

EVALUATION OF BREEDING VALUE OF COWS ON THE BASIS OF THEIR
OWN AND PEDIGREE PERFORMANCE IN THARPARKAR CATTLE

Bewertung des Züchtungswerts von Kühen auf Grund ihrer eigenen
und Stammbaumleistung in Tharparkar Rindvieh

NARENDER SINGH *
M. GURNANI *

INDIA

Accurate evaluation of breeding value of cow on the basis of its own early performance and/or performance of its relatives, is a pre-requisite to effective genetic improvement. The fact that the observed genetic change differs widely from expected genetic change suggests reappraisal of procedures of evaluation of breeding values of cows. The theoretical formulae, given by Young (1961), for estimation of the weights to be given to various amounts of information on the cow, its paternal half-sisters and dam are based on various assumptions. The heritability is assumed to be same for first and subsequent records. Also the repeatability is assumed to be same for the various repeated records. Not all these assumptions hold true in actual situations. It was, therefore, considered useful to evaluate the weightages to be given to the cows' own records in all possible combinations with available records of its dam and paternal half-sisters by fitting multiple linear regressions of breeding value of cow, based on lifetime production, on the above various combinations.

The data for this investigation pertains to the Tharparkar herd maintained at this Institute. There were 120 cows which had information on first five lactation records and ten paternal half-sisters. Among these cows the number of cows which had information upto five lactations of their dam was 70. The breeding value of the cow (B) was taken as average milk yield per month from the commencement of first lactation to the termination of fifth lactation. This was taken as the dependent variable. The independent variables were the various combinations of varying amounts of information on Individual (I_0 = zero information, I_1 = first lactation production, I_2 = average of first two lactations and so on upto I_5 = average of first five lactations of the cow), its dam (M_0 = zero information, M_1 = first lactation production, M_2 = average of first two lactations and so on upto M_5 = average of first five lactations of dam) and paternal half-sisters (S_0 = no information on paternal half-sisters (PHS), S_3 = average of first lactation of first three PHS, S_5 = average of first lactation of first five PHS and S_{10} = average of first lactation records of first ten paternal half-sisters). The multiple regressions of breeding value of cow on all possible combinations of the varying amounts of information on cow, its dam and paternal half-sisters were fitted. The accuracy of each of the regression models was evaluated on the basis coefficient of determination ($R^2\%$) (Draper and Smith, 1966).

* Division of Dairy Cattle Genetics, National Dairy Research Institute,
Karnal INDIA-132001.

Table-1: Accuracy of prediction ($R^2\%$) of breeding value of cows on the basis of different combinations of records of cow (I), its dam (M) and paternal half-sisters (S).

| | I_0 | I_1 | I_2 | I_3 | I_4 | I_5 |
|--------------|-------|-------|-------|-------|-------|-------|
| $M_0 S_0$ | - | 27.89 | 36.58 | 46.98 | 52.00 | 58.03 |
| M_1 | 0.01 | 26.89 | 36.67 | 47.41 | 52.02 | 52.75 |
| M_2 | 0.24 | 29.31 | 38.39 | 49.02 | 54.71 | 61.48 |
| M_3 | 0.72 | 34.14 | 44.77 | 57.22 | 65.55 | 72.56 |
| M_4 | 1.23 | 51.19 | 66.50 | 83.48 | 96.68 | 96.77 |
| M_5 | 4.80 | 59.05 | 81.92 | 92.39 | 96.90 | 97.03 |
| S_3 | 4.51 | 27.28 | 36.79 | 49.68 | 55.25 | 53.04 |
| S_5 | 4.93 | 27.57 | 36.94 | 48.40 | 52.62 | 53.18 |
| S_{10} | 5.09 | 27.81 | 36.97 | 48.12 | 52.52 | 53.29 |
| $M_1 S_3$ | 4.51 | 27.49 | 37.03 | 48.95 | 52.37 | 53.11 |
| $M_1 S_5$ | 5.57 | 27.79 | 37.24 | 48.44 | 52.63 | 53.31 |
| $M_1 S_{10}$ | 6.57 | 27.89 | 37.36 | 48.24 | 52.56 | 53.37 |
| $M_2 S_3$ | 4.47 | 29.54 | 38.62 | 51.75 | 55.02 | 61.58 |
| $M_2 S_5$ | 5.55 | 29.72 | 38.79 | 50.57 | 55.28 | 61.67 |
| $M_2 S_{10}$ | 5.69 | 29.75 | 38.83 | 48.91 | 55.52 | 61.66 |
| $M_3 S_3$ | 5.11 | 43.21 | 44.90 | 60.36 | 66.28 | 72.52 |
| $M_3 S_5$ | 6.25 | 34.56 | 44.99 | 59.27 | 65.96 | 72.57 |
| $M_3 S_{10}$ | 6.29 | 40.56 | 45.02 | 58.84 | 65.98 | 72.63 |
| $M_4 S_3$ | 7.07 | 51.29 | 66.32 | 86.93 | 92.70 | 94.23 |
| $M_4 S_5$ | 8.63 | 51.31 | 66.35 | 83.92 | 93.68 | 95.63 |
| $M_4 S_{10}$ | 8.85 | 51.39 | 66.38 | 83.58 | 96.69 | 96.83 |
| $M_5 S_3$ | 8.87 | 61.78 | 81.23 | 96.15 | 96.86 | 97.02 |
| $M_5 S_5$ | 10.73 | 61.89 | 84.90 | 95.43 | 97.99 | 98.83 |
| $M_5 S_{10}$ | 10.75 | 62.23 | 85.36 | 94.97 | 98.87 | 98.99 |

Note: The subscripts 0,1,2,3,4 & 5 on I and M indicate the number of records available on Individual (cow) and it's dam respectively; the subscripts 0,3,5 & 10 on S indicate the number of paternal half-sisters whose first lactation milk records were available.

The estimated values of accuracy of prediction of breeding value of cows on the basis of fitting of simple or multiple regression on all possible combinations of information on lactation records of the cow, its dam and paternal half-sisters are given in Table-1. It is observed from this table that information on three paternal half-sisters alone would provide better accuracy ($R^2 = 4.51\%$) of prediction of breeding value than that upto four records of dam ($R^2 = 1.23\%$). When the information on dams records and paternal half-sisters records were used together, the maximum accuracy of prediction of breeding value of cow was 10.75% (for five records of dam and ten paternal half-sisters). Cows' own first lactation milk record provided better accuracy (27.89%) than that provided by five records of dam and first records of ten paternal half-sisters (10.75%). When cows' own information was available, incorporation of information on dams' performance provided substantial improvement in accuracy of prediction. Incorporation of information on paternal half-sisters to cows' own information did not bring about any substantial improvement in accuracy of prediction of breeding value of cows. For instance, when cows' first record is available, incorporation of information on dams' five records increased the accuracy of prediction from 27.89 to 59.05%, whereas incorporation of information on ten paternal half-sisters gave the same (27.89%) accuracy of prediction. The incorporation of information on ten paternal half-sisters to the first record of cow and five records of dam increased accuracy of prediction (R^2) from 59.05% to 62.23% only. Similar situation, of small increase in accuracy by incorporation of information on paternal half-sisters to cows' own records and dams' records, is observed for cases when cows' two, three, four and five records are available.

The levels of accuracy obtained in this study were greatly different from the theoretical estimates based on formulae given by Young (1961) using estimates of heritability and repeatability obtained in this study. The differences in observed and theoretical estimates of accuracy could be due to several reasons: (i) Estimates of genetic parameters may not be unbiased and efficient, (ii) Assumptions underlying the derivation of theoretical formulae may not be holding true and (iii) Limited size of the data.

On the basis of the present analysis it may be concluded that for effecting multi-stage selection at various stages of the life of a female calf/cow, incorporation of information on dam to the cows' own records would provide better accuracy of selection than the incorporation of information on paternal half-sisters.

SUMMARY

The available data on milk production of Tharparkar cows at National Dairy Research Institute, Karnal since 1930 upto date, which had at least five lactations was compiled alongwith the information on milk production of their dams upto five lactations and paternal half sibs. The breeding value of cow was defined as the average milk yield per month during the productive period upto the termination of fifth lactation. Multiple linear regressions for the breeding value of cows on the various possible combinations of averages of lactation records of cows, dams and paternal half-sibs were fitted. It was found that when cow's own information is not available, the information on paternal half-sibs alone, and in combination

with the dams' performance was useful. When information on dam alone was available, it was not effective in providing an adequate amount of predictability of breeding value of daughters. When the cows' own records were available, the incorporation of information on dams for prediction of breeding value of cows seemed to be very useful whereas the addition of information on paternal half-sibs was comparatively of little use. For affecting multistage selection at various stages of the life of a female calf/cow, the prediction equations with different levels of accuracy have been worked out.

ZUSAMMENFASSUNG

Die vorhandenen Angaben über Milchproduktion der Tharparkar Kühe in National Dairy Research Institute, Karnal von 1930 bis heute, die mindestens fünf Laktationen hatten, wurde mit den Angaben über Milchleistung ihrer Mütterchen bis fünf Laktationen und väterliche Halbblutnachkommenschaft hatten, zusammengestellt. Der Züchtungswert einer Kuh wurde als monatliche Durchschnittsmilchleistung während der produktiven Periode bis Beendigung der 5. Laktation definiert. Vielfache lineare Regressionen wurden in den Züchtungswert der Kühe auf verschiedene mögliche Kombinationen der Mittelwerte von Laktationsregistrier der Kühe, Mütterchen und väterlichen Nachkommenschaft eingepasst. Es ergab sich, daß, wenn eigene Information einer Kuh nicht vorhanden ist, dann die Angaben von väterlicher Nachkommenschaft und diese mit Mütterchensleistung allein nutzvoll waren. Wenn nur die Information über Mütterchen vorhanden war, genügte es nicht, adequate Voraussagbarkeit des Züchtungswertes von Töchterchen zu bestimmen. Falls die Angaben von einer Kuh vorhanden waren, war die Information über Mütterchen zum Voraus sagen des Züchtungswertes der Kuh auch nutzvoll. Aber die Information über die väterlichen Nachkommenschaft war relativ von geringerem Wert. Um mehrstufige Selektion auf verschiedenen Lebensstufen eines weiblichen Kalbes oder einer Kuh zu ermöglichen, sind die Voraus sagungsgleichungen mit verschiedenen Ebenen der Genauigkeit kalkuliert worden.

References

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