

Research paper

Effectiveness of sire evaluation based on actual and predicted first lactation 305 day milk yield in Rathi Cattle

Manju Nehara*, Urmila Pannu and G C Gahlot

*Department of Animal Genetics and Breeding, College of Veterinary and Animal Science, University of Veterinary and Animal Sciences, Bikaner-334 001, (Rajasthan) India***ABSTRACT**

A total of 362 first lactation 305-day milk yield records of Rathi cows maintained at Livestock Research Station, Nohar and Bikaner over a period of 33 years (1985 to 2017) were analysed which are daughters of 31 sires with five or more progenies per sire. Rathi sires were evaluated on the basis of actual and predicted first lactation 305-day milk yield using single trait animal model (STAM) fitting restricted maximum likelihood (REML) method. The expected breeding value based on actual and predicted first lactation 305-day milk yield (PL305MY) were compared using Spearman's rank correlation. The rank correlation between STAM-A (single trait animal model using actual first lactation 305-day milk yield) and STAM-P (single trait animal model using predicted first lactation 305-day milk yield) was observed 0.60 which showed significant association between ranks of sires based on actual and predicted milk yields. It was inferred that PL305MY may be used as criterion for sire evaluation earlier than actual FL305MY.

Key Words: Single trait sire model, rank correlation, predicted first lactation 305 day milk yield

***Corresponding author:** manju.nehravet@gmail.com

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INTRODUCTION

Rathi is an important dual purpose cattle breed known for both its milking and draught power, found in the arid regions of Rajasthan. The breeding tract of this breed lies in the heart of Thar Desert consisting of Bikaner, Hanumangarh, Ganganagar and Jaisalmer districts of Rajasthan. Scorching summer (50°C), chilly winter (2°C), dry monsoon (less than 200 mm rainfall in a year) and dust storms are the characteristics of the region. Rathi cows are efficient milk producer and thrive well on scanty feed-fodder resources in adverse climatic conditions of Rajasthan. For maintaining high level of milk production of cattle and their further improvement, it is necessary to execute proper breeding programmes for genetic evaluation of males at earliest with high intensity and accuracy of selection. For early sire evaluation, predicted 305 day milk yields on basis of test day milk yields of first lactation is a best alternate of actual 305 day milk yield (Banik *et al.*, 2006; Kokate, 2009; Debbarma, 2010). The REML using animal model is more powerful and

efficient method of sire evaluation than other tradition methods (Singh, 2012; Singh, 2013; Dongre *et al.*, 2014; Singh *et al.* 2016). The present study was designed to evaluate Rathi sires on the basis of PL305MY, which was predicted using fortnightly test day milk yields of first lactation and compared with sire evaluation based on actual FL305MY by single trait animal model method.

MATERIALS AND METHODS

The relevant data on first lactation test day and 305-day milk yield for this study were collected from the history-cum-pedigree sheets and Daily milk yield recording registers of Rathi cattle maintained at Livestock Research Station, Nohar and Bikaner over the period of 33 years (1985 to 2017). The information about test day milk yields were collected at fortnightly interval from daily milking registers. These cows were daughters of 31 sires. 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 this study. For estimation of 305 first lactation yield, records of animals with less than 100 days of lactation length were discarded for prediction of 305 day lactation yield.

Prediction of first lactation 305-day milk yield (PL305DMY)

Following multiple regression method was adopted for prediction of first lactation 305-day milk yield

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

Where,

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

X_i = fortnightly test day record of i^{th} cow

a = Intercept

b_i = Regression coefficient of first lactation 305 day or less milk yield on fortnightly test day record

Sire evaluation by Single trait animal model fitting restricted maximum likelihood method

Single trait animal model fitting restricted maximum likelihood (REML) method was applied on data of FL305MY and PY305MY traits to predict the breeding values of sires and to estimate fixed effects using WOMBAT software (Meyer, 2007). The animal model takes account of relationship between all animals (sires and dams) of pedigree only through numerator relationship matrix. The animal model of analysis fitted the herd, season of calving, period of calving and age groups as fixed effect and animal as random effect for FL305MY. By solving the mixed model equations, the breeding value of the random effect were obtained animal wise.

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

where,

Y_{ijk} = Observation vector of trait with dimension (n x 1)

X = Incidence matrix for fixed effects (periods and season) with dimension (n x p)

Z = Incidence matrix for random effect with dimension (n x q)

h_i = A vector for fixed effects of dimension (p x 1)

s_j = A Vector of random effect with mean zero and variance $G\sigma_s^2$ with dimension (q x 1)

e_{ijk} = Random error vector with dimension (n x 1) with mean zero and variance (0, σ_e^2)

The assumptions of the model are:

$$E(y) = Xh$$

$$E(s) = 0$$

$$E(e) = 0, \text{ and}$$

$$\text{Var}(s) = G = A * G_0$$

$$\text{Var}(e) = R = I * R_0$$

where, A is a numerator relationship matrix

G_0 is the genetic (co)variances matrix between traits of animals

R_0 is the residual (co)variances matrix

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

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

RESULTS AND DISCUSSION

The fortnightly test day milk yields were used to predict first lactation 305-day milk yield (FL305DMY) by using multiple regression method. The backward elimination multiple regression method was used to find the optimum equation for prediction. The final equation containing 2nd, 5th, 8th and 10th fortnightly test day milk yields for prediction of 305 day milk yield with 40 % coefficient of determination (accuracy) was used for prediction (Saini *et al.*,2005). Rathi sires were evaluated using single trait animal model fitting REML on the basis of actual and predicted 305-DMY milk yield records. The breeding values of Rathi sires along with their ranks for FL305MY and PL305MY by single trait animal model fitting REML method have been presented in Table 1.

Table 1: Breeding values of Rathi sires along with their ranks by single trait animal model fitting REML method based on FL305MY (kg) and PL305MY (kg)

Sire ID	N	STAM-A		STAM-P	
		BV	Ranks	BV	Ranks
2	5	1509.52	20	1678.97	8
4	8	1426.04	30	1461.56	29
5	16	1456.91	27	1529.27	21
6	5	1664.95	5	1490.13	26
7	41	1367.50	31	1390.11	30
8	7	1605.37	8	1713.83	6
9	39	1435.67	29	1258.40	31
10	5	1531.92	16	1561.52	15
12	12	1580.01	10	1715.76	5
13	21	1700.86	2	1880.61	1
14	6	1476.97	23	1601.97	14
15	6	1570.77	12	1763.87	2
16	8	1693.90	3	1636.50	11
17	15	1616.88	7	1497.98	25
22	5	1553.55	15	1514.80	23
23	5	1476.33	24	1489.89	27
24	28	1677.20	4	1648.51	10
25	8	1587.83	9	1561.06	16
28	7	1562.12	13	1610.29	13
29	7	1510.65	19	1553.31	17
30	10	1503.45	21	1613.94	12
32	5	1520.40	18	1530.46	20
35	8	1734.14	1	1702.94	7
38	10	1520.51	17	1542.56	18
39	5	1446.92	28	1538.95	19
40	10	1474.89	25	1476.85	28
41	14	1571.48	11	1662.42	9
43	4	1554.19	14	1512.48	24
44	6	1644.54	6	1739.31	3
45	30	1458.69	26	1719.92	4
49	6	1476.98	22	1515.77	22

N = Number of daughters of sire, *BV* = Breeding Value

STAM-A = single trait animal model method based on actual FL305MY

STAM-P = single trait animal model method based on predicted PL305MY

The Spearman's rank correlation was calculated between STAM-A and STAM-P i.e. 0.60 and t-test is applied to estimate significance of association. The results of test of significance revealed significant association between these two criteria of selection. According to results of present study, it is concluded that predicted first lactation 305-day milk yields (on the basis of fortnightly test day milk yields) may be used as alternative selection criterion earlier than

actual 305-day milk yield for sire evaluation.

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