



Original Research

Sire Evaluation Based on First Lactation 305 Day Milk Yield and Monthly Part Lactation Records in Sahiwal Cattle

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Abstract

A total of 476 milk yield records of Sahiwal cows maintained at National Dairy Research Institute (NDRI) Karnal over a period of 51 years (1961-2011) were investigated and among which 371 animals completed their 305 days lactation length were used for the study, which are daughters of 51 sires with five or more progenies per sire. Sahiwal sires were evaluated on the basis of actual, predicted 305-DMY, expected breeding value based on 1st -3rd monthly part lactation milk yield records, expected breeding value based on 1st -6th and 1st -10th monthly part lactation milk yield records. It was inferred that the ranking of sires on the basis of FL305-DMY was significantly different from other criteria of selection.

Key words: Expected Breeding Value, Lactation Milk Yields, Part Lactation.

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Introduction

Sahiwal is one of the best indigenous dairy breeds of indigenous cattle originated from its breeding tract in Montgomery district of Pakistan. However, some herds are also found under field conditions along the Indo-Pak border in Ferozpur and Amritsar districts of Punjab and Sri Ganganagar district of Rajasthan besides some pockets of Uttar Pradesh and Chattisgarh. For bringing about improvement in milk production of cattle, it is must to execute breed improvement program for genetic evaluation of males and females



through selection of superior animals of high genetic merit. Based on predicted milk yield from part lactation records, the animal can be selected for future breeding. Use of monthly part lactation yields will be useful in selecting cows during early younger age resulting in reduced generation interval, increased intensity of selection attributed to the availability of more number of records on daughters having monthly records.

The usefulness of part lactation records depends upon the accuracy with which sires are evaluated on the basis of these records besides the genetic correlations between part lactation milk yield records and 305-day milk yield. Literature available on part lactation milk yield also revealed that these milk yields can be used for prediction of 305-day milk yield as high genetic association between monthly part lactation milk yield and complete milk production records was observed (Garcha and Dev, 1994; Joshi *et al.*, 1996; Das and Sadana, 2003; Raja, 2010; Dongre and Gandhi, 2014). However, no literature is available on role of important monthly part lactation yields for estimation of expected breeding value (EBV) in Sahiwal cattle evaluation. Hence, the present investigation was undertaken with the objective of estimation of breeding value of sires using first lactation monthly part- and 305-day milk yields of the daughters.

Materials and Methods

The data for present investigation were collected from history sheets and daily milk yield records of Sahiwal breed of cattle maintained at National Dairy Research Institute, Karnal. Records on monthly part lactation and first lactation 305-day or less milk yields of 371 Sahiwal cattle spread over a period of 51 years (1961-2011) were collected for the study. These cows were daughters of 51 sires having 5 or more progenies per sire. The minimum temperature falls about 2 °C in winter months, whereas the maximum temperature goes up to 47 °C in summer. The annual rainfall is about 760 to 960 mm out of which most of the rainfall is received during the months of July and August. The relative humidity ranges from 41 to 85 percent. Thus, it is obvious that the cattle maintained at NDRI farm get exposed to extreme climatic conditions. Milk yield data were recorded as first lactation 305-day or less milk yield and monthly part lactation milk yields at an interval of 6th, 35th, 65th, 95th, 125th, 155th, 185th, 215th, 245th and 275th days of lactation. The records of the animals with known pedigree and normal lactation were considered for this study. Culling, disposal in middle of lactation, abortion, stillbirth and other pathological conditions which affected the lactation yield were considered as abnormalities and hence such records were excluded from analysis. For estimation of 305 first lactation yield, records of animals with less than 300 kg were excluded. Similarly, for calculation of part lactation yield, animals with less than 100 days of lactation length were discarded.

Prediction of First Lactation 305-Day Milk Yield (FL305DMY)

Multiple Regression Method

$$\hat{Y}_i = a + b_i \sum X_i$$

Where,

\hat{Y}_i = Estimated first lactation 305 day or less milk yield of the i^{th} cow

X_i = monthly part lactation record of i^{th} cow

a = Intercept

b_i = Regression coefficient of first lactation 305 day or less milk yield on monthly part lactation record

Sire Evaluation Method

Best Linear Unbiased Prediction (BLUP)

Henderson (1975) gave the concept of best linear unbiased prediction (BLUP) method for sire evaluation for mixed model equations. The general model of the BLUP estimation was-

$$Y_{ijk} = Xh_i + Zs_j + e_{ijk}$$

Where, Y_{ijk} = Observation vector of the trait with dimension (nx1)

X = Incidence matrix for fixed effects (period, season and age at first calving)

Z = Incidence matrix for random effect (sire) with dimension (nxq)

h_i = A vector for fixed effects of dimension (px1)

s_j = Vector of random effect with mean zero and variance $G\sigma_s^2$ with dimension (qx1)

e_{ijk} = Random error vector with dimension (nx1) with mean zero and variance $(0, \sigma_e^2)$

The assumptions of the model were:

$$E(y) = Xh$$

$$E(s) = 0$$

$$E(e) = 0$$

$$\text{Var}(s) = G\sigma_s^2$$

$$\text{Var}(e) = I\sigma_e^2$$

From the above model the mixed model equations can be written as follows (Searle *et al*, 1992).

$$\begin{pmatrix} (X' R^{-1} X) & (X' R^{-1} Z) \\ (Z' R^{-1} X) & (Z' R^{-1} Z + G^{-1}) \end{pmatrix} \begin{pmatrix} h \\ s \end{pmatrix} = \begin{pmatrix} (X' R^{-1} Y) \\ (Z' R^{-1} Y) \end{pmatrix}$$

Where, G^{-1} is the diagonal matrix of σ_e^2/σ_s^2 pertaining to sire effect, R^{-1} is the identity matrix, the σ_e^2 is the error component and σ_s^2 is the sire component of variance.

Estimation of Expected Breeding Value (EBV)

The expected breeding value for each sire was calculated using the following formula,

$$EBV = \bar{P} + \frac{nh^2}{1+(n-1)r} (\bar{P}_n - \bar{P})$$

Where

- P_n = Cow's milk averaged over her 'N' records
 P = Avg. milk production
 n = Number of monthly part lactation records
 h^2 = Heritability estimate of part lactation records
 R = Repeatability estimate for part lactation records

The effectiveness of sire evaluation method were compared using the Spearman's rank correlations between breeding values of cows derived from various selection criteria were used to judge their effectiveness. The rank correlation was estimated as

$$r_s = 1 - \left(\frac{6 \sum d_i^2}{n(n^2 - 1)} \right)$$

Where,

- r = Rank correlation coefficient
 n = Number of sires under evaluation
 d_i = Difference of rank between paired items under two selection criteria

The significance of rank correlation was tested by t-test with n-2 degrees of freedom as given below:

$$t = r \sqrt{\frac{(n - 2)}{(1 - r^2)}}$$

Result and Discussion

Sahiwal sires were evaluated on the basis of actual, predicted 305-DMY, expected breeding value based on 1st -3rd monthly part lactation milk yield records, expected breeding value based on 1st -6th and 1st -10th monthly part lactation milk yield records. The Spearman's rank correlations estimated on the basis of these five criteria were presented in Table 1.

Table 1: Rank correlations among various criteria of selection

BASIS	A	B	C	D	E
A	-	0.5701**	0.0897	0.3498**	0.5069**
B		-	0.6174**	0.0317	0.1624**
C			-	0.4104**	0.5152**
D				-	0.7884**
E					-

(**Highly significant $P < 0.01$)

A - Actual 305-DMY

B - Predicted 305-DMY on the basis of optimum prediction equation

C - EBV based on monthly part lactation milk yield from 1st to 3rd months

D - EBV based on monthly part lactation milk yield from 1st to 6th months

E - EBV based on monthly part lactation milk yield from 1st to 10th months

Highest rank correlations among five selection criteria were observed between EBV based on monthly part lactation milk yield from 1st to 6th months and EBV based on monthly part lactation milk yield from 1st to

10th months. The predicted 305-DMY and EBV based on monthly part lactation milk yield comprising 1st to 3rd months was the second highest rank correlation. The lowest rank correlation of breeding values of sires was observed between the predicted 305-DMY and EBV based on monthly part lactation milk yield from 1st to 6th months. The perusal of Table 1 revealed that ranking of sires on the basis of FL305-DMY was significantly different from other criteria of selection based on part lactation monthly milk yields. Similarly, Dongre and Gandhi (2014) reported that the rank correlations of breeding value of sires estimated from different methods of sire evaluation including BLUP based on actual and predicted FL305DMY were statistically highly significant ($P < 0.01$).

Sire Evaluation by Best Linear Unbiased Prediction (BLUP) Method

The average breeding value of Sahiwal sires estimated by best linear unbiased prediction method was 1908.70 kg (Table 2).

Table 2: Expected breeding values (EBVs) of Sahiwal sires using BLUP method

Sire No.	No. of Daughters	EBVs	Rank	Sire No.	No. of Daughters	EBVs	Rank
619	7	1983.12	1	1033	8	1906.95	26
327	14	1974.23	2	1376	9	1902.91	27
526	19	1972.54	3	234	19	1902.14	28
1060	25	1958.14	4	1208	5	1902.06	29
1424	9	1957.36	5	739	9	1901.43	30
977	9	1957.3	6	310	5	1896.47	31
636	24	1951.93	7	428	5	1895.99	32
1090	5	1951.87	8	1404	12	1894.88	33
1056	6	1947.62	9	485	56	1892.28	34
506	5	1944.52	10	1401	5	1890.82	35
1578	35	1944.24	11	1558	7	1888.42	36
446	6	1942.46	12	453	8	1883.25	37
1574	5	1939.59	13	737	9	1880.83	38
369	8	1938.13	14	79	5	1879.32	39
252	13	1935.19	15	1260	5	1877.51	40
1577	7	1931.2	16	971	9	1872.14	41
1421	12	1931.12	17	1575	11	1867.59	42
1299	5	1928.38	18	494	17	1862.44	43
400	5	1925.16	19	1274	5	1856.52	44
309	7	1923.12	20	563	5	1849.6	45
651	11	1917.43	21	918	7	1841.52	46
1576	5	1915.68	22	530	12	1840.21	47
366	5	1914.62	23	1450	7	1833.28	48
1220	5	1913.65	24	404	25	1832.16	49
606	5	1908.24	25	1579	21	1814.19	50
				365	5	1813.81	51

The average breeding value obtained in the present study by this method was higher than the values reported by Banik and Gandhi (2006), Kumar (2007), Kathiravan (2009), Raja (2010) and Debbarma (2010) in Sahiwal cattle. The highest estimated breeding value was 1983.12kg (Sire No. 619) and the minimum breeding value was estimated as 1813.81kg (Sire No. 365). The estimated breeding values of 24 Sahiwal out of 51 sires (47.05%) were above the average breeding value, while the remaining 27 sires (52.94%) had breeding value lower than the average breeding value.

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