ESTIMATION OF BREEDING VALUES OF SAHIWAL CATTLE USING TEST DAY MILK YIELDS

M. S. KHAN, G. BILAL, I. R. BAJWA, Z. REHMAN[1] AND S. AHMAD[2]

Department of Animal Breeding & Genetics, University of Agriculture, Faisalabad; [1]Research Centre for Conservation of Sahiwal cattle, Jhang; [2]NWFP Agriculture University, Peshawar, Pakistan

ABSTRACT

Estimated breeding values of test-day (TD) and 305-day milk yield were calculated to compare ranking of animals on the basis of two information sources under an animal model. Two statistical models were used to analyze 780 first lactation (305-day) and monthly milk yield records. The first model was an individual animal model to analyze lactation milk yield with period-season of calving as fixed effect, while the second model was a repeatability model where monthly milk yield records were analyzed using period-season of calving as fixed effect and animals' additive genetic effect and permanent environmental effect as random factors. In this model, the age at calving, ratio of days in milk to 305-day (as linear and quadratic components) and their reciprocal logs were used as covariables. Ranking of animals for estimated breeding values from the two models was compared. The rank correlations were 0.927 and 0.923 for sires and cows, respectively. Largest rank shift measured in sires and cows showed that ranking of sire was affected less than that of cows. Phenotypic and genetic correlations did not show any clear pattern due to limited number of observations. Higher values of rank correlations suggested that TD milk yields could be used instead of 305-day lactation yields for genetic evaluation of sires and cows. Detailed studies involving larger data sets were however, suggested for validation of results.

Key words: Estimated breeding values, milk yield, Sahiwal cattle, test day model.

INTRODUCTION

The Sahiwal cattle breed is an important national genetic resource of Pakistan. Originated and developed in Pakistan, this breed is now reported to be present in 29 countries (FAO, 2007). In spite of an increasing trend reported in the recent livestock census (GOP, 2006), the population of the breed in the country is under pressure of crossbreeding with exotics for dairy purpose. Deterioration in productivity of this breed has also been documented (Rehman, 2006). The efforts to exploit the genetic potential of the breed through recording at farmer level and dissemination of superior germ plasm are under inception (Iqbal, 2005). These efforts need to be strengthened through the use of accurate models such as test-day models that reduce bias and improve accuracy (Wiggans and Goddard, 1997). Animal model evaluation procedures have recently been proposed for the Sahiwal cattle population but these are based on complete lactation yields (Rehman, 2006).

Evaluation of dairy cattle for milk yield has generally been done for 305-day lactation yield which was obtained by summing up to 10 test-day (TD) records taken approximately at monthly intervals. The factors such as herd management and management group within a herd, days in milk, age at calving and test, pregnancy status and milking times per day (Swalve, 1995) that could affect the TD yield were thus averaged over the lactation period. The test-day models account for these differences and, therefore, are increasingly being used for the genetic evaluation of dairy cattle. These models consider all genetic and environmental effects directly on a test-day basis (Ptak and Schaeffer, 1993) and therefore, improve the accuracy of genetic evaluation, provide better modeling and extending of part lactation is no more needed. Cost of milk recording may also be reduced by having longer intervals between milk recording and less frequent collection of milk samples. However, a test-day model cannot overcome the loss in accuracy from fewer TD or inaccuracies of recording (Wiggans and Goddard, 1997).

The most widely used model has been the repeatability model (Ptak and Schaeffer, 1993). Under this model, consecutive test-day samples from the same lactation are considered as repeated observations on the same trait, and a permanent environmental effect accounts for environmental similarities between different test-days within the same lactation (Vargas *et al.*, 1998). A major disadvantage of the repeatability model is the heterogeneity of the residual variance during the lactation (Ptak and Schaeffer, 1993; Ilatsia *et al.*, 2007). The multiple-trait model has been proposed as a solution to this problem. However, the increase in the amount of information, which can be nearly 10 times higher than with the traditional schemes, results

in a large computational burden (Wiggans and Goddard, 1996).

The milk recording schemes in cattle and buffaloes in Pakistan are not very old and information on performance traits is costly collected due mainly to small herd size and absence of tradition of animal recording. Maximum utilization of available information with respect to milk yield can be efficiently utilized if improved procedures such as test-day models are used for analysis. The method is now being routinely utilized in countries with less well-established milk recording schemes. Genetic parameters of the TD vs lactation milk yield models have been presented previously (Bilal *et al.*, 2008). The present study compared ranking of cows and bulls for breeding values estimated from 305-day milk yield and test-day milk yield.

MATERIALS AND METHODS

The data used for the present study was similar to that reported previously (Bilal *et al.*, 2008). The 4-weekly first lactation milk yield records of 780 Sahiwal cows (calving between 1985 and 2005) at Livestock Experiment Station, Jahangirabad (Khanewal) were used. Lactation length was required to be at least 60 days and maximum test days to be included were 10. These restrictions left 590 records (3949 test day records) for the analysis. There were 112 sires and 470 dams represented in the pedigrees. Year of calving was divided into three periods (1985-1991, 1992-1998 and 1999-2005). Four calving seasons were defined: winter (December to February), spring (March to May), summer (June to August) and autumn (September to November). For cumulative lactation yield, the 305-day milk yield was defined as milk yield upto 305-days of lactation and was calculated by multiplying the test-day yield with 30.5. Number of test-day records per cow averaged 6.69. Breeding values were estimated by the two models. The first model pertained to 305-day lactation milk yield and had period-season of calving as fixed effect and animal's additive genetic and residual effect as random effects. Age at calving was used as covariable (both linear and quadratic components). The breeding values for test day milk yield were estimated in a repeatability animal model having period-season of calving as fixed effect and animals additive genetic effect and permanent environment as random effects. Age at calving was used as covariable. To account for the shape of the lactation curve, ratio of days in milk to 305-day (both linear and quadratic components) and their reciprocal logs were used as covariables (Bilal *et al.*, 2007).

Breeding values for 305-day and TD milk yields were estimated by DFREML program (Meyer, 1997). Breeding values thus obtained were used to get ranking of sires and cows. The ranking of sires and cows from 305-day model and test-day model was compared using Spearman's rank correlation (Sokal and Rohlf, 1995). Genetic trends were drawn from least squares solutions of estimated breeding values (EBVs) with year of birth of the cows in the model.

RESULTS AND DISCUSSION

Average 305-day milk yield was found to be 1142 ± 26 kg, while test-day (TD) yield was 5.6 ± 0.04 kg. These averages are similar to earlier reports (Rehman, 2006). Heritability estimates of 0.082 ± 0.0768 and 0.024 ± 0.0464 obtained for lactation milk yield and test day milk yield were not very high. Earlier studies had reported comparatively higher estimates (Dahlin *et al*., 1998; Bhatti *et al*., 2007). For 305-day yields, the breeding values of sires and cows ranged from –293 to 506 and -278 to 512 kg, respectively. On the other hand, breeding values of sires and cows for test-day milk yields ranged from –0.51 to 0.74 and -0.53 to 0.80 kg, respectively. The EBVs obtained from 305-day milk yields were higher than from the test-day yields, due mainly to higher phenotypic values as well as due to better genetic control of 305-day milk yield (Model I) as compared to TD yield (Model II).

Spearman's rank correlations between breeding values for 305-day and TD milk yields for cows and sires with different number of daughters are given in Table 1. Spearman's rank correlation values indicated that there was a strong correlation between the rankings of animals by the two methods. Generally, sires had stronger rank correlation compared to cows. The rank correlations of sires with 2, 5, 10, 15 and 20 daughters ranged from 0.916 to 1. The value of rank correlations increased with the increase in number of daughters per sire. Similar findings have been documented by Ptak and Schaeffer (1993). Correlations of test-day evaluations with 305-day evaluations ranged from 0.87 to 0.97 in the above referred study. Kaya *et al.* (2003) also reported that for first lactation Holstein cows, rank correlation between the two methods was 0.97. Rank correlation for EBVs of sires were observed as 0.98 in the study of Zavadilova *et al*. (2005).

Shifts in rank for various top listed sires and cows were determined in order to depict changes in both the rankings. The shifts in ranking of first 10, 25, 50, 75, 100 cows and first 5, 10, 25 and 50 sires are given in Table 2. The values show that cows underwent more shifting in ranks than sires. About 60-80% of cows appeared on both the lists in various top lists of cows. The percentage of top list first 50 cows regarding presence on both lists was 60%, while that of sires was 92%. These values are slightly higher than those reported by Swalve (1995) but lower than those reported by Kaya *et al.* (2003). The ranking of sires was less affected than that of cows for test-day yields. This is similar to the findings of Swalve (1995) and Kaya *et*

al. (2003). Swalve (1995) reported that the largest rank shift in cows seemed to be associated with lactation curves that deviated greatly from standard lactation curve.

Genetic and phenotypic correlations between individual TD and 305-day milk yields are given in Table 3. In general, the values of phenotypic correlation were less than the genetic correlations. Genetic correlations varied from -0.77 to 0.99 and showed no clear pattern. It could be due to limited number of observations in the present study. However, correlations decreased with increasing intervals between two test-

days. These results are in agreement with the previous studies (Kettunen *et al.*, 1998; Shadparvar and Yazdanshenas, 2005). Genetic correlation between TD and 305-day yields was found to be almost 0.00 which is contradictory to the previous studies (Jamrozik and Schaeffer, 1997; Shadparvar and Yazdanshenas, 2005). These unexpected results may be due to random choice of the milk yields i.e. milk yield at every 4th week and may be partially due to recording inaccuracy apart from variation in the milk yield of cows due to environmental factors such as feeding and seasonal fluctuations.

Table 1: Rank correlations between estimated breeding values from 305-day and test- day models

| Type of animals	No. of animals	Spearman's rank correlation (r_s)
Cows	590	0.923
Sires	112	0.927
Sires with (≥ 2 daughters)	76	0.916
Sires with (≥ 5 daughters)	42	0.925
Sires with (≥ 10 daughters)	21	0.919
Sires with (≥ 15 daughters)	10	0.952
Sires with (≥ 20 daughters)	3	1.000

Table 2: Shifts in rankings of sires* and cows from 305-day list to test-day (TD) list

| Type of animals	Animals on both lists	% animals on both lists	Largest rank shift		
			305-day list	TD list	Difference
Cows (first 10)	8	80	5	10	5
Cows (first 25)	18	72	9	15	6
Cows (first 50)	30	60	48	6	42
Cows (first 75)	53	71	14	66	52
Cows (first 100)	72	72	23	93	70
Sires (first 5)	3	60	2	3	1
Sires (first 10)	7	70	4	8	4
Sires (first 25)	19	76	22	9	13
Sires (first 50)	46	92	29	4	25

* ≥ 5 daughters.

Table 3: Genetic (above diagonal) and phenotypic (below diagonal) correlations between test-day (TD) yield and 305-day yield

	TD1	TD2	TD3	TD4	TD5	TD6	TD7	TD8	TD9	TD10	305-day
TD1		-0.76	0.40	-0.77	-0.02	0.93	0.88	0.14	0.58	0.93	0.00
TD2	0.50		0.91	0.37	-0.34	0.47	0.23	0.73	0.50	-0.07	0.00
TD3	0.43	0.69		-0.10	-0.23	0.13	0.18	0.85	0.86	-0.69	0.00
TD4	0.38	0.60	0.72		0.004	0.30	0.70	0.93	0.99	-0.53	0.00
TD5	0.31	0.46	-0.56	0.62		0.66	0.93	0.41	0.97	0.94	0.00
TD6	0.26	0.42	0.45	0.58	0.63		0.89	0.98	0.99	-0.57	0.01
TD7	0.33	0.29	0.39	0.44	0.55	0.62		0.31	0.96	0.99	0.01
TD8	0.12	0.22	0.20	0.17	0.23	0.37	0.43		0.99	-0.93	0.05
TD9	0.37	0.19	0.31	0.23	0.31	0.44	0.46	0.36		0.89	0.07
TD10	-0.06	-0.06	0.19	0.11	0.20	0.19	0.29	0.25	0.32		0.00
305-day	0.00	0.00	0.00	0.00	0.00	0.01	.01	0.04	0.08	0.00	
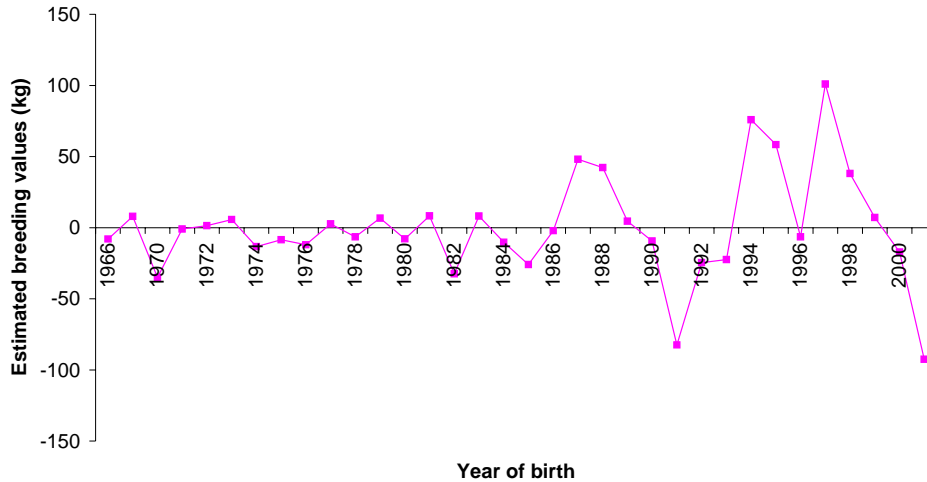
Fig. 1: Genetic trend for 305-day milk yield.
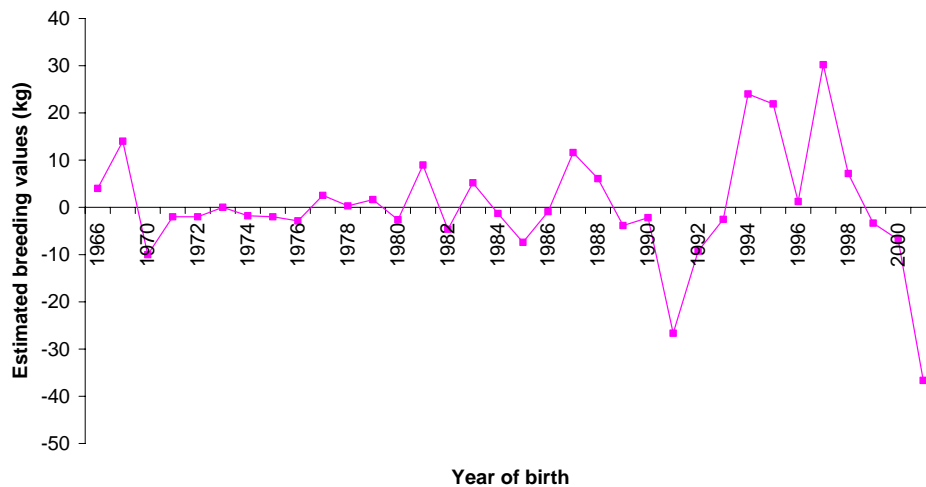
Fig. 2: Genetic trend for test-day milk yield.

Genetic trend for 305-day milk yield (Model I) is shown in Fig. 1, while for test-day milk yields (Model II) is given in Fig. 2. Trends obtained from both the models resembled each other and were close to zero with wide fluctuation in the recent years.

The present study attempted to document the genetic trend of milk yield recorded at 4-week interval and cumulative lactation milk yield for first parity Sahiwal cows. Although genetic trend in milk yield was close to zero, ranking of sires and cows for estimated breeding values were similar for the test-day and 305-day milk yield. The test-day models may be more precise than the lactation yield models but the data set used in the present study were limited for documenting the genetic trend, especially when genetic control of the traits was very low. Nevertheless, future studies should embark upon large scale computerization of test day

yields of Sahiwal cows from all the institutional and other herds so that models used in the present study could be tested for generalization of results.

REFERENCES

Bhatti, A. A., M. S. Khan, Z. Rehman, A. U. Hyder and F. Hassan, 2007. Selection of Sahiwal cattle bulls

on pedigree and progeny. Asian-Aust. J. Anim. Sci., 20: 12-18.

Bilal, G., M. S. Khan, I. R. Bajwa and M. Shafiq, 2008. Genetic control of test-day milk yield in Sahiwal cattle. Pakistan Vet. J., 28(1): 21-24.

Dahlin, A., U. N. Khan, A. H. Zafar, M. Saleem, M. A. Chaudhry and J. Philipsson, 1998. Genetic and environmental causes of variation in milk production traits of Sahiwal cattle in Pakistan. Anim. Sci., 66: 307-318.

FAO, 2007. The state of the world's animal genetic resources for food and agriculture. FAO, Rome, Italy.

GOP, 2006. Livestock Census 2006. Agricultural Census Organization, Statistic Division, Govt. Pakistan, Lahore.

Ilatsia, E. D., T. K. Muasya, W. B. Muhuyi and A. K. Kahi, 2007. Genetic and phenotypic parameters for test day milk yield of Sahiwal cattle in the semi-arid tropics. Animal, 1: 185-192.

Iqbal, J., 2005. Importance of conservation of Sahiwal cattle in Pakistan. National Workshop on Production Recording of Sahiwal Cattle in Pakistan. Univ. Agri. Faisalabad, Pakistan.

Jamrozik, J. and L. R. Schaeffer, 1997. Estimation of genetic parameters for a test-day model with random regression for yield traits of first lactation Holstein. J. Dairy Sci., 80: 762-770.

Kaya, I., Y. Akbas and C. Uzmay, 2003. Estimation of breeding values for dairy cattle using test-day milk yields. Turkish J. Vet. Anim. Sci., 27: 459-464.

Kettunen, A., E. A. Mantysaari, I. Stranden, J. Poso and M. Liddaur, 1998. Estimation of genetic parameters for first lactation test-day milk production using random regression models. Proc.

6th World Congr. Genet. Appl. Livest. Prod., Armidale, New South Wales, Australia, 23: 307.

Meyer, K., 1997. DFREML Version 3.0. User Notes. [http://agbu.une.edu.au/~kmeyer/dfreml.html].

Ptak, E. and L. R. Schaeffer, 1993. Use of test-day yields for genetic evaluation of dairy sires and cows. Livest. Prod. Sci., 34: 23-34.

Rehman, Z., 2006. Inter-herd performance and genetic evaluation of Sahiwal cattle in Pakistan. PhD Thesis, Univ. Agri. Faisalabad, Pakistan.

Shadparvar, A. A. and M. S. Yazdanshenas, 2005. Genetic parameters of milk yield and milk fat percentage test-day records of Iranian Holstein cows. Asian-Aust. J. Anim. Sci., 18: 1231-1236.

Sokal, R. R. and F. J. Rohlf, 1995. Biometry. W. H. Freeman and Co., New York, USA.

Swalve, H. H., 1995. Test-day model in the analysis of dairy production data – A review. Arch. Tierz., 38: 591-612.

Vargas, B., E. Perez and J. A. M. Van Arendonk, 1998. Analysis of test day yield data of Costa Rican dairy cattle. J. Dairy Sci., 81: 255-263.

Wiggans, G. R. and M. E. Goddard, 1996. A computationally feasible test day model with separate first and later lactation genetic effects. Proc. New Zealand. Soc. Anim. Prod., 56: 19.

Wiggans, G. R. and M. E. Goddard, 1997. A computationally feasible test-day model for genetic evaluation of yield traits in the United States. J. Dairy Sci., 80: 1795-1800.

Zavadilova, L., E. Nimcova, J. Poibyl and J. Wolf, 2005. Definition of subgroups for fixed regression in the test-day animal model for milk production of Holstein cattle in the Czech Republic. Czech J. Anim. Sci., 50: 7–13.