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EFFECTIVNESS AND COMPARISON OF FOUR METHODS OF SIRE EVALUATION TO IMPROVE MILK TRAITS OF FLECKVIEH CATTLE

M.H. Khalil[1], A.M. Soliman[2], A.M., S.M. Zahed[3], and E.A. Afifi[1]

1- Department of Animal Production, Faculty of Agriculture at Moshtohor, University of Zagazig, Banha Branch, Qalyobia, Egypt, 2- Department of Animal Production, Faculty of Agriculture, University of Zagazig, Zagazig, Egypt, 3- Animal Production Research Institute, Ministry of Agriculture, Giza, Egypt

SUMMARY

Data on 7959 daughters extracted from 19215 first-lactation records were used in evaluating 69 Fleckvieh sires. All sires whose had at least 100 daughters were included in such evaluation. Sire transmitting abilities (STA) were estimated using four methods of best linear unbiased predictor without relationship coefficient matrix (BLUP1), BLUP using restricted maximum likelihood (REML) in estimation of variance component (BLUP2), ordinary least square (OLS) and contemporary comparison (CC). Records of 305-day lactation for yields of milk (MY), fat (FY), protein (PY), fat-plus-protein (FPY) and carrier (CY) were used. Criteria for judging the merits of different methods of sire evaluation involved the Product-moment correlation (r_{PM}), Spearman rank correlation (r_S) and Kendall rank correlation (r_K). To assess the accuracy of different methods of sire evaluation, standard error (SE) of each method was calculated along with the percentage of reduction in standard error (RSE) due to using one method instead of another. The last criterion for judging the difference between methods is the sum of square of difference between methods (SSD).

For OLS, BLUP1, BLUP2 and CC methods, there was a difference of 1289, 1255, 1101 and 2371 Kg for MY; 1210, 1177, 1032, 2231 Kg for CY; 53, 51, 45 and 104 Kg for FY; 36, 34, 30 and 70 Kg for PY and 87, 85, 74 and 176 Kg for FPY. For all traits, the largest differences were obtained by CC and the lowest differences were observed by BLUP2. Among all sires, the percentage of sires having negative estimates of STA in OLS, BLUP1, BLUP2 and CC methods were 57, 57, 57 and 55% for MY; 49, 52, 52 and 54% for FY; 51, 52, 49 and 51% for PY; 54, 55, 54 and 54% for FPY and 55, 57, 57 and 55% for CY. The smallest absolute differences between BLUP2 vs BLUP1 and BLUP2 vs OLS were recorded by the largest number of sires. For MY and CY, there were about 83% and 72% of the sires representing an absolute difference of <40 Kg in comparisons of BLUP2 vs BLUP1 and BLUP2 vs OLS, respectively, while 12% of the sires representing an absolute difference of >60 Kg in these two comparisons were observed. A reverse trend in comparison of BLUP2 vs CC was observed where the largest number of sires was found in the smallest absolute difference. Estimates of rPM between all combinations of two methods of BLUP2, BLUP1 and OLS were greater than 0.992 (P<0.001), while they were lower for comparison of CC and each of OLS, BLUP1 and BLUP2 (0.523-0.659), i.e. BLUP2, BLUP1 and OLS were in close agreement as measured by the rank correlations. The same trend was observed when considering rS and rK with a slight decrease in the figures. For all traits, BLUP2 has the lowest estimates of SE, while CC has the largest estimates. Also, estimates of RSE from using BLUP2, BLUP1 and OLS instead of CC were large and ranged from 45.5 to 56.3%. On the other hand, RSE estimates ranged from 11.8 to 17.1% from using BLUP2 instead of BLUP1 or OLS, while they ranged from 2.0 to 4.4% from using BLUP1 instead of OLS, i.e. both methods of BLUP1 and OLS are similar since RSE were the lowest. There were no differences between BLUP1 and OLS in ranking of sires. For all traits, a great closeness between BLUP1 and OLS was evidenced since estimates of SSD were the lowest, while comparison of BLUP2 and CC had the largest estimates of SSD. Similar estimates of SSD between CC and each of BLUP1 and OLS were obtained.

Keywords: Fleckvieh, sire evaluation, milk traits

INTRODUCTION

In dairy cattle breeding, selection of sires for milk-yield traits is the most important aspect of genetic improvement. Sire evaluation programmes are also essential because the majority of genetic improvement can be attained through the selection of males rather than selection of females. Before the last three decades, contemporary comparison method was used in estimation of transmitting ability of sires. During the last two decades, the superiority of mixed-model methods was well established. During these two decades, procedure of best linear unbiased predictor (BLUP) was developed by Henderson (1972) and it was used throughout the world for sire evaluation. However, actual difference in response achieved over methods of evaluation will depend on the trait in question and the structure of data (Sorensen, 1988).

Comparisons of different methods of sire evaluations in real life data is always a troublesome task. The true genetic values are not known and therefore the comparisons can only demonstrate that the methods are dif ferent, but not show which of them is the best (Danell and Eriksson, 1982). Henderson (1975) therefore concluded that analytical methods for comparisons of alternative sire evaluation methods should be preferred, rather than comparison of actual data. If the properties of one method are known to be better than the properties of another, the better method could be chosen as the basis for the comparisons. From Animal Breeding theory (Henderson, 1984), the BLUP method can be considered as a better method than the contemporary or herdmate method (Henderson, 1972 & 1974). Criteria to define the best method are not uniform from one research report to another (Hargrove et al., 1974).

The objectives of the present study were: (1) to evaluate the genetic merit of Fleckvieh sires for 305-day milk traits (yields of milk, fat, protein, fat-plus-protein and carrier of the first lactation) using different methods of sire evaluation, (2) to quantify the differences between these methods and finally (3) to detect which method is the best under our data set structure. Special emphasis of sire evaluation was paid for data collected for a short period of five years.

MATERIALS AND METHODS

Data

Data on performance of 305-day lactation of Fleckvieh cattle were obtained from Official Test Federation of Austrian Cattle Breeders (ZAR) in lower Austria. Detailed descriptions of these data have been presented by Hartmann et al. (1992). Records were begun between 1977 and 1982. A total of 10886 records extracted from 19215 first-lactation records were used for estimating genetic parameters. All normal records of less than 305 day milk along with those reaching 305 day were included.

Milk traits of 305-day lactation included yields of milk (MY), fat (FY), protein (PY), fat-plus-protin (FPY) and carrier (CY). The data set was comprised only cows who had information on their first lactation. To avoid bias due to differences among sires in the average values of herd, each record was expressed as a deviation from the herd average, i.e. herd effect was eliminated. Consequently, any herd that contains only one record didn't contribute to the present study. Also, if the cow was changed from a herd to another, their records were eliminated.

METHODS AND MODELS

To avoid the bias from effect of cow selection, only records of first lactation were used in this part of sire evaluation assuming that: (1) the environmental correlation among paternal-half-sisters assumed to be zero, (2) no inbreeding in the population exists, (3) there is no relationships between sires, and (4) the herdmates for daughters of all sires have the same average genetic value. All sires with at least 100 daugh ters were included in such evaluation. As a result of these assumptions, 69 sires representing 7959 daughters were used. Estimates of heritability of first lactation only and variance components given by Afifi et al. (1994) were used. The four methods described below were used in such sire evaluation.

Contemporary Comparison (CC)

Procedures of contemporary comparison (CC) were described in details by Johansson and Rendel (1968).

Accordingly, all lactation records were adjusted for non-genetic effects (age at calving and days open) using different sets of correction factors derived from the polynomial regression coefficients calculated from these data set and for year-season effects using the least-square constants obtained by the following model:

$$Y_{iklmn} = \mu + S_i + Y_{Sk} + A_l + D_m + e_{iklmn} \quad \text{(model 1)} \ . \ (1)$$

where: Y_{iklmn}= 2X-305 milk record expressed as a deviation from the herd average, μ= the overall mean, S_i= the random effect of ith sire, YS_k= the fixed effect of kth year-season combination (K=16), A_l= the fixed effect of lth age at calving (classes classified monthly from <24 month to 61 month), D_m= the fixed effect of mth days open (classes starting from <45 days as a first class and an interval of 30 days thereafter) and e_{iklmn}= the random error $(0, \sigma^2_e)$.

Daughters records of each sire were expressed as weighted average deviations from contemporaries calving in the same herd-year-season (Kennedy and Moxley, 1977; Powell et al., 1978; Vinson et al., 1982) and there fore the transmitting ability of each sire (STA) was calculated as:

$$STA = bD_W \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (2)$$

where $b= nh^2/4+(n-1)h^2$, since n= number of daughters per sire and h^2= heritability; $D_W = \Sigma W\ (D - HA)/\ \Sigma W$, since W= n1n2/n1+n2 (effective number of daughters per sire, D= daughters average and HA= herd average.

Ordinary Least Square (OLS) Procedure

Estimation of this procedure for unbalanced data has been described by Harvey (1960). In this least-square procedure, sire is considered as a fixed effect. In the present study, year-season adjusted records were analyzed. Using the matrix notation to express the procedure to avoid a plethora of suffixes and summation symbols, we can exposit the following form (Henderson, 1978; Thompson, 1979):

$$= X\beta + Zs + e \quad \text{(Model 2)} \quad \ldots\ldots\ldots\ (3)$$

where y= (n x 1) vector of 2X, 305 milk observations on one yield trait, X and Z= n x t matrix and n x b matrix, respectively and both are assumed to be of full rank, and β and s= vectors of size t and b representing the unknown fixed effects of age at calving (15 class), days open (6 class), and 69 sire. The variance of e is known non-singular variances matrix R. The variance matrix of y is then ZZ +R = V, so the least squares equations are:

$$\begin{bmatrix} X'X & X'Z \\ Z'X & Z'Z \end{bmatrix} \begin{bmatrix} \beta \\ s \end{bmatrix} = \begin{bmatrix} X'y \\ Z'y \end{bmatrix} \quad \ldots\ldots\ (4)$$

Best Linear Unbiased Predictor (BLUP1) Procedure without relationship coefficient matrix (A^{-1}). The BLUP procedure and their applications to sire evaluation are described by Henderson (1972). One set of crossclassified non-interacting random effects (sire) is absorbed (Harvey, 1990). Accordingly, BLUP estimates for random sire effects absorbed by maximum likelihood were obtained. BLUP procedures were used to evaluate directly the sires from records of their daughters according to the previous model (Model 2) with regard to the sire as a random effect. This procedure account for heritability, number of daughters, genetic trend and differences in levels of herdmate sires (Freeman, 1988). The solution of mixed model equations in simplified form are:

$$\begin{bmatrix} X'X & X'Z \\ Z'X & Z'Z+K \end{bmatrix} \begin{bmatrix} \beta \\ s \end{bmatrix} = \begin{bmatrix} X'y \\ Z'y \end{bmatrix} \quad \ldots\ldots\ (5)$$

where $K = \sigma^2_e/\sigma^2_s$ (i.e. 13.0, 11.8, 13.8, 11.9 and 12.9 for MY, FY, PY, FPY and CY, respectively) and solution to s, is called BLUP predictor of s. BLUP using Restricted Maximum Likelihood (REML) Procedure (BLUP2).

In this method, restricted maximum likelihood (REML) was used for estimating variance components to be used in estimation of BLUP. In this case, the mixed-model equations of Henderson were used to obtain best linear unbiased predictors (BLUP) of the random effects, best linear unbiased estimators (BLUE) of the fixed effects and minimum normal quadratic unbiased estimators (MINQUE) of the variance components. In this situation, the random effects may or may be not correlated and Henderson's mixed model, in matrix notation, is:

$$y = X\beta + Zs + e. \quad \ldots\ldots\ (6)$$

where y= a vector of observation of milk trait, X and Z= known incidence matrices for fixed and random effects, s= unknown vector of random effect of sire, ß= unknown column vector of the fixed effects of year-season (14 class), age at calving (15 class) and days open (6 class), and e= a column vector of the random error. E(y)= Xß, E(s)= E(e)= 0, V(e)= $I\sigma^2_e$ and V(s)=Ik-1, where I= an identity matrix. The mixed model equations are:

$$\begin{bmatrix} X'X & X'Z \\ Z'X & Z'Z+Ik \end{bmatrix} \begin{bmatrix} \beta \\ s \end{bmatrix} = \begin{bmatrix} X'y \\ Z'y \end{bmatrix} \quad \ldots\ldots\ldots (7)$$

where k= σ^2_e/σ^2_s estimated by REML procedure (i.e. K= 1.04, 1.17, 2.03, 1.22 and 1.08 for MY, FY, PY, FPY and CY, respectively). In such a case, no relationships are assumed to exist (A^{-1} = I, the identity matrix). The Minimum variance normal quadratic unbiased estimates (MINQUE) of sire (σ^2_s) and error (σ^2_e) variance components as described by Henderson (1984) were calculated using LSMLMW program of Harvey (Harvey, 1990). Searle (1989) found that iterative MINQUE estimators are equal to REML estimators and therefore σ^2_s and σ^2_e were obtained as REML estimators.

Evaluation and accuracy of methods

The criteria for judging the merits of different methods of sire evaluation are the correlations between these methods such as Product-moment correlation, Spearman-rank correlation and Kendell-rank correlation (Har grove et al., 1974; Kress et al., 1977; Kennedy and Moxley, 1977; Dempfle and Hagger, 1979; Danell and Eriksson, 1982; Kemp et al., 1984; Mabry et al., 1987; Vig and Tiwana, 1988; Tajani and Rai, 1990). The product-moment correlation (r_{PM}) is a measure to calculate the correlation among estimates of sire merit.

Spearman's rank-order correlation (r_S) is a parametric measure to calculate the correlation among ranks of the sire. For the Spearman rank correlation, the data are first ranked. The Spearman correlation was then computed among ranks (SAS Procedure Guide, 1988). By using the rank correlation, we can decide which method is more correlated with others and which is less ones.

Kendall's correlation (r_K) is a measure calculated from concordances and discordances (SAS Procedue Guide, 1988). Concordance is measured by determining whether values of paired observation (e.g. CC, OLS, BLUP1 or BLUP2) vary together (in concord) or differently (in discord).

The other criteria to assess the accuracy of different methods of sire evaluation are the standard error (SE) of each method and the percentage of reduction in standard error (RSE) due to using one method instead of another. These estimates were calculated since they were used by many investigators as measures of accuracy for different methods of sire evaluation (Miller et al., 1967; Henderson, 1974; Ufford et al., 1979; Jensen, 1980; Kumar and Narian, 1980; Eriksson and Danell, 1984; Raheja, 1992). Another criterion useful and helpful in judging the merits of alternatives of sire evaluation methods is the sum of square of difference between methods (SSD). Comparisons were made firstly between each alternative method (CC or OLS or BLUP1) and the thought to be method ideal (BLUP2), secondly between each of OLS or CC and BLUP1 and finally between CC and OLS.

RESULTS AND DISCUSSION

Estimates of sire transmitting ability (STA)

Sire transmitting abilities (STA) were estimated by procedures of contemporary comparison (CC), ordinary least square (OLS), best linear unbiased predictor without A^{-1} (BLUP1) and BLUP considering restricted maximum likelihood (REML) in estimation of variance components (BLUP2). Considering all sires, the minimum and maximum estimates of STA are presented in Table 1. The difference (and the average difference) between minimum and maximum values of STA for different methods of sire evaluation are also illustrated in Table 1. For CC, OLS, BLUP1 and BLUP2 methods, there was a difference of 2371, 1289, 1255 and 1101 Kg for MY, respectively. The same trend of differences were also observed for CY (2231, 1210, 1177 and 1032 Kg), FY (104, 53, 51 and 45 Kg), PY (70, 36, 34 and 30 Kg) and FPY (176, 87, 85 and 74 Kg). For all traits, the largest differences were obtained by CC and the lowest differences were observed by BLUP2 (Table 1).

For all milk traits, the differences in STA for OLS were much lower than those for CC (Table 1). Miller et al. (1967) showed that the largest differences in STA estimated by CC were 1672 Kg for MY and 58.1 Kg for FY, while for OLS displayed lowest differences 1519 and 54.9 Kg, respectively. Raheja (1992) found that the lowest difference (548 Kg) in STA was with CC, while the largest difference (1956 Kg) was recorded by OLS followed by BLUP (1098 Kg).

Table 1. Minimum and maximum values for sire transmitting abilities estimated by best linear unbiased predictor considering REML in estimation of variance component (BLUP2), BLUP without A^{-1} (BLUP1), ordinary least- square (OLS) and contemporary comparison (CC)

	All sires				Top 10 sires
Trait+	Minimum	Maximum	difference	average++	difference
MY					
BLUP2	-347	754	1101	16.0	515
BLUP1	-427	828	1255	18.1	561
OLS	-446	843	1289	18.6	574
CC	-878	1493	2371	34.3	1050
FY					
BLUP2	-15	30	45	0.7	21
BLUP1	-18	33	51	0.7	23
OLS	-19	34	53	0.8	24
CC	-37	67	104	1.5	48
PY					
BLUP2	-10	20	30	0.4	13
BLUP1	-12	22	34	0.5	14
OLS	-13	23	36	0.5	14
CC	-28	42	70	1.0	32
FPY					
BLUP2	-25	49	74	1.1	35
BLUP1	-31	54	85	1.2	38
OLS	-32	55	87	1.3	38
CC	-66	110	176	2.6	78
CY					
BLUP2	-323	709	1032	15.0	488
BLUP1	-398	779	1177	17.1	535
OLS	-416	794	1210	17.5	545
CC	-823	1408	2231	32.3	1002

\+ Number of sires used for evaluation was 69 sires; each had at least
100 daughters.

++ average= difference value divided by number of sires.

The differences in estimates of STA for BLUP1 were slightly larger than those for BLUP2 (Table 1). For MY, Keown (1974) found that the difference in STA was smaller for BLUP with A^{-1} than BLUP without A^{-1} (1123 vs 1260 Kg). Everett and Keown (1984) reported that lower difference was obtained by BLUP with A^{-1} than BLUP without A^{-1} (245 vs 443 Kg for MY). A reverse trend for MY was found by Sadek et al. (1993) who reported slightly larger STA of MY in BLUP with A^{-1} than those of BLUP without A^{-1} (340 vs 325 Kg).

For all milk traits, differences in STA estimated by OLS are nearly similar to estimates of STA obtained by BLUP1 (Table 1). Therefore, both methods have the same trend in the evaluation of sires. Similarly, Keown (1974) found that the difference in STA was slightly greater for OLS than for BLUP without A^{-1} (1280 vs 1260 Kg). Raheja (1992) reported that differences in estimates of STA obtained by OLS were larger than those estimated by BLUP without A^{-1} (1956 vs 1098 Kg for MY).

Differences in STA estimated by OLS for all traits were larger than those estimated by BLUP without A^{-1} (Table 1). Keown (1974) reported that differences in STA estimated by OLS were larger than those estimated by BLUP with A^{-1} (1280 vs 1123 Kg for MY).

As expected, the differences in STA estimated by CC were much larger than those estimated by BLUP1 (Table 1). In contrary, Raheja (1992) reported that differences in STA estimated by CC were much lower than those estimated by BLUP without A^{-1} (548 vs 1098 Kg for MY).

Considering the first top ten sires, we notice that the differences between maximum and minimum in STA were smaller than that when considering all sires (Table 1). For all milk traits, the lowest differences in STA of the top ten sires were recorded by BLUP2 while the largest estimates were recorded by CC (Table 1). Estimates of BLUP2 vs CC were 515 vs 1050 Kg for MY, 21 vs 48 Kg for FY, 13 vs 32 Kg for PY, 35 vs 78 Kg for FPY and 488 vs 1002 Kg for CY. Raheja (1992) found that estimates of average difference between the top ten sires in STA of MY (31.0, 119.7 and 52.2 Kg in CC, OLS and BLUP, respectively) were larger than those between all sires (14.0, 50.2 and 28.2 Kg, respectively). Sadek et al. (1993) reported that the average difference in STA of MY between the top ten sires was larger than that between all sires (10.1 vs 4.11 Kg in BLUP without A^{-1} and 11.0 vs 4.31 Kg in BLUP with A^{-1}).

Figures given in Table 2 show that percent of sires that are common between BLUP2 and BLUP1 or between BLUP2 and OLS ranged from 90-100% (i.e. the same top ten sires in BLUP2 are found in BLUP1 and OLS). For CC vs BLUP2, percentages of common sires between these two methods ranged from 70-90%. The percentages of sires remaining in the same position (i.e. don't changing their rank) ranged from 70-80% for MY, PY and CY, while they ranged from 50-60% for FY and FPY (Table 2).

Table 2. Percentages of sires common (CS) and remaining in the same position (RS) in different methods of sire evaluation compared with BLUP2 for different milk traits

Trait and comparison	BLUP1 vs BLUP2	OLS vs BLUP2	CC vs BLUP2
MY			
% CS	100	100	80
% RS	70	70	20
FY			
% CS	100	100	90
% RS	60	60	30
PY			
% CS	100	100	90
% RS	80	70	20
FPY			
% CS	100	100	90
% RS	50	50	30
CY			
% CS	100	90	70
% RS	70	80	20

Among all sires, the percentages of sires who had negative estimates of STA for OLS, BLUP1, BLUP2 and CC methods are 57, 57, 57 and 55% for MY; 49, 52, 52 and 54% for FY; 51, 52, 49 and 51% for PY; 54, 55, 54 and 54% for FPY and 55, 57, 57 and 55% for CY. Across all methods, the largest average of percentage of negative estimates of STA was recorded by BLUP1 (55%), followed by BLUP2 and CC (54%), while the lowest average recorded by OLS (53%). Keown (1974) found that the percentages of negative estimates of STA were 46, 46 and 27% in OLS, BLUP1 and BLUP2. Raheja (1992) found that the percentage of negative estimates of STA were 74, 67 and 62% for methods of OLS, BLUP1 and CC, respectively. The same author added that the overall ranking of sires did not change much between OLS and BLUP1.

Among all traits, the largest percent of negative STA was recorded for MY (57%) followed by CY (56%), FPY (54%), FY (52%), while the lowest percent was recorded for PY (51%). Gacula et al. (1968) found that the percentages of negative expected breeding values were 40, 60 and 40% for MY, FY and PY, respectively. Schaeffer et al. (1975) found that the percentages of negative values of sire proofs were 36.7% for MY and 56.7% for FY.

Table 3 shows the distribution of the absolute difference among estimates of STA obtained by different methods of sire evaluation. These results showed that the smallest absolute differences between BLUP2 vs BLUP1 and BLUP2 vs OLS were recorded by the largest number of sires. In this respect and for MY and CY, there were about 83% and 72% of sires (57 sires out of 69) representing an absolute difference of <40 Kg in comparisons of BLUP2 vs BLUP1 and BLUP2 vs OLS, respectively. But there were less than 12% of the sires representing an absolute difference of >60 Kg in these two comparisons. The reverse trend was observed in comparison of BLUP2 vs CC (i.e. the largest number of sires was found in the largest absolute difference and the smallest number of sires was found in the smallest absolute difference). Similar trends were observed for other milk traits of FY, PY and FPY (Table 3). For comparison of BLUP with and without A^{-1}, Sadek et al. (1993) found that the largest number of sires (59 out of 79) had a small absolute difference of <10 Kg, while the smallest number of sires (2 out of 79) was presented in the largest absolute difference of 40-49 Kg.

Criteria for comparison of methods

A rank correlation that is significantly less than 1.0 would indicate that the animals were re-ranked (Everett and Keown, 1984; Kemp et al., 1984; Carlson et al., 1984; Tajane and Rai, 1990). The product-moment correlations (r_{PM}) between all combinations of two methods of BLUP2, BLUP1 and OLS were greater than 0.992 (Table 4). These figures clearly demonstrate the closeness between both methods of BLUP2 and each of BLUP1 and OLS. Consequently, any computerized method (BLUP or OLS) may be effective in the evaluation of sires. Estimates of rPM between CC and each of OLS, BLUP1 and BLUP2 showed the lowest correlations

(Table 4). The estimates ranged from 0.523 to 0.659. This means that there was a large discloseness between all computerized methods (BLUP2, BLUP1 and OLS) and the simple method (CC). The same findings were observed by Kennedy and Moxley (1977) for fat percent who reported a correlation of 0.85 between CC and BLUP. In practice and for comparison of sire proving schemes, these correlations are not effective.

Table 3. Distribution of the absolute difference (Kg) among estimates of STA calculated by BLUP1, OLS and CC relative to BLUP2 for different milk traits

Trait	Absolute difference	BLUP2 vs BLUP1		BLUP2 vs OLS		BLUP2 vs CC	
		No. of sires	%	No. of sires	%	No. of sires	%
MY							
	<20	42	60.9	36	52.2	4	5.8
	20-39	15	21.7	14	20.3	4	5.8
	40-59	4	5.8	9	13.0	5	7.2
	60-79	7	10.1	4	5.8	7	10.2
	80-99	1	1.5	5	7.2	4	5.8
	>100	0	0.0	1	1.5	45	65.2
FY							
	<1	36	52.2	31	44.9	1	1.5
	1	19	27.5	18	26.1	3	4.3
	2	7	10.1	8	11.6	8	11.6
	3	6	8.7	4	5.8	8	11.6
	4	1	1.5	8	11.6	49	71.0
PY							
	<1	33	47.8	30	43.5	4	5.8
	1	24	34.8	20	29.0	9	13.1
	2	9	13.0	10	14.5	8	11.6
	3	3	4.4	6	8.7	5	7.2
	4	0	0.0	3	4.3	43	62.3
FPY							
	<1	23	33.3	18	26.1	1	1.5
	1-2	32	46.4	29	42.0	6	8.7
	3-4	8	11.6	10	14.5	8	11.6
	5-6	6	8.7	7	10.2	1	1.5
	>6	0	0.0	5	7.2	53	76.7
CY							
	<20	44	63.7	40	58.0	4	5.8
	20-39	14	20.3	14	20.3	4	5.8
	40-59	7	10.2	6	8.7	6	8.7
	60-79	4	5.8	5	7.2	6	8.7
	80-99	0	0.0	4	5.8	5	7.2
	>100	0	0.0	0	0.0	44	63.8

Correlations obtained here (Table 4) indicate that the sires were reranked when using the computerized methods (BLUP2, BLUP1 and OLS) which are different from these ranks obtained by CC method. Theoretically, CC is biased due to the presence of genetic trend and non-random distribution of herdmates sires (Kennedy and Moxely, 1977; Freeman, 1988). The closer correspondence between BLUP2 and BLUP1 may be due to their computational similarities which indicate that there is no significant inbreeding in the population considered. The accuracy in estimating variance components by REML procedure and consequently the more precise ratio of variances (σ^2_e/σ^2_s) and also adding the identity relationship coefficient matrix (A^{-1}) did not create great differences between estimates of STA for the two methods. The REML estimation of variance component in a sire model had been shown to lead to substantial reduction in biases due to cow culling (Ouweltjes et al., 1988).

Table 4. Product-moment correlations (r_{PM}), Spearman rank correlations (r_S) and Kendall rank correlations (r_K) among methods of sire evaluation for different milk traits

Trait	Methods correlated+					
	BLUP2&BLUP1	BLUP2&OLS	BLUP2&CC	BLUP1&OLS	BLUP1&CC	OLS&CC
r_{PM}						
MY	0.998	0.993	0.655	0.995	0.649	0.646
FY	0.998	0.995	0.617	0.998	0.610	0.614
PY	0.995	0.992	0.541	0.997	0.523	0.527
FPY	0.998	0.995	0.607	0.998	0.601	0.599
CY	0.998	0.996	0.659	0.998	0.653	0.654
r_S						
MY	0.997	0.982	0.707	0.985	0.701	0.688
FY	0.998	0.993	0.650	0.995	0.641	0.656
PY	0.996	0.992	0.585	0.994	0.562	0.575
FPY	0.999	0.993	0.676	0.995	0.672	0.672
CY	0.998	0.993	0.706	0.996	0.703	0.702
r_K						
MY	0.971	0.936	0.508	0.962	0.507	0.496
FY	0.986	0.968	0.502	0.981	0.495	0.509
PY	0.974	0.963	0.441	0.982	0.418	0.430
FPY	0.985	0.962	0.512	0.979	0.510	0.512
CY	0.976	0.953	0.505	0.977	0.503	0.505

+ The standard error of all estimates are less than of 0.0001.

The slight decrease in estimates of Spearman (r_S) and Kendall (r_K) rank correlations among computerized methods (OLS, BLUP1 and BLUP2) may be due to that certain kind of selection may lead to a bias in least-square estimates (Henderson, 1984). Keown (1974) reported that evaluations of sires by OLS and BLUP1 were similar which indicate that with large numbers of daughters and addition of variance ratio (=15) to the diagonals, both items have little effect on the evaluation of sires. This also may be due to that OLS may be affected more by the interaction between sires and herd than BLUP. In comparison between CC and each of OLS, BLUP1 and BLUP2, estimates of rank correlation (r_S) had the same trend for all milk traits where estimates ranged from 0.562 to 0.707 (Table 4). The estimates ranged from 0.982 to 0.999 between any combination of two methods of BLUP2, BLUP1 and OLS. The same trend was also observed when considering the Kendall rank correlation (r_K). Miller et al. (1967) reported that rS between CC and each method of OLS and maximum likelihood (ML) was found to be less than that of OLS with ML (0.95 vs 0.99 for MY). Kennedy and Moxley (1977) found a close correlation between CC and BLUP for FY. They concluded that there was no genetic trend and also no large differences in levels of herdmate sires.

With respect to bias, computerized methods (BLUP2, BLUP1 and OLS) appear to be valid theoretically and they could be preferred over the handy method (CC). This trend was evidenced by Kennedy and Moxley (1977).

Estimates of SE and RSE are represented in Tables 5 and 6. For all traits, BLUP2 had the lowest estimates of SE, while CC had the largest estimates. For 305-day milk yield, Ráheja (1992) found that SE for estimates of STA obtained by BLUP was smaller (28.43) than estimates calculated by CC and OLS (30.2 and 63.02). Including A^{-1} in BLUP will increase the accuracy of STA estimates (through reduction of predicted error variance, PEV) than BLUP without A^{-1} (Henderson, 1975; Kennedy and Moxley, 1977; Jensen, 1980; Carlson et al., 1984; Everett and Keown, 1984). Sadek et al. (1993) found that inclusion of A^{-1} in BLUP caused little increase in sire variance (σ^2_s) and little decrease in error variance (σ^2_e).

Estimates of percentages of reduction (RSE) gained from using the ideal method instead of other alternative ones (Table 6) illustrate the desirability. For all traits, estimates of RSE from using BLUP2, BLUP1 and OLS instead of CC were large and ranged from 45.5 to 56.3% (Table 6). On the other hand, RSE estimates ranged from 11.8 to 17.1% from using BLUP2 instead of BLUP1 or OLS, while they ranged from 2.0 to 4.4% from using BLUP1 instead of OLS. These figures showed that the lowest RSE was between BLUP1 and OLS, which it means that both methods are similar and there were no differences between them in ranking of sires. This agrees well with Keown (1974) who come to the conclusion that evaluations of sires by OLS and BLUP1 are similar.

Table 5. The standard error (SE) of each method of sire evaluation for different milk traits

Method	MY	FY	PY	FPY	CY
BLUP2	24	1.05	0.75	1.80	22.61
BLUP1	27	1.19	0.86	2.05	25.64
OLS	28	1.23	0.90	2.11	26.30
CC	55	2.34	1.65	3.99	52.00

Table 6. Reduction percent in standard error (RSE) gained from using BLUP2 instead of other alternative methods and sum of square of difference (SSD) between different methods of sire evaluation

Comparison	MY	FY	PY	FPY	CY
RSE+					
BLUP2 vs BLUP1	11.8	11.8	12.8	12.2	11.8
vs OLS	13.6	17.1	16.7	14.7	14.0
vs CC	56.3	55.1	54.5	54.9	56.5
BLUP1 vs OLS	2.0	3.3	4.4	2.8	2.5
vs CC	50.5	49.1	47.9	48.6	50.7
OLS vs CC	49.1	47.4	45.5	47.1	49.4
SSD					
BLUP2 vs BLUP1	59960	117	87	343	51590
vs OLS	117395	214	162	631	85111
vs CC	5098988	8605	4333	25240	4460972
BLUP1 vs OLS	36595	35	33	110	12205
vs CC	4269670	7246	3572	21027	3740560
OLS vs CC	4242559	6869	3319	20001	3611539

+ Percent of reduction in SE due to using BLUP2 instead of BLUP1, using BLUP2 instead of OLS, ... etc.

The BLUP2 was nearer to BLUP1 than OLS since the differences between BLUP2 and OLS were larger than those between BLUP2 and BLUP1 (Table 6). Including REML in calculation of BLUP will lead to a great difference in sire evaluation when compared with both methods of OLS and BLUP1 (Keown, 1974; Henderson, 1975; Carlson et al., 1984). Carlson et al. (1984) reported that BLUP without A^{-1} drastically reduced the predicted error variance (PEV) by about 59.3% from CC, while BLUP with A^{-1} reduced PEV by about 17.0% more than BLUP without A^{-1}.

The largest differences in ranking of sires occurred with CC (Table 6) since the largest RSE were found between CC and other computerized methods (BLUP2, BLUP1 and OLS). This means that CC widely differed from other computerized methods in ranking of sires.

Estimates of SSD are given in Table 6. For all traits, a great closeness between BLUP1 and OLS was evidenced since their estimates of SSD were the lowest (Table 6). Thus, STA recorded by BLUP1 and OLS were less different from other methods. In contrast, BLUP2 and CC have the largest estimates of SSD. Also, SSD estimates between CC and the remaining other two methods (BLUP1 and OLS) were found to be greater than those estimates of SSD between BLUP1 and OLS (Table 6). Over all six combinations of two methods, the STA recorded by CC method were more different from other methods, while the BLUP1 and OLS yielded STA whose estimates were more similar.

CONCLUSION

For all methods of sire evaluation, a larger difference in all milk traits between the top ten sires than among all sires set was evidenced. These high variability lead to conclude that there is a possibility for rapid genetic progress and consequently there is a considerable potential for the improvement of milk traits through selection (Abubakar, 1987). The rank correlations between BLUP2 and BLUP1, BLUP2 and OLS and BLUP1 and OLS were the highest, while correlations between CC and the remaining three methods were rather low. Since ranking of sires by BLUP2, BLUP1 and OLS is nearly similar, any one of these methods should select exactly the same sires and consequently will give the same genetic progress. Choice among various methods depends, to a greater extend, upon the computational difficulty and the relative accuracy for each method (Carlson et al., 1984; Freeman, 1988; Tajani and Rai, 1990). These observations demonstrate also closeness between computerized methods (BLUP2, BLUP1 and OLS), while a large discloseness between computerized methods and simple method (CC) was evidenced. This could have a large practical consequence in the usage or culling of AI sires. Based on results obtained in the population under study, the continued use of the CC method is not, therefore, recommended for the evaluation of sires. Although BLUP had the lowest estimates of SE and SSD relative to OLS and CC (i.e. more accuracy), it involves more complex computing procedures (Carlson et al., 1984, Freeman, 1988, Tajani and Rai, 1990). When the cost of this more complex computation is reasonable, BLUP should be considered to evaluate sires because it allows a fair comparison of bulls.

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مقارنة فاعلية أربعة طرق لتقييم الطلائق بغرض تحسين صفات اللبـن فـى ماشية الفلاكفى

مـاهر خليل حسب النبى[1] - أشرف محمد سليمان[2] - سميح زاهد[3] - عزت عطا عفيفى[1]

[1]- قسم الإنتاج الحيوانى ، كلية الزراعـة بمشتهر، جامعـة الزقـازيق، بنهـا، ج.م.ع.، [2]- قسم الإنتـاج الحيـوانى ، كليــة الزراعـة، جامعـة الزقـازيق، [3]- معهد بحوث الإنتاج الحيوانى، الدقى، الجيزة، ج.م.ع.

أجرى تقييم الطلائق من خلال تقدير القيمة التمريرية لعدد ٦٩ طلوقة لكل منها ١٠٠ بنت على الأقل بإستخدام بيانـات الموسـم او الإدرار لعدد٧٩٥٩ سجل تم إستخلاصها من ١٩٢١٥ سجل ، استخدم لذلك أربعـة طـرق هـى : طريقة أحسن التقديرات الخطية الغير متحيزه بدون إستخدام مصفوفة معـامل القرابـة (BLUP1) - طريقـة أحسـن التقديـرات الخطيـة الغيـر متحـيزة باستخدام طريقـة معظمـة الإحتمـال المقيده (REML) فـى تقديـر مكونـات التباين (BLUP2) - طريقة المربعات الصغـرى العاديـة (OLS) وطريقـة مقارنة المعاصرات (CC).

أجريت مقارنة بين الطرق المختلفة المستخدمة فى تقييم الطلائق بإستخدام: معامل الارتباط العزومى (r_{pm}) - معامل الارتباط لسيبيرمان (r_s) وكذلك معامل إرتباط الرتب لكندال (r_k). ولتقدير دقة الطرق المختلفة لتقييم الطلائق أو الأبقار استخدم لذلك الخطأ القياسى (SE) لكل طريقة - نسبة الإنخفاض فى الخطأ القياسى (RSE) الناتج من إستخدام أى طريقة بدلا من الأخرى - وتقدير مجموع مربعات الإنحرافات (SDD) بين الطـرق المختلفة. ويمكـن تلخيص النتائج المتحصل عليها من تلك الدراسات فيما يلى :

١- كانت الفروق بيـن أقصـى وأدنـى قيمـة تمريريـة للطلائـق هـى ١٢٨٩ ، ١٢٥٥، ١١٠١، ٢٣٧١ كجم عند إستخدام طريقة OLS طريقة BLUP1، طريقة BLUP2 وطريقة CC على التوالى وذلك بالنسبة لمحصـول اللبـن فى حين كانت ١٢١٠، ١١٧٧، ١٠٣٢، ٢٢٣١ كجم بالنسبة لمحصول اللبـن الخـالى مـن الدهـن والـبروتين ٥٣، ٥١، ٤٥، ١٠٤ كجم بالنسبة لمحصـول الدهن وكانت ٣٦، ٣٤، ٣٠، ٧٠ كجـم بالنسبـة لمحصـول الـبروتين وكـانت ٨٧، ٨٥، ٧٤، ١٧٦ كجم بالنسبة لمحصول الدهن والبروتين معا ، أظهرت الطلائق التى تم تقييمها بطريقة مقارنة المعاصرات أعلى فروق بيـن أعلـى القيم التمريرية وأدناها بينمـا كـانت هـذه الفـروق قليلـة عند اسـتخدام طريقـة BLUP2.

٢- علىمستوى جميع الطلائق التى تم تقييمها، كانت نسبة الطلائق ذات القيمة التمريرية السالبة فى الطرق الأربعة هى ٥٧، ٥٧، ٥٧، ٥٥٪ بنفس ترتيبها السابق بالنسبة لمحصول اللبن - ٤٩، ٥٢،٥٢، ٥٤٪ بالنسبة لمحصول الدهن -٥١، ٥٢، ٤٩، ٥١٪ بالنسبة لمحصول البروتين ٥٤، ٥٥، ٥٤، ٥٤٪ بالنسبة لمحصول الدهن والبروتين معا وكانت ٥٥، ٥٧، ٥٧، ٥٥٪ بالنسبة لمحصول اللبن الخالى من الدهن والبروتين. على مستوى جميع طرق التقييم الأربعة أظهرت طريقة BLUP1 أعلى نسبة قيم تمريرية سالبة (٥٥٪) تلاها فى ذلك طريقتى BLUP2, CC (٥٤٪) ثم فى النهاية طريقة OLS (٥٣٪)

٣- كانت قيم المعامل الإرتباط العزومى بين كل التوليفات الثنائية الممكنة للطرق BLUP1, BLUP2, CC عالية (٠,٩٩٢) بينما كانت الإرتباطات منخفضة بين طريقة CC وأى من الطرق الثلاثة الباقية (٠,٥٢٣ - ٠,٦٥٩) وهذا يعنى أن الطرق الثلاثة وهى BLUP1, BLUP2, CC أقرب إلى بعضها البعض ٠ هذا وقد لوحظ نفس الإتجاه عند إستخدام معامل إرتباط الرتب لكل من سبيرمان وكندال ٠

٤- كانت طريقة BLUP2 أقل الطرق فىقيم الخطأ القياسى (SE) بينما طريقة CC أعلاهم فى قيمة SE وذلك لجميع الصفات المدروسة ٠ كذلك كان الإختزال فىقيمة الخطأ القياسى (RSE) الناتج من إستخدام أى من BLUP1, BLUP2, OLS بدلا من CC أكبر مايمكن حيث تراوحت القيم بين ٤٥,٥ - ٥٦,٣٪ ومن جهة أخرى تراوحت قيم RSE بين ١١,٨ - ١٧,١٪ عند إستخدام BLUP2 بدلا من BLUP1 أو OLS بينما تراوحت القيم بين ٢,٠ -٤,٤ عند استخدام BLUP1 بدلا من OLS وهذا يعنى أن كلا من OLS & BLUP1 اكثر تشابها. على مستوى جميع الصفات المدروسة إتضح أيضا شدة التشابه بين BLUP, OLS حيث كانت قيم مجموع مربعات الإنحرافات (SSD) بين الطريقتين أقل مايمكن بينما كانت أكبر ما يمكن بين طريقة CC وأى من الطرق الثلاثة الأخرى ٠

أوضحت نتائج هذه الدراسة أن أدق الطرق المستخدمة فىتقييم الطلائق هى طريقة BLUP2 وأقلها دقة هى طريقة CC بينما كانت BLUP1, OLS وسطا بين BLUP2, CC.