

EVALUATION OF BREEDING VALUE OF BULLS ON THE BASIS OF  
PEDIGREE AND PROGENY PERFORMANCE

Bewertung des Züchtungswertes von Bullen nach ihrem Stammbaum =  
und ihrer Nachzuchteleistung

A.K. ARYA \*  
M. GURNANI \*

INDIA

For maximizing genetic gain by selection it is important to evaluate breeding value of bull on the basis of its pedigree and progeny information with accuracy as high as possible. When information on very large number of daughters of bull is available, the role of pedigree in improving the accuracy of estimation of bull's breeding value would be negligibly small. On the other hand if the information on small number of bull's progeny is available, as is generally the situation in most of organized farms in India, incorporating information on pedigree can be useful in increasing accuracy of evaluation of breeding value of Bulls. The efficacy of theoretical assessment of evaluation of breeding value of bulls, by using the daughters' records, records on bull's dam and paternal half sibs, by the formulae given by Young (1961) is subject to validity of several assumptions. The estimates of heritability and repeatability are assumed to be unbiased. Further heritability of first and subsequent lactation records is assumed to be same. Thirdly repeatability of lactation milk production is assumed to be same for various lactation records. In actual situations, such assumptions may not hold true leading to larger differences in expected and observed genetic changes. It was, therefore, considered useful to evaluate the relative weightage that should be given to various amounts of information to bull's daughters, dam and paternal half-sisters in evaluation of breeding value of bull by multiple regression method.

The data for the present analysis pertains to the Tharparkar cattle herd maintained at this Institute. The first lactation milk production performance records of 650 daughters of 24 bulls each having a minimum of 10 daughters were available. The first three lactation milk production records of the dams of these bulls under study and first lactation milk production records of at least three paternal half-sibs were available. The lactation yield was taken upto 305 days of lactation. The lactation yield for less than 305 days but greater than or equal to 100 days was taken as standard 305-days lactation record without any correction. The cows with milk yield for less than 100 days were not considered.

The breeding value of bulls on the basis of information on all the available daughters was evaluated by the procedure given by Robertson (1959) using heritability estimate of first lactation production as 0.18. The number of daughters of these bulls ranged from 11 to 70 (eight bulls had daughters ranging from 11 to 15, two bulls had daughters ranging from 16 to 20, six bulls had daughters ranging from 21 to 30, and remaining eight bulls had more than 40 daughters each). The simple/multiple

---

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

**Table-1:** The accuracy ( $R^2\%$ ) of prediction of breeding value of bulls by fitting of multiple regression on various combinations of information on daughters (P), dam (M) and paternal half-sisters (S).

		$P_0$	$P_3$	$P_6$	$P_9$
$S_0$	$M_0$	-	51.68	71.47	78.83
	$M_1$	32.94	65.49	76.54	81.86
	$M_2$	31.51	59.11	75.68	81.17
	$M_3$	33.31	62.05	75.72	81.80
	$S_3$	0.18	56.16	75.19	79.48
	$S_6$	0.30	54.31	75.23	79.38
	$S_9$	1.33	54.02	75.33	79.33
$S_3$	$M_1$	39.04	65.51	76.59	82.15
$S_3$	$M_2$	34.45	62.07	76.01	81.47
$S_3$	$M_3$	36.12	62.31	76.05	82.08
$S_6$	$M_1$	40.58	65.65	76.65	82.14
$S_6$	$M_2$	36.88	61.78	76.02	81.45
$S_6$	$M_3$	40.37	61.82	75.97	82.07
$S_9$	$M_1$	42.29	65.68	76.69	82.14
$S_9$	$M_2$	38.24	61.81	76.10	81.46
$S_9$	$M_3$	41.46	62.09	76.05	82.06

$P_0$  : No information on daughters;

$P_3, P_6, P_9$  : average first lactation production of first three, six and nine daughters respectively;

$S_0$  : No information on paternal half-sisters;

$S_3, S_6, S_9$  : average first lactation milk production of first three, six and nine paternal half-sisters respectively;

$M_0$  : No information on dam;

$M_1$  : first lactation milk production of dam;

$M_2, M_3$  : average of first two and first three lactations, respectively, of dam.

regressions of breeding value of bulls was fitted on various combinations of information on their first three ( $P_3$ ), first six ( $P_6$ ) and first nine ( $P_9$ ) daughters, dams first ( $M_1$ ), average of first two ( $M_2$ ), average of first three ( $M_3$ ) lactation milk records, and first lactation records of first three ( $S_3$ ), first six ( $S_6$ ) and first nine ( $S_9$ ) paternal half-sisters. The accuracy of each of the simple/multiple linear regression models fitted was evaluated as coefficient of determination ( $R^2$ ) (Draper and Smith, 1966).

The accuracy values ( $R^2$ ) of fitting various simple/multiple regression models are given in Table-1. It was seen that the estimation of fitting breeding values of bulls on dams information gave much higher values of accuracy (32.9 to 33.3%) as compared to the information as paternal half-sisters (0.2 to 1.3%). Information on three daughters gave higher accuracy (51.7%) than the information on dams records or paternal half-sisters, separately or in all combinations (Maximum  $R^2 = 42.3\%$ ). When three daughters of bull were available, incorporating information on dams yielded more increases in accuracy as compared to incorporating information on paternal half-sisters. It appears that when three daughters of bull are available, incorporating information on dams' first lactation is useful. (It is normally expected that the  $R^2$  values would increase when additional amount of information is used for prediction. As the correlations of breeding value with first record or average of several records may not be same, so intuitive expectations may not hold true. Further differences in  $R^2$  values can arise due to sampling error. The comparisons being made here apply only to those  $R^2$  values which were statistically significantly different). When first six daughters of the bull were taken, there was five percent increase in accuracy by addition of information on dams' first lactation. The further incorporation of information on dams subsequent records or paternal half-sisters was not advantageous. When first nine daughters of the bull were taken, incorporation of information on dams' first lactation record increased accuracy of prediction of breeding value by only three percent. Further incorporation of information on dams' subsequent lactations or paternal half-sisters did not appear to be of much advantage.

The values of accuracy ( $R^2$ ) of prediction of breeding value as found here by fitting multiple regression were much different from the values expected on the basis of the formulae given by Young (1961). The reasons possibly could be: (i) the assumptions underlying the formulae may not hold true, (ii) the small size of the sample.

## SUMMARY

The predicted breeding values (PBVs) of Tharparkar bulls, were computed as per Robertson's (1959) method, considering all the possible combinations of information on dams (records varying from first to third), paternal half-sibs (first 3, 6 and 9) and progeny (first 3, 6 and 9 daughters). When the information on bull's daughters was not available, the information on dam's records alone, and in combination with paternal half-sibs' performance to some extent was found to be useful for prediction of the breeding value of bulls. When information on paternal half-sibs alone was available, it was not effective in providing an adequate amount of predictability of breeding value of bulls. When the information on three daughters of bull was available, the incorporation of information on dams, for prediction of breeding value of bulls, was useful, whereas the addition of information on paternal half-sibs was comparatively of very little use. When information on six to nine daughters of bull was available, incorporation of information on pedigree was of little or no consequence. The minimum information needed for prediction of breeding value of a Tharparkar bull at different levels of accuracy considered desirable by animal breeders for affecting multistage selection at different stages of life of a bull has been worked out.

## ZUSAMMENFASSUNG

Die vorausgesagten Züchtungswerte (PBVs) der Tharparkar Bullen wurden nach Robertsons (1959) Methode berechnet, indem alle möglichen Kombinationen der Information über Mütterchen (verschiedene Registrierte von 1. bis 3.), väterliche Nachkommenschaft (erste 3, 6 und 9) und die Nachzucht (erste 3, 6 und 9 Töchterchen) in Betracht gezogen wurden. Wenn die Information über Töchterchen von Bullen fehlte, war selbst die Information über Mütterchensregistrier und mit väterlicher Nachkommenschaftsleistung einigermaßen nützlich, um den Züchtungswert der Bullen Vorauszusagen. Wenn nur die Information über väterliche Nachkommenschaft vorhanden ist, genügte es nicht, adequate Voraussagbarkeit des Züchtungswerts von Bullen zu bestimmen. Wenn die Information über drei Töchter eines Bullen vorhanden war, war die Information über Mütterchen zur Voraus sagen des Züchtungswerts von Bullen auch nützlich. Aber die Information über die väterlichen Nachkommenschaft war relativ von geringerem Wert. Wenn die Information über 6 bis 9 Töchter von einem Bullen vorhanden war, war die Information über Nachzucht von kleinem oder keinem Wert. Die minimale Information, die für Voraus sagen von Züchtungswert eines Tharparkar Bullen auf verschiedene Genauigkeits ebene erwartet ist, und die die Tierzüchter erwünschen, um die mehrstufige Selektion auf verschiedenen Lebensstufen eines Bullen zu ermöglichen, wird hier berechnet.

## References

- Draper, N.R. and Smith, H. 1966. Applied Regression analysis. John Wiley & Sons, Inc., N.Y.
- Robertson, A. 1959. A simple method of pedigree evaluation in dairy cattle. *Anim. Prod.*, 1(2):167.
- Young, S.S.Y. 1961. The use of dam's and sire's records in animal selection. *Heredity*, 16:91.