

## Comparison of sire evaluation methods in Holstein Friesian in the central highlands of Ethiopia

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### ABSTRACT

First lactation records (387) of Friesian-Boran crossbred cows, daughters of 37 Holstein Friesian (HF) sires were analyzed. Holstein Friesian sires were evaluated based on breeding values estimated considering first lactation 305-days milk yield of their progeny using 4 sire evaluation methods, viz. contemporary comparison (CC), least squares method (LS), best linear unbiased prediction (BLUP) and derivative free restricted maximum likelihood (DFREML). The effectiveness of the methods was judged using various criteria, viz. error variance, coefficient of determination, coefficient of variation and rank correlation. The highest (1781.1 kg) and lowest (1766.78 kg) average breeding values were obtained by CC and DFREML methods, respectively. DFREML had the smallest (197061 kg<sup>2</sup>) error variance and highest (60%) R<sup>2</sup> value and was adjudged as the most efficient and accurate method compared with others. The CV values computed by different methods were similar indicating lack of meaningful variation amongst the methods as far as stability is concerned. The rank correlations between the ranks of HF sires evaluated by different methods were high (greater than 0.93), indicating that ranking of sires using any of these methods could yield similar order. The implication of the result is that, based on availability and computational suitability of the method, one can use any of the methods in sire evaluation under the Ethiopian condition.

**Key words:** Breeding value, Ethiopia, Holstein Friesian, Sire evaluation methods

In Ethiopia, cattle production plays an important role in the economies of the farmers and the country at large. However, production per animal is extremely low. The average lactation milk production for the indigenous cows ranges from 494-850 kg under optimum management (EARO 1999).

To meet the ever-increasing demand for milk and milk products in Ethiopia, genetic improvement of the indigenous cattle basically focusing on crossbreeding, has been suggested and is being practiced for the last five decades but with little success. The collection, processing and distribution of semen from exotic breeds (mainly HF) for crossbreeding in the organized herds and local farmers herd are done by National Artificial Insemination Center (NAIC). At present, the selection criteria for young males for future breeding are based on physical appraisal traits of the young bulls and the milk production performance of their dam. These attributes

may not adequately represent the real potential of the sire for milk production. In fact, Mohammed (2004) reported that the most frequently used i.e. preferred sires were not of the highest breeding values, and breeding values of the sires did not improve over the three decades of study period. Therefore, selection of sire in the future should base on breeding value of the sire. Breeding value of the sire could be estimated using different sire evaluation methods. One has to look in the efficiency of these methods with practical applicability to the local conditions. This paper reports breeding value of HF sires using 4 sire evaluation methods and compares the methods in terms of efficiency, accuracy and stability of the methods to the conditions of Ethiopian highlands.

### MATERIALS AND METHODS

This study was based on data collected from experimental dairy cattle herds of the International Livestock Research Institute (ILRI) at the Debre Zeit Research Station and of the Ethiopian Institute of Agricultural Research (EIAR) at the Holeta Agricultural Research Station. First lactation records of 387 Friesian-Boran crossbred cows, daughters of 37 HF sires were used for this study. The data were spread

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over 15 years (1990-2004). Sires with records on at least 5 daughters were considered.

Holstein Friesian sires were evaluated and ranked on the basis of their estimated breeding values considering first lactation 305 days milk yield of their progeny using 4 sire evaluation methods. The methods evaluated were: contemporary comparison (CC), least squares method (LS), best linear unbiased prediction (BLUP) and derivative free restricted maximum likelihood (DFREML) methods. For contemporary comparison the index given by Robertson and Randel (1954) was used. In the least squares analysis, method developed by Harvey (1966) was used to estimate the breeding value of the bulls (SAS 2002). The breeding value of sires was also estimated by BLUP as given by Henderson (1973, 1975). Package of Meyer (1998) was utilized for the estimation of the breeding values for DFREML. Single trait animal model was used for estimation of the breeding value of sires. HF bulls were evaluated based on performance of HF-Ethiopian Boran crossbred cows (progenies). Therefore, the breeding values estimated should be judged with this premise. Before estimation of breeding values, data were adjusted for significant non genetic factors. These included genotype (4 classes: 50, 62.5, 75 and 87.5 % Holstein Friesian inheritance); calving period (5 classes: 1990-92, 1993-95, 1996-98, 1999-2001, 2002-04); calving season, grouped into 3 classes, based on the pattern of annual rainfall distribution in the area (November - February: dry period; March - June: light rains; and July - October: main rainy season); and herd (2 classes: Debre Zeit, Holeta).

The effectiveness of the different sire evaluation methods was judged using various criteria, which included within sire variance or error variance (The method giving lowest error variance had higher efficiency and was considered most appropriate); coefficient of determination (higher  $R^2$  value of fitting the model indicated higher accuracy); coefficient of variation (the method that would least alter the CV as compared to unadjusted data was considered more stable) and rank correlation. The spearman's rank correlation between the ranks of breeding values of sires derived by various methods was estimated by SAS (2002). Higher rank correlation amongst the sires from different sire evaluation methods revealed higher degree of similarity of ranking from different methods.

## RESULTS AND DISCUSSION

### *Descriptive information*

The different descriptive statistics such as mean, minimum and maximum breeding value and range are presented in Table 1. The average breeding values of 37 HF sires evaluated on the basis of first lactation 305 days milk yield by CC, LSM, BLUP and DFREML methods were 1781.1, 1776.7, 1766.84 and 1766.78 kg, respectively. The minimum BV was obtained in the LSM (850.4) whereas the maximum was recorded in DFREML (2480.9).

### *Comparison of the sire evaluation methods*

Results of error variance, coefficient of determination and coefficient of variation were not available for contemporary comparison method. Thus, comparison was not made against contemporary comparison.

### *Within sire variance or error variance*

The error variance of the different methods of sire evaluation studied along with their relative efficiency is summarized in Table 2. The results indicated that DFREML method had the smallest error variance and was adjudged as the most efficient method of sire evaluation. BLUP method was second followed by LSM. The relative efficiencies of LSM and BLUP with respect to the most efficient method (DFREML) were, 95.32 and 99.98, respectively. As can be observed from the results, both methods had relative efficiency of greater than 95% indicating that the methods have estimated breeding values with fairly high accuracy. Literature reports comparing relative efficiency of different sire evaluation methods are not consistent. For example, BLUP method has been advocated by various workers (Henderson 1973, Harvey 1987, Raheja 1992) as one of the most efficient sire evaluation methods compared to the conventional CC and LSM. However, Tajane and Rai (1990) and Deb *et al.* (1998) reported that LSM was the most efficient method of sire evaluation compared to the BLUP. In full agreement to the present study Banik (2004) and Mukherjee (2005) reported DFREML method as the most efficient method compared to CC, LSM and BLUP. The inconsistent literature reports on the efficiency of different sire evaluation methods would thus necessitate application of other methods that suit the prevailing local conditions.

Table 1. Average breeding values (BV) of sires for first lactation 305 days milk yield by different methods

| Sire evaluation method | Average BV | Minimum BV (% below average BV) | Maximum BV (% above average BV) | Number of sires over average BV | Number of sires below average BV (% of sires) | Range of BV (% of sires) |
|------------------------|------------|---------------------------------|---------------------------------|---------------------------------|-----------------------------------------------|--------------------------|
| CC                     | 1781.1     | 1531.1 (14.0)                   | 2233.6 (25.4)                   | 18 (48.6)                       | 19 (51.4)                                     | 702.5                    |
| LSM                    | 1776.7     | 850.4 (52.1)                    | 2475.1 (39.3)                   | 19 (51.4)                       | 18 (48.6)                                     | 1624.7                   |
| BLUP                   | 1766.84    | 1162.5 (34.2)                   | 2385.8 (35.0)                   | 19 (51.4)                       | 18 (48.6)                                     | 1223.3                   |
| DFREML                 | 1766.78    | 1377.1 (22.1)                   | 2480.9 (40.4)                   | 19 (51.4)                       | 18 (48.6)                                     | 1103.8                   |

Table 2. Relative efficiency of different sire evaluation methods

| Method | Error variance | Relative efficiency | R <sup>2</sup> (%) | CV (%) |
|--------|----------------|---------------------|--------------------|--------|
| LSM    | 206743.80      | 95.32               | 38.3               | 25.53  |
| BLUP   | 197095.45      | 99.98               | 56.5               | 25.01  |
| DFREML | 197061.00      | 100.00              | 60.0               | 25.00  |

#### Coefficient of determination

Of the methods studied, DFREML was again found to have highest (60%) R<sup>2</sup> value followed by BLUP (56.5%). The LSM (38.3%) was the least efficient. Therefore, the criterion of using R<sup>2</sup> again confirmed the superiority of DFREML method compared with the other methods. Gandhi and Gurnani (1991) compared the accuracy of LSM, SRLSM and BLUP methods using R<sup>2</sup> value and revealed that LSM method was most accurate (R<sup>2</sup> of 15.34) followed by SRLSM and BLUP in that order. Banik (2004) on the other hand found higher R<sup>2</sup> value in DFREML method followed by CC, LSM and SRLSM.

#### Coefficient of variation (CV %)

The CV of unadjusted data was 37.5%. The CV values of the population by the different methods were more or less similar. The values ranged from 25% in DFREML to 25.53% in LSM method. Therefore, as far as stability is concerned, there is no meaningful variation among the different sire evaluation methods. Gandhi and Gurnani (1991) reported that CC and BLUP methods were the least stable methods of sire evaluation in Sahiwal cattle. Banik (2004) on the other hand suggested BLUP method as the most stable method on account of CV %.

#### Rank correlation of the sire evaluation methods

The correlation coefficients between the ranks of HF sires evaluated by various sire evaluation methods were all high, greater than 0.93. All the values were highly significant ( $P < 0.01$ ) (Table 3).

The rank correlations of DFREML (most efficient method) with CC, LSM and BLUP were 0.965, 0.940 and 0.953, respectively. These results revealed that ranking of sires using anyone of these methods could yield similar order. Therefore, based on availability and computational suitability of the method, one can use the method of choice in sire evaluation. Literature reports on correlations between rankings of the

Table 3. Spearman's rank correlations between different sire evaluation methods

| Method | LSM     | BLUP    | DFREML  |
|--------|---------|---------|---------|
| CC     | 0.965** | 0.947** | 0.965** |
| LSM    |         | 0.958** | 0.940** |
| BLUP   |         |         | 0.953** |

sire's breeding values estimated by different sire evaluation methods are substantial. Raheja (1992), Gaur *et al.* (2001), Banik (2004) and Mukherjee (2005) reported high rank correlations between LSM, SRLSM and BLUP methods and suggested that these methods were more or less similar in ranking of dairy sires and any of the methods could be used to obtain unbiased estimates of breeding values of sires.

In all the criteria set to compare the efficiency of different methods it was observed that DFREML method was the most efficient followed by BLUP. However, the Spearman's rank correlation coefficients between the various sire evaluation methods were all high and significant. The implication of the result is that, based on availability and computational suitability of the method, one can use any of the methods in sire evaluation. Until a progeny testing program is in place, it is expected that NAIC would continue with its policy of recruiting young bulls, based on their dam's performance, for breeding. It is important, however, that the association between breeding value of sires and the selection criterion of NAIC should be studied in the future.

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