RESEARCH ARTICLE Asian Journal of Dairy and Food Research, Volume 40 Issue 1: 14-19 (March 2021)

Sire Evaluation Based on First Lactation 305 Day Milk Yield and Individual Part Lactation Records in Frieswal Cattle

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10.18805/ajdfr.DR-1610

ABSTRACT

Background: Frieswal, the crossbred cattle, between sahiwal and Holstein Friesian breed with 62.50 per cent of exotic (inheritance) with total lactation milk yield of (4000 Kg) with average lactation length 300 days (PDC Annual Report, 2015-16). Presently, the Frieswal Animal is mainly maintained at 36 Military Farms located in various agro-climatic regions in the country.

Methods: The present study was undertaken on first lactation 305 days and part lactation records of 1470 Frieswal cows maintained over a period of 10 years (2003-2012) from military farm at CIRC Meerut Uttar Pradesh as well as Ambala. The success of any breed improvement programme depends mainly on the Sire evaluation which involves the estimation of expected breeding value of the bulls on the basis of average first lactation 305-day or less milk yield and part lactation records of their daughters (FL305DMY).

Result: The estimate breeding value of 55 Frieswal sires on the basis of first lactation 305-day or less milk yield and individually part lactation records, by LSM, BLUP and DFREML methods were 2701.48 kg and 2660.70 kg, followed by 333.40, kg and 329.17 kg, respectively. A number of 55 Frieswal sires with three or more daughters were evaluated and ranked on the basis of first lactation 305-day milk yield and individual third month part lactation was having better heritability and comparatively higher genetic correlations with the first lactation 305-days or less milk yield.

Key words: Expected breeding value, Lactation milk yields, Part lactation record.

INTRODUCTION

The Frieswal cattle is define crossbred having 62.50 per cent of exotic inheritance and yielding 4000 Kg of milk with 4% butter fat in a lactation of 300 days under good managemental conditions (PDC Annual Report, 2002-03). Presently, the Frieswal crossbreds are mainly maintained at 36 military farms located in various agro-climatic regions in the country. The total number of adult Frieswal females at military farms as on 31st December, 2014 was 18624 including 10577 adult cows, 6118 young stocks and 1929 calves. (Annual Report, CIRC- Meerut, (2014 Agriculture) and Animal Husbandry activities are considered as an integral part of Indian tradition and culture since civilization. The contribution of livestock sector to the national gross domestic product at current prices during the year 2013-14 was 4.1% while the contribution of whole agricultural sector including livestock sector was 13.9%. Under such situation, the cross breeding of low producing Indian cattle with the high producing exotic dairy breeds will be the only or one of the method of choice for increasing the milk production.

MATERIALS AND METHODS

The data on Frieswal cattle born over a period of 10 years (2003-2012) from Military dairy Farms *viz.*, Ambala and Meerut Uttar Pradesh were utilized for the present study. The Military farm at Meerut is located at 28° 98' N latitude and 77° 71' E longitude. The temperature varies with a wide range of 4°C during peak winter and 44°C during summer. The Military farm, Ambala is located in the cantonment area on the South-East of Ambala City. It is located between 30° 19' to 30° 23' N latitude and 76° 46' to 76° 51' E longitude.

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How to cite this article: Rajeev, Kumar, R. and Singh, R. (2021). Sire Evaluation Based on First Lactation 305 Day Milk Yield and Individual Part Lactation Records in Frieswal Cattle. Asian Journal of Dairy and Food Research. 40(1): 14-19. DOI: 10.18805/ajdfr.DR-1610.

Submitted: 15-12-2020 **Accepted:** 03-02-2021 **Online:** 13-03-2021

Sire evaluation methods

Estimation of breeding value of sires for milk yield was done by using three methods following methods LSM, BLUP and DFREML. The sires having at least three progenies were only considered for the analysis and a total of 55 Frieswal sires were evaluated for ranking estimated for first lactation 305 or less milk yield and different part lactation yields of 836 daughters by the above methods.

Least squares method (LSM)

The least squares method discussed by Harvey (1987) was used to estimate the breeding value of sires. The following model was considered.

$$Y_{ij} = \mu + S_i + e_{ij}$$

Where,

Y_{ij} = j^{th} dependent single trait of the daughter of i^{th} sire.

μ = Population mean.

S_i = Effect of i^{th} sire.

e_{ij} = Random error assumed to be normally independently distributed with mean zero and constant variance *i.e.* NID (0, σ_e^2).

The index of ith sire was estimated by following formula:

$$I = \mu + S_i$$

Where,

I = Index of i^{th} sire.

μ = Population mean.

S_i = Least squares constant of i^{th} sire.

Best linear unbiased prediction (BLUP)

The breeding value of sires was estimated by best linear unbiased prediction (BLUP) method as given by Henderson (1973, 1975).

The general model of BLUP estimation was considered as follows:

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

Where,

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

X = Design matrix or incidence matrix for fixed effects with dimension (n x p).

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

Z = Design matrix or incidence matrix for random effects with dimension (n x q).

s_j = Vector of random effect with mean zero and variance G σ_s^2 with dimension (q x 1).

e_{ijk} = Random error vector with dimension (n x 1) with mean zero and variance I σ_e^2 solving B, the best linear unbiased prediction of breeding values of the sires was obtained.

Derivative free restricted maximum likelihood method (DFREML)

For DFREML estimation following animal model was considered:

$$Y_{ijk} = Xb_i + Zu_j + e_{ijk}$$

Where,

Y_{ijk}, h_i, s_j and e_{ijk} denote the vector of observation, fixed effects, random effects and residual errors, respectively and X and Z are incidence matrices pertaining to h and s.

RESULTS AND DISCUSSION

Sire evaluation

Three different sire evaluation methods *viz.,* least squares (LSM), best linear unbiased prediction (BLUP) and derivative free restricted maximum likelihood (DFREML) were used for estimating the expected breeding values of Frieswal sires and to rank them accordingly.

Breeding value estimation for first lactation 305-day or less milk yield

Least squares method

The breeding value of 55 Frieswal sires evaluated on the basis of first lactation 305-day or less milk yield by least squares method was 2701.48 (kg) (Table 1), which was near the estimate of 2668.10 kg reported by Mukherjee (2005) and 2744.60 kg reported by Rathee (2015) in the same breed. However, estimates lower than the present value were also reported by Pundir *et al.* (2004), (Banik and Gandhi 2006), Kumar (2007), Kathiravan (2009), Raja (2010) in different breeds of cattle. The results revealed that the estimated breeding values of 29 (52.73%) Frieswal sires were above the average breeding value. The top ranking sire with the highest breeding value of 3749.63 kg had 38.80% genetic superiority over the overall average, whereas the sire ranked at bottom with lowest breeding value of 1847.71 kg was 31.60% below the overall average breeding value of sires (Table 3). The difference between these two extreme breeding values was highest (1901.92 kg) indicating that this method discriminated amongst bulls to the highest extent as compared to other methods. However, the difference obtained in the present study was higher than the difference reported by Mukherjee (2005) and Rathee (2015) in Frieswal cattle.

Best linear unbiased prediction method (BLUP)

The average breeding value of Frieswal sires for first lactation 305-day or less milk yield estimated by best linear unbiased prediction method was 2660.70 kg (Table 1) and the estimates ranged from 2490.89 to 2783.10 kg. The average breeding value obtained in the present study by this method was near to the value reported by Mukherjee (2005) but lower than the value reported by Rathee (2015) in Frieswal cattle. However, the estimate obtained was higher than the average estimates reported by Pundir *et al.* (2004), Banik and Gandhi (2006), Kumar (2007), Kathiravan (2007), Kathiravan (2009) and Raja (2010) in Sahiwal cattle. The study also revealed that 49.09 per cent of Frieswal sires had breeding values above the overall average while 50.91 per cent had breeding values below the overall average. Perusal of (Table 3) revealed that this method gave the lowest range of breeding value (292.21 kg) among the three different methods of sire evaluation used indicating that this method was discriminating amongst sires to the minimum extent. Similar to the present findings, (Deulkar and Kothekar 1999) and Raja (2010) in Sahiwal cattle, Mukherjee (2005) and Rathee (2015) in Frieswal cattle also reported the BLUP method discriminated the sires to the minimum extent as compared to the other methods. On the contrary, (Banik and Gandhi 2007) reported that the range of breeding values estimated by BLUP method was the highest (1655 kg) among the different methods and this method discriminated amongst the bulls to the highest extent in Sahiwal cattle.

Derivative free restricted maximum likelihood method (DFREML)

The evaluation of breeding value of sires by this method gave the average breeding value as 2761.90 kg (Table 1) and the estimate is similar to the estimate of 2781.0 kg reported by Mukherjee (2005) in Frieswal cattle. Among the

Table 1: Expected breeding value (EBV) of Frieswal sires along with their ranks for first lactation 305-day or less milk yield by various methods

Sire code	No. of records	LSM		BLUP		DFREML		Sire code	No. of records	LSM		BLUP		DFREML	
		BV	Rank	BV	Rank	BV	Rank			BV	Rank	BV	Rank	BV	Rank
Overall	839	2701.5		2660.7		2761.9		Overall							
1	46	2862.9	17	2597.6	49	2783.9	27	18	3	3331.3	2	2736.7	7	2920.7	15
2	14	2851.4	21	2767.5	4	2937.5	12	19	3	2455.6	42	2666.8	26	2667.6	38
3	12	1847.7	55	2499.6	54	2041.2	54	20	5	2704.1	29	2678.5	23	2640.5	41
4	7	2811.7	23	2613.8	45	2617.7	44	21	3	2208	51	2651.4	35	2635.7	42
5	7	2271.5	50	2618.2	40	2403.8	52	22	3	2409.8	47	2614.6	44	2487.3	47
6	8	2482.8	41	2698.1	15	2666.7	39	23	8	3005.6	9	2670.4	25	2893.8	16
7	8	2912.7	14	2762.2	5	2855.1	18	24	14	2415.4	46	2715.9	11	2644.1	40
8	3	2971.3	11	2685.7	19	2740.8	32	25	7	2653.3	31	2684.8	22	2677.4	37
9	36	3067.1	9	2708.1	13	3085.1	6	26	3	2489.1	40	2652.4	32	2603.7	45
10	11	2676	30	2629.1	37	2825.4	23	27	3	2587.5	36	2614.6	43	2633.9	43
11	13	2932.4	13	2735.6	8	3154.3	5	28	10	2869.1	16	2665.2	27	2921.9	14
12	3	2083	53	2564.2	52	2475.4	49	29	4	2880.4	15	2694.2	16	2849.1	19
13	11	2706.2	28	2613	46	2759.3	30	30	21	2365.9	49	2490.9	55	1927.7	55
14	16	2505.3	39	2750.9	6	2730.8	34	31	4	3749.6	1	2768.5	3	3203.9	2
15	59	2748.6	27	2632.6	36	2933.6	13	32	19	2998.3	10	2652.3	33	2841.7	20
16	3	2588.3	35	2659.0	28	2816.5	24	33	4	2380.3	48	2627.9	38	2712.1	35
17	10	3157.5	5	2686.2	18	2970.6	11	34	3	1895.5	54	2600.4	48	2429.5	51

Table 1: Continue...

Sire code	No. of records	LSM		BLUP		DFREML		Sire code	No. of records	LSM		BLUP		DFREML	
		BV	Rank	BV	Rank	BV	Rank			BV	Rank	BV	Rank	BV	Rank
Overall								OverAll							
35	64	2857.4	19	2730.1	9	3185.4	4	46	71	2852.6	20	2578.6	50	2808.6	25
36	5	3110.5	6	2708.7	12	2991.6	9	47	6	2787.7	25	2656.0	30	2840.7	21
37	21	3171.3	4	2685.1	21	3032.2	8	48	6	2507.4	38	2702.8	14	2736.1	33
38	33	2944.8	12	2564.3	51	2746.7	31	49	60	2813.7	22	2717.8	10	3066.6	7
39	52	2593.3	34	2673.6	24	2839.9	22	50	9	3030.0	8	2779.9	2	3187.	3
40	5	2420.5	45	2617.4	41	2460.3	50	51	31	2750.9	26	2656.3	29	2776.4	28
41	13	2436.7	44	2539.1	53	2526.5	46	52	3	2647.6	32	2654.4	31	2798.5	26
42	14	2811.6	24	2685.5	20	2982.5	10	53	23	2857.7	18	2625.1	39	2870.1	17
43	9	2571.0	37	2651.8	34	2483.5	48	54	6	3309.3	3	2783.1	1	3262.1	1
44	17	2145.9	52	2614.6	42	2360.6	53	55	4	2453.6	43	2612.2	47	2690.6	36
45	3	2631.8	33	2693.5	17	2768.7	29								

Table 2: Expected breeding value (EBV) of Frieswal sires along with their ranks for individual third month milk yield by various methods in Frieswal cattle.

Sire code	No. of	LSM		BLUP		DFREML		Sire code	No. of	LSM		BLUP		DFREML	
	records	BV	Rank	BV	Rank	BV	Rank		records	BV	Rank	BV	Rank	BV	Rank
Overall	839	333.4		329.1		337.6		Overall							
1	46	337.5	24	317.9	46	328.5	46	18	3	397.8	6	334.1	20	340.8	20
2	14	341.7	21	336.4	16	341.8	16	19	3	321.8	36	330.6	30	336.7	30
3	12	245.2	55	317.0	54	314.1	54	20	5	327.4	33	331.2	35	335.6	35
4	7	336.5	27	326.6	39	334.5	39	21	3	284.6	48	328.3	40	334.5	40
5	7	262.8	51	323.3	52	324.5	52	22	3	245.5	54	323.4	45	328.5	45
6	8	316.5	39	332.7	33	335.9	33	23	8	405.9	5	335.7	9	347.9	9
7	8	337.2	25	334.4	26	337.6	26	24	14	304	43	332.4	42	331.9	42
8	3	356	13	330.7	28	337.1	28	25	7	334.2	30	332.1	31	336.6	31
9	36	367.9	10	332.3	6	350.7	6	26	3	334.1	31	330.2	32	335.9	32
10	11	319.2	38	324.42	36	335.5	36	27	3	340.3	22	326.3	38	334.8	38
11	13	334.8	29	329.3	14	342.4	14	28	10	351.2	15	329.1	19	340.9	19
12	3	245.6	53	320.2	47	328.1	47	29	4	415.8	4	337.7	10	346.8	10
13	11	338.8	23	328.7	21	340.8	21	30	21	282.8	49	314.5	55	303.2	55
14	16	299.1	45	329.3	50	327.2	50	31	4	450.8	1	336.9	7	348.2	7
15	59	323.2	35	321.	29	336.8	29	32	19	344.5	20	324.2	41	334.2	41
16	3	336.3	28	330.3	23	340.1	23	33	4	308.1	41	328.2	27	337.6	27
17	10	393.2	7	333.1	11	345.5	11	34	3	255.5	52	326.2	43	331.5	43

Table 2: Continue...

Sire code	No. of	LSM		BLUP		DFREML		Sire code	No. of	LSM		BLUP		DFREML	
	records	BV	Rank	BV	Rank	BV	Rank		records	BV	Rank	BV	Rank	BV	Rank
Overall								OverAll							
35	64	347.2	17	332.2	2	355.2	2	46	71	351.1	16	323.6	18	341.1	18
36	5	370.3	9	332.1	15	342.2	15	47	6	355.5	14	330.1	22	340.1	22
37	21	391.4	8	335.6	3	353.6	3	48	6	337.1	26	335.6	17	341.1	17
38	33	358.4	11	323.4	24	339.1	24	49	60	346.4	18	333.5	4	352.2	4
39	52	328.8	32	332.7	13	343.8	13	50	9	423.1	2	346.6	1	360.2	1
40	5	265.1	50	322.9	51	326.5	51	51	31	325.3	34	324.2	44	330.6	44
41	13	293.8	46	316.8	53	324.4	53	52	3	320.5	37	329.3	25	338.8	25
42	14	345.9	19	332.1	12	345.2	12	53	23	357.5	12	331.6	8	348.2	8
43	9	305	42	327.2	48	327.9	48	54	6	416.9	3	339.4	5	351.9	5
44	17	288.1	47	329.1	49	327.3	49	55	4	303.7	44	325.7	37	335.5	37
45	3	308.3	40	329.9	34	335.9	34								

LSM – Least squares method; BLUP – Best linear unbiased prediction method; DFREML – Derivative free restricted maximum likelihood method.

Table 3: Average expected breeding value (EBV) for first lactation 305-day or less milk yield, individual third month milk yield by different single trait methods in Frieswal sires.

Sire evaluation methods	Average EBV	Number of sires above average EBV	Number of sires below average EBV	Maximum EBV	Minimum EBV
First lactation 305-day or less milk yield					
LSM	2701.48	29.00 (52.73)	26.00 (47.27)	3749.63 (38.80)	1847.71(31.60)
BLUP	2660.70	27.00 (49.09)	28.00 (50.91)	2783.10 (04.60)	2490.89 (06.38)
DFREML	2761.90	29.00 (52.73)	26.00 (47.27)	3262.14 (18.11)	1927.68 (30.20)
Individual third month milk yield					
LSM	333.40	31.00 (56.36)	24.00 (43.64)	450.88 (35.24)	245.29 (26.43)
BLUP	329.18	31.00 (56.36)	24.00 (43.64)	346.61 (05.29)	314.53 (04.45)
DFREML	337.64	27.00 (47.09)	28.00 (50.91)	360.28 (06.71)	303.30 (10.17)

LSM - Least squares method; BLUP - Best linear unbiased prediction method; DFREML - Derivative free restricted maximum likelihood method.

four methods used, the DFREML method gave the maximum overall average breeding value for the Frieswal sires for first lactation 305-day or less milk yield. Twenty nine (52.73%) out of 55 sires showed higher breeding values than the average breeding value. The highest breeding value was estimated as 3262.14 kg, which was 18.11% higher than the average breeding value (Table 3). The lowest breeding value was 1927.68 kg, which was 30.20% lesser than the average breeding value. Banik and Gandhi (2006) and Kumar (2009) reported lower significant estimates (1503.99 and 1523.7 kg, respectively).

Breeding value estimation for individual third month milk yield

Least squares method

The average breeding value of Frieswal sires estimated by this method for individual third month milk yield was 333.40 kg (Table 2). Thirty one sires (56.36%) out of 55 sires had breeding value above average breeding value, while 24 (43.64%) were had breeding values below the average breeding value. The highest breeding value was observed as 450.88 kg, which was 35.24% higher than the average breeding value, whereas: the lowest breeding value was observed as 245.29 kg, which was 26.43% lower than the average breeding value (Table 3). The difference of breeding values between the upper and lower estimates was 205.59 kg, which was the highest amongst the three methods of sire evaluation used. Similar to the present findings, Raja (2010) also reported that the LSM method discriminated the sires to the maximum extent as it gave the maximum difference between the lowest and highest estimates among the four different methods of sire evaluation.

Best linear unbiased prediction method (BLUP)

The average breeding value of Frieswal sires estimated by best linear unbiased prediction method was 329.18 kg (Table 2). The estimated breeding values of 31 sires (56.36%) were above the average breeding value, while 24 sires (43.64) had the breeding values lower than the average breeding value. The maximum expected breeding value was observed as 346.61 kg which was 05.29% higher than the overall average while the lowest breeding value was 314.53, which was 04.45% below the overall average (Table 3). The difference between the maximum and minimum breeding value was estimated as 32.08 kg, which was the lowest among the three different methods used for evaluation indicating that this method discriminate the sires for individual third month milk yield to the lowest extent.

Derivative free restricted maximum likelihood method with univariate model (DFREML)

The average breeding value of Frieswal sires evaluated by the derivative free restricted maximum likelihood method using univariate model for individual third month milk yield was 337.64 kg (Table 2). The average estimate obtained by this method was higher than the averages estimated by the other two methods. The results revealed that 27 sires (47.09%) out of 55 sires had breeding values above the overall average, while 28 sires (50.91%) had breeding values below the overall average. The top ranked sire had the breeding value of 360.28 kg, which was 06.71% above the overall mean; while the lowest ranked sire had the breeding value of 303.30 kg, which was 10.17% below the overall average breeding value (Table 3). The difference between the highest and lowest breeding values was estimated as 56.98 (kg).

CONCLUSION

The DFREML method was adjudged as the most efficient and stable method of sire evaluation among the three methods used in Frieswal cattle. Frieswal sires may be evaluated on the basis of individual third month/ cumulative 90 days milk yield. This would lower the generation interval and increase the intensity of selection from progeny testing, if practised.

ACKNOWLEDGEMENT

Authors are highly thankful to the Director, ICARCentral Institute for Research on Cattle, Meerut Cantt., Meerut for providing necessary facilities during the dissertation work at institute.

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