



## Evaluation of HF crossbred bulls under field progeny testing programme at different agro-climatic regions in India

A K DAS\*, RANI ALEX, RAVINDER KUMAR, N V PATIL, UMESH SINGH, SUSHIL KUMAR, S K RATHEE, S TYAGI, K ANIL KUMAR, R L BHAGAT and P P DUBEY

ICAR-Central Institute for Research on Cattle, Meerut Cantt., Uttar Pradesh 250 001 India

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### ABSTRACT

Adequate numbers of progeny tested bulls are not available in India and whatever small number of bulls are progeny tested, they have low repeatability as the progeny tests are based on small number of daughters mostly reared at the institutional farms. But extending the progeny testing programmes to the farmer's herds will sort out the issue of less number of progeny per bull. The first lactation records of 4,782 crossbred cows which were daughters of 121 bulls and calved over a period of 12 years from 1996 to 2008 were used to determine the genetic worth of HF crossbred bulls under different agro-climatic conditions and to assess their ranking. The average first lactation milk yield in field HF crossbred cows was 2806.51±56.06 kg. In this evaluation average number of progeny per bull was 39.5. The breeding value of bulls was estimated as 2,920.59 kg for 1<sup>st</sup> ranked bull and 2662.58 kg for 121<sup>st</sup> ranked bull. A total of 47 bulls (38%) showed higher breeding values ranging from 2,807.91 to 2,920.59 kg over and above the herd average. Among the fixed effects, the centre of field progeny testing programme and year of calving had significant effect on first lactation milk yield of daughters. The increasing trend of first lactation milk yield over years is a clear indication of a successful large scale progeny testing programme under field conditions.

**Keywords:** Age at first calving, Field progeny testing, First lactation milk yield, Frieswal

A synthetic strain of cattle named Frieswal has been developed at ICAR-Central Institute for Research on Cattle in collaboration with Military farms with 50–75% exotic inheritance. Holstein-Friesian crosses have gained most popularity among all crossbred due to their highest milk production (Singh *et al.* 2000, Upadhyay *et al.* 2002, Akhter *et al.* 2003). Keeping in view the availability of large HF crossbred population in the country Field Progeny Testing (FPT) program was initiated at ICAR-CIRC, Meerut, Uttar Pradesh in the year 1992 in collaboration with Agricultural Universities and Non-Government Organization at different agro-climatic regions of the country to evaluate crossbred cattle under field condition. At present this programme is running in association with Kerala Veterinary and Animal Sciences University (KVASU), Thrissur; BAIF Development Research Foundation, Pune; Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana and G.B. Pant University of Agriculture and Technology (GBPUA&T), Pantnagar for the evaluation and genetic improvement of HF crossbred cattle. The increased use of AI and embryo transfer has made it possible for sires to produce offspring in production environments under vastly different management systems and geographical

areas (Williams *et al.* 2012). A large number of cows are being inseminated in the program so that records of sufficient daughters are achieved for sire evaluation despite significant data loss (Kumar *et al.* 2015). Evaluation of bulls through progeny testing and their extensive use has been a major source of genetic improvement in dairy animals. Selection of sires on the basis of daughters first lactation milk production trait would be a better choice in crossbred cattle (Singh *et al.* 2017). Evaluation of bulls under field conditions removes possibility of genotype × environment interaction and results in production of quality bulls suitable to field conditions. This study was carried out to evaluate the breeding value of crossbred bulls and to rank them on the basis of first lactation 305 days milk yield of daughters.

### MATERIALS AND METHODS

The Field Progeny Testing program envisages testing of 30 Frieswal (HF × Sahiwal) bulls in each batch having 62.5% exotic inheritance and dam's minimum mature equivalent milk yield of 4,500 kg. This project covers about 32,000 test females in the field conditions at four different locations, viz. Kerala Veterinary and Animal Sciences University (KVASU), Mannuthy, Thrissur; Guru Angad Dev Veterinary and Animal Sciences University (GADVASU) Ludhiana; BAIF Development Research

\*Corresponding author e-mail: achintya137@yahoo.com.

Table 1. Breeding Value of top 15 crossbred Bulls based on first lactation milk yield of daughters

Bull name	Bull Origin	Set no	Progeny size	Breeding value	Genetic superiority over population	% of genetic superiority over population	Ranking
Overall mean			4782		2806.51±56.06		
Dipesh	BAIF	2	69	2920.59	114.08	4.06	1
Jani	CIRC	2	33	2901.37	94.86	3.38	2
Dhiraj	BAIF	2	42	2885.63	79.12	2.82	3
Dhanaji	BAIF	5	30	2882.65	76.14	2.71	4
Mangu	CIRC	5	20	2879.43	72.92	2.60	5
Glory	BAIF	4	24	2878.31	71.8	2.56	6
Hari	BAIF	5	26	2874.8	68.29	2.43	7
Harsh	BAIF	5	24	2868.24	61.73	2.20	8
Balwan	CIRC	2	64	2861.63	55.12	1.96	9
Yara	BAIF	4	19	2861.56	55.05	1.96	10
Deva	CIRC	2	112	2860.21	53.7	1.91	11
Hamdam	BAIF	4	22	2858.74	52.23	1.86	12
Honaji	BAIF	5	27	2855.13	48.62	1.73	13
Hameed	BAIF	1	181	2854.55	48.04	1.71	14
David	BAIF	1	49	2847.67	41.16	1.47	15

Foundation, Central Research Station, Uruli-Kanchan, Pune and G.B. Pant University of Agriculture and Technology (GBPUA&T) Pantnagar (Das *et al.* 2017). The first lactation records of 4,782 crossbred cows maintained at farmers' herds in three different units were used in analysis for evaluation of bulls. The Pantnagar unit was not included in the analysis as data was not available for the bulls under evaluation. These crossbred cows which were daughters of 121 bulls and calved during 17 years from 1997 to 2013 were used in the present analysis. The model used in the study included location of the field unit, place of season and year of calving and the set in which bull was inducted as fixed effects whereas data was collected from three units as GADVASU, Ludhiana; KVASU, Thrissur and BAIF, Urlikanchan, Pune accordingly and data was divided into 3 units. Bulls were inducted from 3 different sources, i.e. GADVASU, Ludhiana; ICAR-CIRC, Meerut, and BAIF, Pune accordingly and data was grouped into 3 as place of origin of bulls. Each year of calving was divided into 4 seasons, i.e. winter (December to February), summer (March to May) rainy (June to August) and post-monsoon (September to November) based on climatic conditions. Data was also divided into 17 groups on the basis of year of calving. Bulls were divided into 6 groups based on their set numbers to account for selection over years (Gaur *et al.* 2008). Bulls with less than 14 daughters record were excluded from the study. The bulls were evaluated based on first lactation 305 days milk yield of their daughters in field conditions at farmers herd. The milk yield of cows was estimated during test day records.

Bulls' breeding values were estimated through best linear unbiased prediction (BLUP) procedure using suitable option in least squares and maximum likelihood computer package (Harvey 1990). The heritability estimate of 305 days milk yield used in BLUP analysis was taken as 0.25. The following model was used for analysis of both data sets

$$Y_{ijklmn} = \mu + SG_i + SR_{ij} + Y_k + SN_l + F_m + P_n + b(A_{ijklmn} - \bar{A}_{ijklmn}) + e_{ijklmn}$$

$Y_{ijklmn}$ , observation of 305 days 1<sup>st</sup> lactation milk yield on n<sup>th</sup> daughter of j<sup>th</sup> sire within i<sup>th</sup> sire group;  $\mu$ , overall mean;  $SG_i$ , fixed effect of i<sup>th</sup> sire group;  $SR_{ij}$ , random effect of j<sup>th</sup> sire within i<sup>th</sup> sire group;  $Y_k$ , fixed effect of k<sup>th</sup> year of calving;  $SN_l$ , fixed effect of l<sup>th</sup> season of calving;  $F_m$ , fixed effect of m<sup>th</sup> centre;  $P_n$ , fixed effect of n<sup>th</sup> place of Bull; b, regression of 305 days 1<sup>st</sup> lactation milk yield on age at first calving;  $A_{ijklmn}$ , age at first calving;  $\bar{A}_{ijklmn}$ , average age at first calving, and  $e_{ijklmn}$ , random residual error.

## RESULTS AND DISCUSSION

The first lactation 305 days milk yield records of 4,782 daughters from 121 bulls from three Field Progeny Testing units (GADVASU, KVASU and BAIF) were analyzed and evaluated for ranking of bulls. The 121 bulls were inducted in 6 different sets from July 1995 to September 2006. Bulls were inducted from three different sources as BAIF, Pune, GADVASU, Ludhiana and ICAR-CIRC, Meerut. The overall first lactation milk yield in crossbred cows was 2806.51±56.06 kg (Table 1).

A total 121 bulls were inducted in 6 different sets, out of which 47 bulls (38%) exceeded their breeding value above the herd average (2806.51 kg) and it ranged from 2807.91 to 2920.59 kg. Number of daughters per bull varied from 14 to 181 whereas average number of daughter per bull was 39. The genetic superiority and percentage genetic superiority of the top 27 bulls (22.3%) over population varied from 28.99 to 114.08 and 1.03 to 4.06, respectively. The details of top 15 bulls under evaluation were summarized in Table 1. The bulls named Dipesh, Dhiraj, Dhanaji, Glory, Hari, and Harsh from BAIF unit ranked 1<sup>st</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> respectively and the percentage genetic superiority over population was 4.06, 2.82, 2.71, 2.56 2.43 and 2.20, respectively. The bulls named Jani,

Table 2. Least squares mean of first lactation milk yield based on set, origin of bulls, season and year of calving and centre

Effect	No. of observations	Mean±SE
Overall Mean	4782	2755.36±12.42
<i>Set of Induction</i>		
SET1	800	2754.35±57.09
SET2	941	2783.59±43.80
SET3	852	2775.85±37.25
SET4	769	2785.83±42.27
SET5	684	2834.16±49.77
SET6	736	2800.50±57.88
<i>Place of origin of bulls</i>		
GADVASU	1558	2806.97±23.31
ICAR-CIRC	806	2771.73±25.72
BAIF	2418	2788.45±19.15
<i>Season of calving</i>		
Winter	1667	2773.24±20.96
Summer	1256	2768.13±22.18
Rainy	794	2818.40±25.04
Post Monsoon	1065	2796.42±22.52
<i>Centre</i>		
GADVASU	1779	2977.29±21.11
KVASU	1128	2411.84±24.26
BAIF	1875	2978.01±21.86
<i>Year of calving</i>		
1997	46	2582.00±108.97
1998	155	2659.41±80.10
1999	210	2634.13±73.77
2000	256	2650.38±70.56
2001	209	2761.99±66.30
2002	271	2694.16±58.70
2003	233	2624.41±59.26
2004	278	2676.26±52.14
2005	269	2729.29±44.48
2006	514	2718.62±36.69
2007	403	2741.21±37.05
2008	515	2754.39±36.71
2009	577	2752.88±41.05
2010	408	2880.49±49.66
2011	326	2985.17±60.47
2012	90	3402.52±82.89
2013	22	3166.50±135.46
Regression on AFC	**	-0.25±0.05

\*\*P&lt;0.01.

Mangu, Balwan and Deva from ICAR-CIRC ranked 2<sup>nd</sup>, 5<sup>th</sup> and 11<sup>th</sup> rank respectively with percentage genetic superiority over population as 3.38, 2.60, 1.96 and 1.91, respectively.

The breeding values of the bulls in the present investigation were higher than that reported by Gaur (2003) in Holstein-Friesian × Sahiwal cross who observed the breeding value of young crossbred bulls ranging from 2,481 to 2,768 kg for first lactation milk yield. The breeding value of certain bulls was higher than corresponding daughters average (phenotypic value) in all sets. This reflected that genetic potential of the bulls could not be exploited fully in the given environment. Bulls within the set had minimum variation in first lactation milk yield while those between

the sets had maximum variation. The breeding values for first lactation milk yield varies from 2,706.40 to 2,854.55 kg in 1<sup>st</sup> set, from 2,743.40 to 2,920.59 kg in 2<sup>nd</sup> set, from 2,700.49 to 2,846.07 kg in 3<sup>rd</sup> set, from 2,662.58 to 2,878.31 kg in 4<sup>th</sup> set, from 2,683.22 to 2,882.65 kg in 5<sup>th</sup> set and from 2,704.58 to 2,811.5 kg in 6<sup>th</sup> set. Some bulls having more number of daughters had their low breeding value as compared to those with less number of daughters. The accuracy was however more for the bulls evaluated based on more number of daughters.

The first lactation milk yield of daughters of bulls of different sets was found as 2,754.35±57.09 kg in 1<sup>st</sup> set, 2,783.59±43.80 kg in 2<sup>nd</sup> set, 2,775.85±37.25 kg in 3<sup>rd</sup> set, 2,785.83±42.27 kg in 4<sup>th</sup> set, 2,834.16±49.77 kg in 5<sup>th</sup> set and 2,800.50±57.88 kg in 6<sup>th</sup> set which clearly indicates that there is a trend of gradual improvement in milk production in progenies of bulls under test. The improved breeding value of the bulls in subsequent sets and positive trends reflected that the program has moved in desired direction and further improvement may be expected in near future when more number of sets will be introduced in the program.

The performance of different units varied significantly (P<0.01). The Frieswal cows in the field areas of KVASU, Thrissur unit shows lowest least square means for first lactation milk yield as 2,411.84±24.26 kg as compared to GADVASU, Ludhiana as 2,977.29±21.11 kg and BAIF, Pune as 2,978.01±21.86 kg. Similar finding was also observed in earlier studies (Kumar *et al.* 2015, Gaur *et al.* 2006 and 2008). Through the intervention of Field Progeny Testing programme of this institute the average first lactation 305 days milk yield of the Frieswal progenies in the adopted villages of FPT project has been increased by 51.2% in KVASU, 39.7% in GADVASU, and 11.14% in BAIF unit. Subsequently average age at first calving (AFC) of the Frieswal progenies has been reduced by 9.87% in KVASU, 12.23% in GADVASU, and 2.35% in BAIF unit (Annual Report 2017–18, ICAR-CIRC). It is expected that different units have different levels of production because of variation in the climatic condition and level of management at different farmers herd. Moreover there are marked differences in average herd size in different units as in GADVASU, Ludhiana 63% farmers have an average herd size of 5–10 cows; in KVASU, Thrissur 56.2% farmers have less than 3 cows and in BAIF, Pune 52% farmers have an average herd size of 3–5 cows. The cows calved during the rainy season had the highest least square means for first lactation milk yield (2,818.40±25.04 kg) followed by those calved during post monsoon (2,796.42±22.52 kg) during winter (2,773.24±20.96 kg) and during summer (2,768.13±22.18 kg) in field conditions (Table 2). This variation could be due to the type of feed, environmental deviations and management practice adopted by different farmers at different locations and in field conditions farmers do not opt for alternatives as in the case of organized farms. Similar finding was also observed in earlier studies (Kumar *et al.* 2015). There was a trend of increasing first lactation

milk yield year wise and which was lowest (2,582.00±108.97 kg) in the year 1997 and highest (3,402.52±82.89 kg) in the year 2012. Year of calving has significant effect on first lactation milk yield. Significant effect of year of calving (Gaur *et al.* 2008, Komatwar *et al.* 2010, Kumar *et al.* 2017) on milk yield were reported in previous studies. On the other hand, many workers (Nehra 2011, Rajeev *et al.* 2017, Singh *et al.* 2018) reported non-significant effect of season and period of calving on the first lactation milk yield. The variation in milk yield observed in different years indicated the level of management as well as environmental effects prevailed in those years.

In the present study the same set of bulls were used in different agro-climatic conditions in India, so that ranking of genotypes will not be affected by different environment, leading to nullify effect of G×E interaction, rather than scaling effect. So that superior individuals will perform equally in different environment and agro-climatic conditions. In this case, breeding program was optimized to respond to multiple environment requirements. The breeders have to choose the genotypes which are able to adapt to those environments, viz. selection of a specific genotype for each environment. Selection of a trait in one environment with the goal for improving the same trait in other environment known as indirect selection can also be viewed as one of the breeding strategies (Hammami *et al.* 2009).

The results of the program are encouraging and are comparable with the performance of Holstein-Friesian crosses maintained under farm conditions (Singh *et al.* 2014). The semen of top ranked bulls is used in nominating mating for production of male calves for induction in the new sets. The program is not only restricted to produce and test the superior crossbred male calves in the field but is consistently improving genetic potential of the cows available in the operational area as well as in nearby areas of the program leading to consistent increase in milk production.

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