|
| | **LSM (days)** | **BLUP (days)** | **REML (days)** | **LSM (days)** | **BLUP (days)** | **REML (days)** |
| 4 | 2608.07 | 2598.66 | 2560.23 | 2523.81 | 2564.94 | 2281.20 |
| 13 | 2547.75 | 2561.53 | 2472.86 | 2605.93 | 2608.10 | 2415.30 |
| 24 | 2511.81 | 2540.26 | 2421.40 | 2535.60 | 2567.35 | 2296.20 |
| 26 | 2386.07 | 2480.46 | 2268.06 | 2471.90 | 2532.33 | 2190.56 |
| 127 | 2725.09 | 2667.29 | 2723.53 | 2632.35 | 2625.04 | 2461.62 |
| 140 | **1870.09** | **2212.35** | **1603.20** | 2417.45 | 2498.36 | 2095.77 |
| 141 | 2544.36 | 2560.46 | 2468.57 | 2654.48 | 2641.57 | 2502.89 |
| 142 | 2628.01 | 2603.65 | 2574.71 | 2533.56 | 2573.40 | 2301.15 |
| 144 | 2698.51 | 2648.97 | 2681.69 | 2586.69 | 2597.32 | 2383.14 |
| 208 | 2622.53 | 2613.44 | 2590.25 | 2656.37 | 2639.67 | 2503.02 |
| 279 | 2519.04 | 2543.48 | 2429.72 | 2610.09 | 2611.27 | 2423.40 |
| 281 | 2356.71 | 2441.09 | 2189.18 | 2483.65 | 2535.29 | 2206.49 |
| 283 | 2592.37 | 2595.09 | 2547.23 | 2604.94 | 2608.27 | 2414.63 |
| 3606 | 2183.18 | 2343.83 | 1952.06 | **2354.28** | **2459.77** | **1986.82** |
| 3610 | **2826.43** | **2725.74** | **2865.38** | 2755.48 | 2699.10 | 2673.00 |
| 3611 | 2592.10 | 2588.15 | 2534.71 | 2683.69 | 2626.73 | 2470.03 |
| 3612 | 2709.93 | 2668.96 | 2721.19 | 2643.12 | 2633.57 | 2482.36 |
| 4302 | 2736.92 | 2687.65 | 2785.51 | 2750.14 | 2698.22 | 2671.72 |
| 4303 | 2574.48 | 2580.55 | 2514.28 | 2740.82 | 2687.11 | 2644.20 |
| 4304 | 2783.89 | 2713.71 | 2827.59 | **2858.70** | **2750.02** | **2837.92** |

**Table: 2 Average breeding value estimates for actual and predicted first lactation milk yield using different sire evaluation methods in Jersey crossbred sires.**

| Method | Average breeding value (ABV) (kg) | Number of sires | | Maximum breeding value (kg) | Minimum breeding value (kg) | Difference |
|---|---|---|---|---|---|---|
| | | Above ABV | Below ABV | | | |
| Actual first lactation (305days) milk yield | | | | | | |
| LSM | 2550.82 | 12(60%) | 8(40%) | 2826.43(10.80%) | 1870.09(26.69%) | 956.34 |
| BLUP | 2568.77 | 12(60%) | 8(40%) | 2725.74(6.11%) | 2212.35(13.87%) | 513.39 |
| REML | 2484.18 | 12(60%) | 8(40%) | 2865.38(15.34%) | 1603.20(35.46%) | 1262.18 |
| Predicted first lactation (305days) milk yield | | | | | | |
| LSM | 2602.90 | 12(60%) | 8(40%) | 2858.70(9.83%) | 2354.28(9.55%) | 504.42 |
| BLUP | 2607.87 | 12(60%) | 8(40%) | 2750.02(5.45%) | 2459.77(5.67%) | 290.25 |
| REML | 2411.62 | 12(60%) | 8(40%) | 2837.92(17.68%) | 1986.82(17.61%) | 851.10 |

The results revealed that breeding values for predicted first lactation milk yield (305days) ranged from 2354.28 to 2858.70kg, 2459.77 to 2750.02kg and 1986.82 to 2837.92kg in LSM, BLUP and REML, respectively and highest estimated breeding value was observed by least squares method (Table 1), which was in consonance with the findings Singh and Singh (2016a) and Ambhore et al. (2018). The results showed that 17.68% of higher genetic superiority and 17.61% of lower genetic superiority than average breeding value was observed by restricted maximum likelihood method (Table 2).

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The lowest difference between maximum and minimum breeding values was 290.25 kg recorded by best linear unbiased prediction method, which shows that BLUP method has small genetic variations among the tested bulls in comparison to other methods. Almost similar results were reported using BLUP method by Berhanu (2008) in Holstein Friesian and Jersey cattle with a difference of 304.80 kg respectively. These findings of lowest genetic variations by BLUP method were coincided with results of Ratna Rao (1993) in Holstein Friesian and Jersey cattle.

The average breeding value of 20 Jersey crossbred sires with five or more daughters were estimated for actual first lactation 305 days milk yield estimated by different methods was found to be 2550.82 kg (LSM), 2568.77 kg (BLUP) and 2484.18 kg (REML). Whereas, the average breeding value for predicted first lactation 305 days milk yield estimated by

different methods was found to be 2602.90 kg (LSM), 2607.87 kg (BLUP) and 2411.62 kg (REML), respectively, which were lower than Dhanraj et al. (2022) (Table 2).

The accuracy and effectiveness of three different sire evaluation methods used in this study for the estimation of breeding values of sires was judged through error variance, coefficient of determination and coefficient of variation.

## Comparative evaluation of different sire evaluation methods for first lactation milk yield traits:

**Table 3. Genetic merit of Jersey crossbred sires for first lactation milk yield traits based on estimated breeding value by different sire evaluation methods with their respective ranks.**

| Actual FL305DMY | | | | Predicted FL305DMY | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sire no** | **LSM** | **BLUP** | **REML** | | **Sire no** | **LSM** | **BLUP** | **REML** |
| 3610 | 2826.43 (1) | 2725.74 (1) | 2865.38 (1) | 4304 (1) | 4304 | 2858.70(1) | 2750.02(1) | 2837.92(1) |
| 4304 | 2783.89 (2) | 2713.71(2) | 2827.59(2) | 3610 (2) | 3610 | 2755.48(2) | 2699.1(2) | 2673(2) |
| 4302 | 2736.92(3) | 2687.65(3) | 2785.51(3) | 4302 (3) | 4302 | 2750.14(3) | 2698.22(3) | 2671.72(3) |
| 3612 | 2725.09(5) | 2668.96(4) | 2723.53(5) | 4303 (4) | 4303 | 2740.82(4) | 2687.11(4) | 2644.2(4) |
| 127 | 2709.93(4) | 2667.29(5) | 2721.19(4) | 3611 (5) | 3611 | 2683.69(5) | 2641.57(7) | 2503.02(6) |
| 144 | 2698.51(6) | 2648.97(6) | 2681.69(6) | 208 (6) | 208 | 2656.37(6) | 2639.67(6) | 2502.89(7) |
| 208 | 2628.01(8) | 2613.44(7) | 2590.25(7) | 141 (7) | 141 | 2654.48(7) | 2633.57(8) | 2482.36(8) |
| 142 | 2622.53(7) | 2603.65(8) | 2574.71(8) | 3612 (8) | 3612 | 2643.12(8) | 2626.73(5) | 2470.03(5) |
| 4 | 2608.07(9) | 2598.66(9) | 2560.23(8) | 127 (9) | 127 | 2632.35(9) | 2625.04(9) | 2461.62(9) |
| 283 | 2592.37(10) | 2595.09(10) | 2547.23(10) | 279 (10) | 279 | 2610.09(10) | 2611.27(10) | 2423.4(10) |
| 3611 | 2592.10(11) | 2588.15(11) | 2534.71(11) | 13 (11) | 13 | 2605.93(11) | 2608.27(12) | 2415.3(11) |
| 4303 | 2574.48(12) | 2580.55(12) | 2514.28(12) | 283 (12) | 283 | 2604.94(12) | 2608.10(11) | 2414.63(12) |
| 13 | 2547.75(13) | 2561.53(13) | 2472.86(13) | 144 (13) | 144 | 2586.69(13) | 2597.32(13) | 2383.14(13) |
| 141 | 2544.36(14) | 2560.46(14) | 2468.57(14) | 24 (14) | 24 | 2535.60(14) | 2573.40(15) | 2301.15(15) |
| 279 | 2519.04(15) | 2543.48(15) | 2429.72(15) | 142 (15) | 142 | 2533.56(15) | 2567.35(14) | 2296.2(14) |
| 24 | 2511.81(16) | 2540.26(16) | 2421.40(16) | 4 (16) | 4 | 2523.81(16) | 2564.94(16) | 2281.2(16) |
| 26 | 2386.07(17) | 2480.46(17) | 2268.06(17) | 281 (17) | 281 | 2483.65(17) | 2535.29(17) | 2206.49(17) |
| 281 | 2356.71(18) | 2441.09(18) | 2189.18(18) | 26 (18) | 26 | 2471(18) | 2532.33(18) | 2190.56(18) |
| 3606 | 2183.18(19) | 2343.83(19) | 1952.06(19) | 140 (19) | 140 | 2417.45(19) | 2498.36(19) | 2095.77(19) |
| 140 | 1870.09(20) | 2212.35(20) | 1603.20(20) | 3606 (20) | 3606 | 2354.28(20) | 2459.77(20) | 1986.82(20) |

**Error variance**

The contents of Table 3 revealed that on the basis of error variance of the estimates, REML method was found to be most efficient method with low error variance value as 173002 $kg^2$ for actual first lactation 305 days milk yield, 177075.00 $kg^2$ for predicted first lactation 305 days milk yield, Ramesh (2013), Ambhore et al. (2018) and Vani et al. (2018) also reported that REML method is the most efficient over the LSM and BLUP methods of sire evaluation. However, REML was considered more efficient in actual and predicted FLMY. In accordance to present findings REML method in comparison to LSM and BLUP methods was found to be the most efficient method of sire evaluation.

**Coefficient of determination ($R^2$%)**

In the present study the REML method showed highest $R^2$ value (%) for majority of the first lactation milk yield traits, as 49.60 (actual FL305DMY), 43.10 (predicted FL305DMY), followed by LSM method where $R^2$ values (%) for the respective traits were 18.20, 15.40. Similar to these findings, Ambhore et al. (2018) and Vani et al. (2018) reported higher $R^2$ value for first lactation milk yield traits by REML method. Therefore, REML estimates were most accurate for actual FLMY.

**Coefficient of variation (CV %)**

The contents of Table 3 revealed that LSM and BLUP methods were found to be with similar lower coefficient of variation values for actual and predicted first lactation milk yield traits indicating that these methods were almost equal stable. Similar findings were noticed by Pandey et al. (2013), Dongre and Gandhi (2014) and Vani et al. (2018).

The findings of present study revealed that for majority of first lactation milk yield traits LSM and BLUP methods were found as with similar degree of stability, followed by REML method.

## Rank correlations and product moment correlations among different sire evaluation methods for first lactation reproductive traits

The Spearman's rank correlations among sire ranks and simple product moment correlations between estimated breeding values of sires were also used to judge the effectiveness of different sire evaluation methods.

**Rank correlations**

The correlation coefficient ranks between sires evaluated by various methods of sire evaluation for all first lactation milk yield traits were found to be highly significant ($P \leq 0.01$ ranged from 0.997 (LSM x BLUP) to 0.998 (LSM x REML and BLUP x REML) for actual first lactation 305 days milk yield, 0.986 (LSM x BLUP) to 0.997 (BLUP x REML) for predicted first lactation 305 days milk yield

These results revealed that, higher (near to unity) rank correlations amongst sires from different sire evaluation methods have higher degree of similarity of ranking. Ranking of sires by using anyone of these methods could result in similar ranking of sires ranging from 98% to 99% for first lactation milk yield. The present findings confirmed with the results of Ramesh (2013), Lodhi et al. (2015), Vani et al. (2018), who also reported highly significant rank correlations (0.90 to 0.95) for first lactation milk yield. The present study revealed that BLUP with REML method are equally effective and could be better option for estimating breeding values for first lactation milk yield, Similar findings were also reported by Dahiya et al. (2005), Singh and Singh (2016). For majority of the first lactation milk yield traits.

**Simple product moment correlations**

It was observed that product moment correlations between estimated sire merits by different methods for all first lactation milk yield traits were highly significant ($P \leq 0.01$). The perusal of results indicates that the association between the methods ranged from 0.996 (LSM with BLUP) to 1.000 (BLUP with REML) for actual and predicted first lactation 305 days milk yield. These results are in agreement with the findings of Lodhi et al. (2015), Vani et al. (2018) for first lactation milk yield and for age at first calving.

Since rank correlations and product moment correlations by REML with BLUP method were highly correlated and revealed that REML and BLUP method can well be used for evaluation of sires under field conditions, followed by LSM with BLUP method. It was observed that rank correlations were comparatively higher than product moment correlations for different first lactation milk yield traits calculated by various sire evaluation methods.

The estimated breeding values of sires had very high significant product moment and rank correlations among first lactation milk yield traits estimated by various methods, indicating that there was higher degree of similarity in ranking of sires by REML with BLUP method.

**Sire ranking on the basis of estimated breeding value for first lactation milk yield traits by different sire evaluation methods**

The contents of Table 5 revealed that sire no. 3610 had highest merit for actual first lactation 305 days milk yield and ranked as 1$^{st}$ and same sire ranked 2$^{nd}$ for predicted first lactation 305 days milk yield by all the three methods of sire evaluation. It was found that top ten sires hold similar ranks by being in top ten irrespective of methods employed for computation of breeding values (Table 3).

Sire no. 140 was found to be lowest in merit for actual first lactation 305 days milk yield and sire no. 3606 found to be lowest in merit for predicted first lactation 305 days milk yield by all three methods of sire evaluation (Table 3). It was found that ten sires out of bottom ten shared their ranks by being in bottom position under three methods of sire evaluation (Table 3).

**Conclusion**

Sire evaluation on the basis of predicted data was similar to the evaluation on the basis of the actual data indicating that the predicted data can be used as alternative for early animal evaluation and reduction of generation interval. Based on error variance and coefficient of determination, REML was most efficient and accurate method of sire evaluation. Based on coefficient of variation values for comparison among methods for first lactation milk yield traits, LSM and BLUP were found to be most stable methods. Highly significant difference observed between simple product moment and rank correlations for first lactation milk yield traits revealed high degree of similarity by REML with BLUP method. Therefore, preference should be given to use REML, followed by LSM and BLUP methods for sire evaluation of Jersey crossbred cattle under field progeny testing programme.

**Conflict of interest:** No conflict of interest

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