International Journal of Veterinary Sciences and Animal Husbandry

ISSN: 2456-2912
VET 2023; SP-8 (5): 222-226

www.veterinarypaper.com
Received: 12-07-2023
Accepted: 17-08-2023

Vipin Kumar Singh
Ph.D. Scholar, SHUATS, Prayagraj, Uttar Pradesh, India

Rampal Singh
Associate Professor, Department of AG & B, SHUATS, Prayagraj, Uttar Pradesh, India

Neeraj
HOD, SHUATS, Prayagraj, Uttar Pradesh, India

Ramesh Pandey
Associate Professor, Department of LPM, SHUATS, Prayagraj, Uttar Pradesh, India

Sabysachi Mukherjee
Principal Scientist (AG & B)
ICAR-NDRI, Karnal, Haryana, India

Anupama Mukharjee
Principal Scientist (AG&B)
ICAR-NDRI Karnal, Haryana, India

Corresponding Author:
Vipin Kumar Singh
Ph.D. Scholar, SHUATS, Prayagraj, Uttar Pradesh, India

Estimation of breeding value by using of BLUF and animal model for milk production and reproduction traits of HF herd in organized dairy farm in India

Vipin Kumar Singh, Rampal Singh, Neeraj, Ramesh Pandey, Sabysachi Mukherjee, and Anupama Mukharjee

Abstract
Evaluation of production and reproduction traits of heifers is very important for life time traits selection. Aim of the present study is to evaluate the sires as well as dams so that we can achieve genetic improvement in less generation and can get more progeny with dam`s superior genetics as well.
Methods: The data for present investigation were collected from history sheets and daily milk yield records from year 2007 to 2014 of Holstein Frisian breed of cattle maintained Bhagyalaxmi Dairy Farm Manchar Pune. The study was on 973 dam record and 64 sire to study of Genetic and non-genetic factor effects on first lactation production reproduction traits and evaluation of sires and dam. Estimation of breeding value for traits used LSML mixed model (Harvey, 1990), animal model (Wombat, Meyer, 2007).
Results: The EBV for FLTMY ranged from 6315.10 kg to 4956.57 kg and average 5573.50 kg. EBV for FL300/305DMY by using of sires predicted though BLUP-sire model. The EBV for FL300/305DMYranged from 5758.55 kg to 4480.26 kg and average 5041.41 kg. The EBV for FDP ranged from 85.57 days to 133.46 days with average 109.02 days. The EBV for FLL ranged from 316.31 days to 368.09 days with average 334.65 days. The overall result indicated that sufficient variability for growth traits present in the herd that is important for bringing effective selection for sustainable milk production in dairy cattle genetic.

Keywords: Breeding value, first lactation yield, wombat, BLUP animal model, rank correlation

Introduction
Enhancing of milk production per cattle by improvement of economic (production and reproduction traits) traits. Improvement in economic traits by selection of superior the Germplasm sires and dams.

Progeny testing programme has been found to the most authentic and reliable tool for genetic up-gradation in progeny. The exotic dairy breeds which are being admired currently for their production potential are entirely due to the afore-said programme. However, in India, most of the progeny testing is limited to organized farms with a small herd size. This is a limiting factor in assessing the sires breeding values. Thus the need for sire evaluation for the additive genetic value (breeding value or transmitting ability) to its progeny has gained greater importance. Therefore, accurate, efficient and early evaluation of breeding value of sires becomes paramount important.

Henderson (1976) [2] reported BLUP (Best Linear Unbiased Prediction) is one of the methods of statistical analysis and estimation of numerical score are given to traits and compiled as predictions for future use. In recent past, the BLUP procedure has been widely used as standard method of sire evaluation.

However, over the last decade considerable research efforts have concentrated on the development of specialized and efficient algorithms. This has been closely linked to advances in the genetic evaluation of animals by Best Linear Unbiased prediction (BLUP). However, ML and REML allow the random effect of models to be expressed in terms of the genetic merit or breeding value of animals. These models are called individual animal models (IAM) and incorporate information on relationship between all animals (Meyer, 1989b, 1991) [5, 7].

This requires the inverse of numerator information in the analysis. This requires the inverse of numerator relationship matrix A, which made the AM computationally feasible for large data sets. Kennedy and Sorensen (1988) [3] discussed the genetic properties of animal models, outlining how the AM can account for change in genetic means and variance. Thus the AM allows an optimal analysis of data involving multiple generations arising, for instances, from selection experiments (Sorensen and Kennedy, 1986; Kennedy, 1988) [9, 3].

Materials and Methods

The data for present investigation were collected from history sheets and daily milk yield records of Holstein Frisian breed of cattle maintained Bhagyalaxmi Dairy Farm Manchar Pune. The records on first lactation production and reproduction performance of Holstein Frisian cattle spread over a period of 8 years (2007-2014) were collected.

Statistical analysis

Estimation of breeding value using BLUP sire model Estimation of breeding value of sires by using software. The general model of BLUP estimation was considered as follows:

$Y_{ijk} = Xh_i + Z_{sj} + e_{ijk}$

Where,
Y_{ijk} = Observation vector of trait with dimension (n x 1)
X = Design matrix or incidence matrix for fixed effects with dimension (n 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 σs 2 with dimension (q x 1)

e_{ijk} = Random error vector with dimension (n x 1) with mean zero and variance I σe 2

Estimation of breeding value using BLUP Animal model:

The single trait animal model will be considered for estimation of breeding value using WOMBAT software (Meyer 2007) [6]. The following animal model will be considered:

$Y_{ijk} = X\,b_i + Z\,u_j + e_{ijk}$

Where,
Y_{ijk} =k^{th} observation of j^{th} random effect of i^{th} fixed effect
b_i= Vector of observation of fixed effect
X = Incidence matrix of fixed effect
u = Vector of additive genetic effect (animal effect)
Z = Incidence matrix of random effect
e_{ijk}= Vector of residual errors

Rank correlations

The correlation between the rankings of the sires based on their estimated breeding value by any two methods will be tested by Spearman's rank correlation (Spearman, 1904) [10] as follows:

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

Where,
r = rank correlation coefficient
n = no of sires under evaluation
D_i= difference between paired items under two methods

The significant of correlation will be tested by t-test with n-2 (degree of freedom) as given below

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

Result and Discussion

EBV for FLTMY by using of HF sires predicted through BLUP-sire model are presented in Table.1. The EBV for FLTMY ranged from 6315.10 kg to 4956.57 kg and average 5573.50 kg. EBV for FL300/305DMY by using of sires predicted though BLUP-sire model are presented Table.1. The EBV for FL300/305DMY ranged from 5758.55 kg to 4480.26 kg and average 5041.41 kg. EBV for FCI by using of HF sires predicted through BLUP-sire model presented in Table 2. The EBV for FCI ranged from 391.92 days to 470.14 days. EBV for FDP by using of HF sires by predicted through BLUP-sire model presented in table 2. The EBV for FDP ranged from 85.57 days to 133.46 days. EBV for FLL by using of 42 HF sires by predicted through BLUP-sire model presented in table 2. The EBV for FLL ranged from 316.31 days to 368.09 days. EBV for AFC by using of 49 HF sires by predicted through BLUP-sire model presented in table 3. The EBV for AFC ranged from 757.98 days to 803.60 days. EBV of 49 sires 22 sires (44.9%) were lower than average EBV (779.35 days) whereas 27 sires (55.1%) had higher than average EBV. Garima *et al*. (2015) [1] was reported EBVs for first lactation traits FLTMY range from 3332.41 kg to 2944.47 kg, AFC range from 1293.11 days to 1410.24 days, FDP range from 158.07 days to 204.67 days, FCI range from 517.89 days to 561.57 days, FLL range from 375.10 days to 344.08 days in Sahiwal and crossbred cattle by using of BLUP.

Estimated breeding values (EBVs) of sires obtained large genetic variation between sires for all first lactation production and reproduction traits. Means there is not same rank of sire for all first lactation production and reproduction traits. In table no 1 and table 2&3 shows same sires have different rank for different traits.

Table 1: Expected breeding values of top 10 HF sires along with their ranks for FLTMY and FL300/305DMY by BLUP-sire model

	FLTMY				FL300/305DMY			
S.N	**Sire name**	**No of Daughters**	**EBV (kg)**	**Rank**	**Sire name**	**No of Daughters**	**EBV (kg)**	**Rank**
1	Merchantile	90	6315.10	1	Merchantile	90	5758.55	1
2	Magnum	10	6269.69	2	Avalanch	51	5591.32	2
3	Avalanch	51	6164.89	3	Tribute	18	5360.38	3
4	Shady	21	6107.01	4	Devoted	138	5347.92	4

5	HF 1492	3	6031.59	5	HF 1492	3	5339.88	5
6	Devoted	138	5945.51	6	Magnum	10	5335.23	6
7	Mission	10	5929.45	7	Tartini	27	5169.29	7
8	Nathan	22	5865.08	8	Ambadas	7	5167.52	8
9	Tribute	18	5721.36	9	Jacobson	16	5163.25	9
10	Adeep	18	5712.01	10	Mission	10	5154.22	10

Table 2: Expected breeding values of top10 HF sires along with their ranks for FCI, FDP FLL by BLUP-sire model

	FCI				FDP				FLL			
S.N.	**Sire name**	**No. of daughters**	**EBV (days)**	**Rank**	**Sire name**	**No. of daughters**	**EBV (days)**	**Rank**	**Sire name**	**No. of daughters**	**EBV (days)**	**Rank**
1	Tartini	27	391.92	1	Tartini	27	85.57	1	Nathan	22	368.09	1
2	Aparadh	11	403.23	2	Tribute	18	87.58	2	Magnum	10	364.28	2
3	Tribute	18	412.01	3	Aparadh	11	91.50	3	Smarty	17	364.28	3
4	Harsh	14	414.61	4	Addidas	4	92.77	4	Shady	21	357.00	4
5	Ajinkya	6	414.93	5	Mission	10	93.96	5	Hf 1492	3	356.36	5
6	Addidas	4	416.06	6	Nandini	4	94.11	6	Mission	10	356.16	6
7	Active	3	418.22	7	Active	3	94.12	7	Rocky	16	350.41	7
8	HF 511	9	422.22	8	Rocky	16	96.30	8	Adeep	18	348.39	8
9	HF-87	3	423.16	9	Jacobson	16	99.27	9	Hf-10	3	347.77	9
10	ANDREW	14	426.39	10	Andrew	14	100.07	10	Jacobson	16	347.23	10

Table 3: Expected breeding values of HF top 10 sires along with their ranks for AFC by BLUP-sire model

S.N.	Sire name	No of daughter	EBV (days)	Rank
1	Nandini	4	757.98	1
2	Nathan	22	758.33	2
3	Aparadh	11	758.53	3
4	Avalanch	51	758.59	4
5	Smarty	17	761.10	5
6	Tartini	27	764.93	6
7	Hf-62	2	764.95	7
8	Jugernaut	9	765.82	8
9	Amay	19	767.10	9
10	HF-27	3	769.19	10

EBV for FLTMY of HF animals (sire, dam, and progeny) predicted through BLUP animal model are presented in table 4.EBV for FLTMY for animal ranged from 12886.4 kg to 5440.7 kg and average 6245.42 kg. EBV of 581 (48.7%) animals out of 1193 animals were above from average EBV and EBV of 612 (51.3%) animals were under average of EBV. EBV of sires ranged from 8250.0 kg to 5497 kg. EVB of 20 sires (41.6%) out of 48 sires were above from average whereas EBV of 28sires (48.7%) were under from average EBV. EBV for FLTMY of dams ranged from 10006.4 kg to 5698.2 kg. EBV of 78 dams (51%) out 153 were above from average EBV whereas 75 dams (49%) were under of average EBV.EBV for FL300/305DMY of progeny ranged from 12886.4 kg to 5440.7 kg. EVB of 466 (47%) progeny out of 991 were above from average EBV whereas EBV of 525 (53%) were under from average EBV.

EBV for FL300/305DMY of HF animals (sire, dam, and progeny) predicted through BLUP animal model are presented in table 4. EBV for FL300/305DMY ranged from 6680 kg to 4414.5 kg and average 5462.3 kg. EBV for FL300/305DMY of 652 animals (54.65%) out of 1193 animals were above from average EBV whereas 541 animals (45.34%) were under from average EBV. EBV for FL300/305DMY of 48 sires ranged from 6680 kg to 4666 kg. EBV of 24 sires (50%) were above from average EBV whereas 24 sires (50%) were under from average EBV. EVB for FL300/305DMY of Dams ranged from 5941.4 kg to 4618.5 kg. EBV of 81 Dams (52.9%) out of 153 dams were above average EBV whereas EBV of 72 Dams (47.1%) were under from average EBV. EBV for FL300/305DMY of progeny ranged from 6418 kg to 4414.5 kg. EBV for FL300/305DMY of 546 progeny (55%) out of 991 progeny were above from average EBV whereas EBV of 445 progeny (45%) were under from average EBV.

EBV for FLL of HF animals estimated through BLUP-Animal model are presented in table 5. EBV for FLL of all animals ranged from 432 days to 294.2 days and average EBV 348.5 days. EVB for FLL 593 (49.8%) animals out of 1193 animals were above from average EBV whereas 600 animals under from average EBV. EBV for FLL of sires ranged from 404.7 days to 305.5 days. EBV of 20 (41.6%) sires out of 48 sires were above average EBV whereas 28 (59.4) sires were under from average EBV. EBV for FLL of Dams ranged from 376 days to 321.6 days. EBV of 61 (39.6) dams out of 154 dams were above from average EBV whereas 93 (60.4% days) dams were under from average EBV.EBV for FLL of progenies ranged from 432 days to 294.2 days. EBV of 529 (53.4%) progeny out of 991progeny were above from average EBV whereas 462 (46.6%) progeny were under from average EBV.

EBV for FCI of all HF animal estimated through BLUP-Animal model are presented in table 5. Animal have lowest value of EBV given 1st rank and highest value of EBV with lowest rank. EBV for FCI of all animals ranged from 394 days to 596.5 days and average EVB 472 days. EBV of 512 (42.9%) animals out of 1193 animals were under from average EBV whereas 681 (57.1%) animals were above from average EBV. EBV for FCI of sires ranged from 394 days to 546 days. EBV for FCI of 29 (60%) sires out of 48 sires were under from average EBV whereas 21 (39.6%) sires were above from average EBV.EBV for FCI of dams ranged from 437.5 days to 520.9 days. EBV of 98 (63.6%) dams out of 154 dams were under from average EBV whereas 56 (36.4%) dams were above from average EBV. EBV for FCI of progenies ranged from 407.4 days to 596.5 days. EBV for FCI of 387 (39%) progenies out of 991 were under from average EBV whereas 604 (61%) progenies were above from average EBV.

EVB for FDP of all animals predicted through BLUP-Animal model are presented in table 5. Animal have lowest EBV raked 1st and animal have heights EBV ranked last. EBV for FDP of animals ranged from 79.3 days to 96.6 days and average EBV 88.3 days. EBV of 512 (42.9%) animals out of 1193 animals were under from average EBV whereas 683 (57.1%) animals were above from average EBV. EBV for FDP of sires ranged from 79.3 days to 96.6 days. EBV of 23 (47.9%) sires out of 48 sires were under from average EBV whereas 25 (52.1%) sires were above from average EBV. EBV for FDP of dams ranged from 84.5 days to 92.6 days. EBV for FDP of 89 (57.8%) dams out of 154 dams were under from average EBV whereas 65 (42.2%) dams were above from average EBV. EVB for FDP of progenies ranged from 81.4 days to 96.6 days. EBV for FDP of 398 (40.2%) progenies out of 991 progenies were under from average EBV whereas 593 (59.8%) progenies were above from average EBV.

EBV for AFC of all animals estimated through BLUP-Animal model are presented in table 5. Animal have lowest EBV ranked 1st and animal have heights EBV ranked last. EBV for AFC of all animal ranked from 734 days to 849 days and average 783.7 days. EBV for AFC 531 (44.5%) animals out of 1193 animals were under from EBV whereas 662 (55.5%) animals were above from average EBV. EBV for AFC of sires ranged from 748.0 days to 825.7 days. EBV for AFC of 23 (47.9%) sires out of 48 sires were under from average EBV whereas 25 (52%) sires were above from average EBV. EBV for AFC of dams ranged from 753.1 days to 813.9 days. EBV for AFC of 88 (57.1%) dams out of 991 dams were under from average EBV whereas 66 (42.9%) dams were above from average EBV. EBV for AFC of all progenies ranged from 734 days to 849 days. EBV for AFC of 420 (42%) progenies out of 991 progenies were under from average EBV whereas 571 (57.6%) were above from average EBV.

Singh (2015) [8] reported EBV for FLTMY, FLL, AFC, FCI, and FDP ranged 2560.29 kg to 1153.47 kg, 390.89 days to 265.67 days, 1007.41 days to 1546.38 days, 365.31 days to 658.35 days, 89.96 days to 303.40 days respectively in Sahiwal sires whereas Lodhi and Singh (2018) [4] were observed average EVB for FLTMY, FCI, FDP, AFC, and FLL 10305.49 kg, 430.95 days, 160 days 1198.26 days and 324.49 days by using wombat in crossbred cattle.

Table 4: Expected breeding values of top 10 HF animal (sires, Dams, Progeny) along with their ranks for production traits FLTMY, FL300/305DMY, by using BLUP- animal model method

	FLTMY (kg)				**FL300/305DMY (kg)**			
	Overall	**6245.42**			**Overall**		**5462.3**	
S. No.	**Animal ID**	**Category of animal**	**EBV**	**Rank**	**Animal ID**	**Category of animal**	**EBV**	**Rank**
1	106645	Progeny	12886.41	1	5	Sire	6680.4916	1
2	5354	Dam	10006.4	2	24	Sire	6463.2117	2
3	106699	Progeny	9163.88	3	105308	Progeny	6418.8795	3
4	24	Sire	8250.01	4	105244	Progeny	6404.7903	4
5	107118	Progeny	8111.06	5	105382	Progeny	6370.5126	5
6	106725	Progeny	7747.7	6	106831	Progeny	6351.2519	6
7	106831	Progeny	7521.29	7	106645	Progeny	6335.9432	7
8	106980	Progeny	7479.9	8	105621	Progeny	6335.6728	8
9	106674	Progeny	7469.12	9	105343	Progeny	6325.2696	9
10	106800	Progeny	7369.94	10	105317	Progeny	6318.1249	10

Table 5: Expected breeding values of top10 HF animal (sires, Dams, Progeny) along with their ranks for reproduction traits FLL, FDP, FCI, AFC by using BLUP- animal model method

	FLL (days)				**FDP (days)**				**FCI (days)**				**AFC (days)**			
	Overall	**348.5**			**Overall**	**88.35**			**Overall**	**472**			**Overall**	**873.7**		
S. No.	**Animal ID**	**Category of animal**	**EBV**	**Rank**	**Animal ID**	**Category of animal**	**EBV**	**Rank**	**Animal ID**	**Category of animal**	**EVB**	**Rank**	**Animal ID**	**Category of animal**	**EBV**	**Rank**
1	105900	Progeny	432.04	1	3	Sire	79.25	1	21	Sire	393.95	1	105705	Progeny	733.97	1
2	107118	Progeny	421.22	2	62	Sire	80.67	2	62	Sire	395.75	2	105923	Progeny	738.7	2
3	106236	Progeny	417.89	3	105110	Progeny	81.4	3	3	Sire	405.84	3	106542	Progeny	739.9	3
4	106645	Progeny	415.21	4	107639	Progeny	81.92	4	107586	Progeny	407.38	4	107943	Progeny	743.76	4
5	105705	Progeny	414.02	5	106402	Progeny	82.11	5	107600	Progeny	408.47	5	107150	Progeny	745.97	5
6	106725	Progeny	412.98	6	106413	Progeny	82.25	6	107639	Progeny	411.98	6	56	Sire	748.04	6
7	105865	Progeny	409.22	7	107580	Progeny	82.3	7	107580	Progeny	413.69	7	107639	Progeny	748.38	7
8	107066	Progeny	408.78	8	105138	Progeny	82.3	8	107633	Progeny	414.47	8	106698	Progeny	749.16	8
9	5354	Dam	404.68	9	106423	Progeny	82.34	9	107654	Progeny	415.02	9	21	Sire	749.22	9
10	56	Sire	404.67	10	107590	Progeny	82.41	10	107566	Progeny	415.67	10	106704	Progeny	749.47	10

Rank correlation between sire model and animal model of EBV for FLMY, FL300/305DMY, FCI, FDP, FLL and AFC are presented in table 4.19. Rank correlation for FLTMY, FL3000/305DMY, FCI, FDP, FLL and AFC were observed 0.82, 0.89, 0.65, 0.87, 0.77 respectively. As data are showing rank correlation for all traits were highly ranging. All correlation estimates were strongly statistically significant (p<0.01).

The comparison of estimated breeding values of traits FLTMY, FL300/305DMY, FCI, FDP, FLL and AFC for sire-model and animal-model, it was reported that rank of sire did not differ significantly from both model.

Table 6: Rank correlation coefficient (r) for EBV of sires of traits between sire-model and animal-model.

Traits	**Rank correlation coefficient (r)**
FLTMY	0.82**
FL300/305DMY	0.85**
FLL	0.87**
FCI	0.89**
FDP	0.65**
AFC	0.77**

** Significant (p<0.01)

Conclusion

- The genetic variance estimated for traits under study indicated that the AFC is an important trait for selection.

- The genetic variance for production traits indicated that attention should be given to individual merit along with the family merit for effective selection.
- The traits like dry period, calving interval need to give proper attention due to their negative correlation with production traits.
- The overall result indicated that sufficient variability for growth traits present in the herd that is important for bringing effective selection for sustainable milk production in dairy cattle genetic improvement program.
- The ranking of sires using animal model-BLUP indicated difference with change in traits.
- The selection of sires should be made based on traits importance.

Recommendation

- The AFC is the choice of traits for making selection of animals for genetic improvement.
- The productive traits selection should be based on reproduction rates. In order to have overall genetic improvement of the herd due consideration needs to be given to traits having negative genetic correlation with the milk production traits.
- Sire selection should be based on first lactation milk yield.

References

1. Garima Bajetha, Singh CV, Barwal RS. Sire evaluation on the basis of first lactation traits using BLUP method in Shahiwal and crossbred cattle. Livestock research international. 2015;3 (4):85-88.
2. Henderson CR. Multitrait sire evaluation using the relationship matrix. J Dairy Sci. 1976;59 (4):769-774.
3. Kennedy BW, Sorensen DA. Properties of mixed model methods. In: ProC. 2nd International confer. Quantitative Genetics. Weir, B.S.; Eisen, E.J.; Goodman, M.M. and Namkoong, G. (editor) Sinauer, Sunderland, Massachuetts, USA; c1988. p. 91-100.
4. Lodhi G, Singh CV. Estimation of breeding values by Wombat method of sires in crossbred cattle. Int J Anim. Sci. 2018;2 (4):1027.
5. Meyer K. Estimation of genetic parameters. In Evolution and Animal Breeding (ed. W. G. Hill & T. F.C. Mackay), Oxford University Press; c1989b. p. 161-167.
6. Meyer K. WOMBAT-A tool for mixed model analyses in quantitative genetics by restricted maximum likelihood (REML). Journal of Zhejiang University Science B. 2007;8:815-21.
7. Meyer K. Estimating variances and covarinences for multivariante animal model by restricted likelihood. Genet. Sel Evol. 1991;23 (1):67-83.
8. Singh. Genetic studies on first lactation and life time traits and sire evaluation using animal model in Sahiwal cattle. M.V.Sc. Thesis G.B.P University of agriculture and Technology. Uttrakhand; c2015.
9. Sorensen DA, Kennedy BW. Analysis of selection experiments using mixed model methodology. J Anim. Sci. 1986;63 (1):245-258.
10. Spearman C. Am. J Psych. 1904;15:88.