Egypt. J.Anim. Prod., 12, No. 2, pp. 109-116 (1972

A Comparison of Four Methods Used in Evaluating Buffalo Sires

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The breeding values of 35 of the Ministry of Agriculture buffalo sires having 669 daughters, each had a 305-day first lactation milk record were estimated by four methods: (1) the first lactation record of the sire's dam,(2) the unweighteed average of first records of daughters, (3) the relative breeding value proposed by Johansson and Robertson (1952), and (4) the index proposed by Mostageer (1969). Estimates calculated by method 4, being based on more sources of information, had the highest, accauracy, and was used as a control procedure to which other methods were compared. Accuracy of estimates computed by methods 2 and 3 approached the accuracy of those obtained from the control procedure as the number of daughters increased. Highly significant correlation coefficients of 0.817 and 0.771 were found between rankings of sires by methods 2 and 4, and betwene 3 and 4, respectively. Method 1 was proved to be poor indicator of sires breeding values.

The effectiveness of any index expressing the breeding value of a sire resides in its ability to maximize the probability of selecting the better of two sires. The absolute values of the estimated breeding value may matter little as long as the esitmates reflect true genetic differences among sires. Estimates should also be expressed in realistic and if possible-in simple terms. Different methods of evaluation of dairy sires have been developed during the last two decades (see Searle 1964 for a review of the methods). Many studies of comparing various methods of sire evaluation showed that in cattle notone of the methods studied was absolutely superior under all circumstances (Barr, 1958, and Van Vleck *et al.* 1961). The accuracy of the estimates obtained by different methods depends largely on the data from which the estimates were computed.

In the present study the breeding values of buffalo-sires were estimated using four methods chosen to include evaluation by the performanc of the sire's dam, by average records, and by mean deviations from contemporary averages. The ability of the different methods to rank buffalo-sires according to their estimated breeding values and the accuracy of the estimates were compared.

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Material and Methods

DATA

A total number of 34 sires having 669 daughters each had a 305-day first lactation milk record were used in the study. Records were collected from three of the experimental farms of the Ministry of Agriculture. Only normal lactations of more than 200-day lactation period and not influenced by any abnormal conditions were considered.

Experimental Procedure

The breeding values of the baffalo-sires were estimated by the following methods.

1. The first lactation record of the sire's dam, A.

2. The unweighted average of first records of daughters D.

3. The relative breeding value, RBV, proposed by Johansson and Robertson 1952).

$$RBV = \frac{2b\ (D-A) + P \times 100}{P}\ ; \qquad (1)$$

where :

$b = \Sigma\ W/\ (\Sigma\ W + V)$,
$W = n_1\ n_2\ /\ (n_1 + n_2)$,
n_1 = the number of daughters,
n_2 = the number of their contemporaries,
$V = (4\text{-}h^2)/h^2$,
h^2 = the intra-herd-year heritability of first records,
D = the average of first records of daughters
A = the average of first records of the contemporaries
and P = the breed-year-average of the first lactation records.

4. The index suggested by Mostageer (1969), which will be referred to as Mostageer Index, MI :

$$MI = 2K\left(\frac{a + N\ (d - .5\ h^2m)}{N + 1}\right)\ ; \qquad (2$$

where $K = (N + 1)\ h^2/\ (4\text{-}Nh^2)$,
$N = (\Sigma\ W\ (4\text{-}h^2)\ /h^2)\ /(4\text{-}h^2/h^2) - h^2)$,
W and h^2 are as defined in equation 1,

and a, d and m are the deviations of the first lactation records of the sire's dam, the daughters average, and the mates' average from their corresponding averages, respectively.

The intra-herd-year heritability of first records which was used in equations 1 and 2 was that estimated by Ragab *et al.* (1970) from the same data ; 0.547.

Formulas for measuring the accuracy of the estimates of breeding values were adapted to the present data. accuracy of the estimates were then calculated using appropriate values for heritability. Sires were ranked according to their estimated breeding values by the four methods. Correlation coeficients between the different methods were calculated.

Results and Discussion

Accuracy of the estimates

In the present data sires were selected solely according to the first records of their dams. The accuracy of an estimate based on such criterion is equal to one fourth the heritability of 0.467 *i.e.* 0.117 where the estimate of heritability was calculted on overall herds and years basis (Ragab *et al* 1970). The accuracy of an estimate of a sire's breeding value calculated from its progency depends on the estimate of heritability and on the number of daughters available. The problem is statistically of finding out the expectec breeding value of that sire geiven an estimate of the daughter average. In the simplest situation of n daughters with one record each, accuracy of the estimate is equal to $n/(n+v)$ where v is as defined in equation 1 and the heritability is the overall herd-year estimate of 0.467. Then the accuracy is $n/(n+7.57)$.

Although the accuracy of the estimate of a sire's breeding value based on more than one daughter exceeds that of the estimate obtained from his dam's first record, yet this estimate may be affected by the selection of the sire's mates. The superiority of daughters of a sire mated to high yielding buffaloes may be due in part to the superiority of their dams. A solution for this problem would have been provided by the equal parent index computed as 2D-M, where D is the averag eof a sire's duaghters and M is the average of the dams of those daughters. But this index was not used in this study because little confidence could be put into it. The reasons for not trusting the index completely arise from mendelian errors at segregation and from errors of appraisal which are not random and may be different in magnitude or direction for daughters or mates of different sires. However, the mates' performances were utilised in a more precies way in Mostageer index (equation 2).

Milk records can be expressed as deviations from some function of contemporary average. Gaunt and Legates (1958) Van Vleck *et al* (1961 a) and Miller (1964) indicated the usefulenss of various functions of daughters and herdmate averages as ranking criteria and in improving the accuracy of the estimate of a dairy sire's breeding value. The difference between the production of a sire's daughters and their herdmates was found to be roughly the same from one level of herd average to another since there was no, or little genotype-environmental interaction (van Vleck, 1963).

In estimating the realtive breeding value (RBV) ; the daughter-herdmates differences are weighted by the harmonic mean of the numbers of daughters and the herdmates $n_1 n_2 / n_1 + n_2$ the sum of which is used instead of n the number of daughters, in measuring the accuracy of the RBV. Given the intra-herd-year heritability of 0.547 the accuracy of the RBV is $\Sigma W/\Sigma W+ 6.40)$.

Mostageer (1969) developed an index in which information about the sire's dam, his daughters and his mates' averages were expressed as deviations from appropriate herd averages. The performances of mates were shown to be of more importance to the accuracy of the estimate of a sire's breeding value as the heritiability gets larger. At the heritability of 0.547, the accuracy of an estimate is equal to $(1.09 \Sigma W + 1) (1.09 \Sigma W + 7.30)$.

In the present study the number of daughters per sire ranged from five to 67. Accuracy of the breeding values estimated by different methods for sires having various numbers of daughters are given in Table 1.

TABLE 1. **Accuracy of the daughter average (D), the relative breeding value (RBV), and Mostageer index (MI).**

	Accuracy of D $= n/(n + 7.57)$	Accuracy of RBV $= W/(W+6.40)$	Accuracy of MI $=(1.09 W W + 1)/(1.09 W W +7.30)$
h^2	0.467	0.547	0.547
n* or W			
5	0.40	0.48	0.51
10	0.57	0.61	0.65
15	0.66	0.70	0.73
20	0.72	0.76	0.78
25	0.76	0.80	0.82
50	0.87	0.89	0.90
67	0.90	0.91	0.92

(*) Dam = one daughter, and accuracy of the estimate based on the dam's first record is therefore $h^2 / 4 = 0.117$.

The accuracy of the evaluation by all methods in which information on progeny were utilized increased asymptotically with increasing the values of N or W. Mostageer index had the highest accuracy in all cases followed by RBV and D. The differences in the accuracy of the estimates were more obvious when th estimates were based on small n or W and diminished gradually as nor W became larger. Increasing n or W would put some limitations on the number of bulls which are sampled. The accuracy of the proof have to be balanced with the selection intensity in order to maximize progress from selection. Henderson (1959) has shown that it is more important to sample a large number of bulls than to obtain high accuracy of the proof.

Methods of ranking sires

The four methods of sire evaluation were used in ranking the 35 sires included in the study. The ranking differed from one method to the other depending on the criterion of estimating the sires' breeding values (Table 2).

TABLE 2. Estimatesof breeding values and ranking of buffalo sires by differentmethods of evaluation

Sire No.	M lbs.	Rank	D lbs.	Rank	RBV %	Rank	M1 lbs.	Rank
9	4883	18	3534	9	98.93	19	745	5
11	4545	22	2763	28	73.26	34	— 131	30
15	3960	28	3354	15	117.90	2	506	12
16	5634	12	2892	25	94.05	26	287	16
17	3960	28	2435	34	76.70	33	— 759	34
18	5533	13	3424	10	102.66	14	584	9
19	5212	15	3209	19	95.15	24	809	3
22	4284	24	2636	32	71.35	35	— 402	31
23	5387	14	3408	12	101.24	18	283	17
24	4157	25	2704	30	84.66	30	— 591	32
25	4103	27	3413	11	96.83	21	619	7
26	3227	33	2457	33	83.85	31	— 794	35
27	4113	26	2751	29	106.44	11	74	25
28	6304	4	2662	31	76.98	32	— 628	33
29	6413	3	2892	25	88.68	28	— 96	28
30	5644	10	3393	14	109.83	8	793	4
31	4494	23	3278	17	94.98	25	491	13
32	5900	7	3027	20	103.86	12	219	20
33	3230	31	3579	6	95.29	23	352	14
34	5679	9	3637	4	115.89	4	889	1
35	5730	8	2972	23	96.17	22	309	15
36	6694	1	3593	5	126.20	1	822	2
37	6686	2	2806	27	90.03	27	— 127	29
38	5033	17	3315	16	109.43	9	214	21
39	5035	16	3541	8	101.32	17	104	24
40	5638	11	3701	2	115.93	3	566	10
41	6103	6	3643	3	110.30	7	557	11
42	4865	19	3559	7	114.01	5	649	6
43	3230	31	3980	1	111.47	6	599	8
45	4784	20	3003	21	97.52	20	228	19
46	4604	21	2949	24	107.07	10	246	18
47	3548	30	2995	22	103.33	13	7	26
48	2417	34	3260	18	101.49	16	193	22
49	2417	34	3398	13	102.65	15	169	23
50	6274	5	2340	35	87.52	29	— 35	27

The ranking of sires according to their dams' first records differed largely from other methods. The wide range of the M values (from 2417 lbs to 6694 lbs. of milk) indicated the higher variability of that index as compared with the daughters' average, D, which ranged from 2340 lbs. to 3980 lbs. of milk. Out of the 35 sires which were selected according to their dams performances only 18 sires could raise their daughters' averages above the breed average i.e. having RBV's greater than 100%. These results together with the very low accuracy of the dam's first record as a criterion for estimating a sire's breeding value indicated that the superiority of a sire's dam might not be wholly genetic. Also, the sire gets a sample half of his dam's genes and mendelian segregation plays a major role in this respest so that there is little expectancy of having a sire with a breeding value close to that of his dam.

In all studies of this type a problem is posed when an attempt is made to determine a criterion for evaluating a sire's "true" breeding value. If large numbers of daughters with recorded production are available and if the records are made nuder random environmental conditions then an average of such records would provide very accurate measure of a sire's breeding value. In data where this situation does not exist, a method of evaluation must be chosen arbitratrily to which other methods are compared. The method chosen in this study was that by Mostageer (1969). The choice of this method as a control seems reasonable since values of MI had the highest accuracy and were based on all sources of information that were utilized in the other methods.

The product moment correlations with the control method, as well as bteween every method of evaluation and the other are given in Table 3.

TABLE 3. Correlation between evaluation methods

Methods	D	RBV	MI
M	— 0.259	— 0.040	0.187
D	—	0.798*	0.817*
RBV	—	—	0.771*

* $P < 0.01$.

Among all methods, the daughters' average (D) was most similar to the control method, MI, followed by the RBV. It appears that with large number of daughters, evaluation of sires by their daughters' average would provide

a good means of ranking sires for the purposes of selection. The method of the sire's dam was least similar to the control procedure showing, again that the first record of a dam is a very poor indicator of her son's breeding value.

Conclusions

It can be assumed that the method proposed by Mostageer (1969) would give the best estimate of a sire's breeding value. If, however large unmber of first records of a sire's daughters (50 records or more)is available the daughters' average would provide evaluation nearly as accurate as the control procedure. Expressing the daughters' records as deviations from contemporary averages when large number of records is available improves the estimate of a sire's breeding value slightly on the expense of easiness of computations. If the number of records is small, the utilization of deviations from contemporary herd averages should be considered.

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مقارنة بين اربع طرق لتقييم طلائق الجاموس

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قدرت القيم التربوية لخمس وثلاثين طلوقة من الطلائق الجاموسى المستعملة فى محطات التجارب التابعة لوزارة الزراعة من السجلات الأولى للأمهات والبنات البالغ عددها ٦٦٩ بنتا لكل منها سجلا واحدا تتراوح مدته من ٢٠٠ الى ٣٠٥ يوم وغير متأثر بأى ظروف غير عادية .

واستعملت أربع طرق لتقدير القيمة التربوية لكل طلوقة :

١ ــ السجل الأول للام .

٢ ــ المتوسط غير الموزون للسجلات الأولى للبنات .

٣ ــ القيمة التربوية النسبية التى اقترحها يوهانسون وروبرتسون سنة ١٩٥٢

٤ ــ دليل انتخابى اقترحه مستير سنة ١٩٦٩

وكانت التقديرات المحسوبة بالطريقة ٤ هى أكثر التقديرات دقة وقد اقتربت دقة التقديرات المحسوبة بالطريقتين ٢ ، ٣ من دقة الطريقة رقم ٤ مع زيادة عدد البنات بينما كانت الطريقة رقم ١ أقلها دقة حيث تساوى درجة دقتها ¼ المعامل الوراثى .

وقد اختبرت الطريقة الرابعة كطريقة قياسية لترتيب الطلائق تبعا لقيمتهم التربوية تقارن بها كفاءة الطرق الأخرى على ترتيب الطلائق وذلك لزيادة درجة دقتها ولاحتوائها على كل مصادر المعلومات المشتملة فى الطرق الأخرى ، وقد وجد أن هناك ارتباط معنوى قدره ٠٫٨١٣ ، ٠٫٧٧١ بين الطريقتين ٢ ، ٤ وبين الطريقتين ٣ ، ٤ على التوالى ــ كما اثبتت الطريقة رقم ١ ضعف قدرتها على ترتيب الطلاق ترتيبا صحيحا .

والخلاصة انه اذا توفرت معلومات عن ٥٠ بنتا أو أكثر للطريقة فان الطريقة رقم ٢ يمكنها أن تعطى تقديرات صحيحة على درجة عالية من الدقة واستعمال احدى الطريقتين ٣ ، ٤ يحسن قليلا من درجة الدقة ــ اما فى حالة وجود اعداد قليلة من البنات فان استعمال احدى الطريقتين ٣ أو ٤ يصبح ضروريا .