Indian Journal of Animal Sciences **85** (3): 316–319, March 2015/Article

Comparative performance evaluation of Frieswal bulls in organized farms and farmers' herds

SUSHIL KUMAR[1], RANI ALEX[2], UMESH SINGH[3], ARUN KUMAR[4] and A K DAS[5]

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

Received 8 July 2014; Accepted 5 November 2014

ABSTRACT

The present study was focused to determine the genetic worth of Frieswal bulls under farm and field conditions and to assess their rankings in both production systems. The first lactation records of 3,582 crossbred cows maintained at Military Farms (2,851) and in farmer's herds (731) which were daughters of 32 bulls and calved during 14 years from 1998 to 2011 were used in the present study. The average first lactation milk yield in crossbred cows was 2,886.60± 32.78 and 2,666.17± 71.21 kg at Military Farms and field units respectively. Year of calving in farms and season of calving in field had significant effect on the first lactation milk yield. Herd/location of the farm was found significant in both conditions. Breeding value estimates of the sires ranged from 2,824.28 to 2,919.19 and from 2,650.41 to 2,758.81 kg under farm and field conditions respectively. Eight bulls (25%) under farm conditions and 27 bulls (84%) under field conditions exceeded their breeding value over the herd average. The low and non-significant product moment correlation (–0.261) and rank correlation (–0.296) between breeding values of bulls under farm and field conditions revealed that bulls with higher ranks for milk production under farm conditions did not retain their superiority in field conditions. Therefore top ranked Frieswal bulls tested under farm conditions cannot be recommended for their use as proven bulls in field conditions. The breeding program should also be optimized to respond to multiple environment requirements, as re-ranking of bulls occurred in the 2 environment conditions.

Key words: Breeding value, Frieswal, Sire × environment interaction

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). But problems of identifying the best sires to match the needs of a herd may arise if sire performance is inconsistent across varying environments, defined as a genotype by environment interaction. Genotype × environment interaction (G×E) is characterized by different responses of genotypes to environmental variations (Falconer and Mackay 1996) due to the lack of adaptation of particular genotypes to specific environmental conditions of production systems. It may also reduce economic performance of animals when the environmental conditions under which candidates have been selected are different from those of commercial populations (Dickerson 1962). Sire herd interaction can bias the breeding decisions and reduce effectiveness of selection, because sires might rank differently across different environments. Various studies have been done to account for G×E interaction in different economically important traits for dairy cattle (Strandberg *et al.* 2009, Mattar *et al.* 2011, Williams *et al.* 2012).

The development of 'Frieswal' a national milch crossbred cattle involving Holstein Friesian and Sahiwal cattle breeds has been progressing so far utilizing the existing crossbred herds available at various Military Farms and undertaking a large scale progeny testing programme. Field progeny testing programme incorporating farmers' herds associated with BAIF Development Research Foundation, Pune, Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Punjab and Kerala Veterinary and Animal Sciences, University, Thrissur, are also using the superior germplasm of Frieswal bulls. The present investigation was undertaken to determine the genetic worth of Frieswal bulls under organized and farmers' herds and to assess their rankings in both production systems.

MATERIALS AND METHODS

The first lactation records of 3,582 crossbred cows maintained at Military Farms (2,851) and in farmers' herds (731) which were daughters of 32 bulls and calved during 14 years from 1998 to 2011 were used in the present analysis. Each year of calving was divided into 3 seasons i.e. winter (November to February), summer (March to

Present address: [1,3,5]Principal Scientist (chaturvedisk@gmail.com, usinghas@gmail.com, achintya137@yahoo.com), [2] Scientist (ranialex01vet@gmail.com), Animal Genetic and Breeding Section. [4]Principal Scientist (karunt04@yahoo.com), Central Sheep and Wool Research Institute, Avikanagar.

June) and rainy (July to October) based on climatological conditions. Bulls were divided into 4 groups based on their year of birth to account for selection over years (Gaur *et al.* 2008). Bulls with less than 5 daughters were excluded from the study. The bulls were evaluated based on first lactation 300 days milk yield of their daughters in Military farms. The milk yield of cows in the field conditions was estimated for 305 days using test records. Data were divided into 2 sets, Military Farms (set 1) and field units (set 2) and separate analysis was done.

Bulls' breeding values were estimated through best linear unbiased prediction (BLUP) procedure using Model 8 in least squares and maximum likelihood computer package (Harvey, 1990). The following model was used for analysis of both data sets

$$Y_{ijklmn}=\mu+S_{gi}+SR_{ij}+Y_k+SN_e+F_m+b\ (A_{ijklmn}-\bar{A}_{ijklmn})+e_{ijklmn}$$

Y_{ijklmn}, observation of 300 (set 1)/305 (set 2) days 1st lactation milk yield on nth daughter of jthsire within ith sire group; μ, overall mean; SG_i, fixed effect of ith sire group; SR_{ij}, random effect of jth sire within ith sire group; Y_k, fixed effect of kth year of calving; SN_l, fixed effect of lth season of calving; F_m, fixed effect of mth herd (set l)/location (set 2); b, regression of 300/305 days 1st 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.

The accuracy of sire evaluation was estimated as per Jain (1982). The ranks of bulls were estimated under farm and field conditions separately. The bull × environment/ production system interaction was analyzed using rank correlation between breeding value of bulls estimated under farm and field conditions (Lengyel *et al.* 2003).

RESULTS AND DISCUSSION

The average first lactation milk yield in crossbred cows was 2,886.60±32.78 kg at Military Farms and 2,666.17±71.21 kg at field units (Table 1). Better feeding and management practices together with the availability of superior germplasm at Military Farms may be the reason for increased production in farms. The cows in the field conditions are composite mixture of different breeds where the cows maintained in the Military Farms belong to Frieswal breed. This can also attribute to the difference in the milk yield. Similar trend of higher production performance in crossbred cows maintained at farms was observed in earlier investigations too (Gaur *et al.* 2006, 2008). The performance of various herd varied significantly in both farm and field conditions in terms of 300/305 day milk yield in Frieswal cows. Frieswal cows at MF Jammu (3,382.96±87.39 kg) produced the highest milk yield in 300 days followed by those maintained at Lucknow (3,381.54±64.82 kg) whereas MF Panagarh (2,084.18±110.44 kg) had lowest. In the field units, farmers' herd associated with BAIF (2,880.59±79.59 kg) and GADUVASU (2,783.49±79.07 kg) had higher milk production in comparison to KVASU (2,334.42±80.32 kg). It is expected that the different herds have different levels of production because of variations in the level of management and climatic condition. Year and season of calving were significant in farms and field conditions, respectively. Significant effects of period of calving (Gaur *et al.* 2008, Komatwar *et al.* 2010) and season of calving (Gaur 2007) on milk yield were reported in previous studies. The variation in milk yield observed in different years indicated the level of management as well as environmental effects prevailed in those years. The cows calved during the rainy season had the highest milk yield (2,713.85±78.05 kg) followed by those calved during winter (2,690.37±77.76 kg) and summer (2,594.28±76.46 kg) in field conditions. This variation could be due to the type of feed, environmental deviations and management; it may be more pronounced in field conditions as farmers will not opt for alternatives as in the case of farms. Effect of age at first calving was significant under farm conditions where as it was nonsignificant in field conditions.

Table 1. Least squares means of first lactation milk yield across the Military Farms and field units based on the year and season of calving

Factor	Military Farms		Field conditions	
	No	Mean	No	Mean
Overall	2851	2886.60± 32.78	731	2666.17± 71.21
Year of calving		**		
1998	281	2917.72± 54.90	9	2750.80±215.36
1999	257	2873.23± 55.97	59	2781.53±130.63
2000	137	3164.00± 68.16	86	2620.76±119.49
2001	231	3091.76± 57.86	60	2816.10±125.91
2002	153	2961.54± 63.82	44	2649.86±118.95
2003	115	3015.38± 71.14	58	2561.92±111.45
2004	172	2852.58± 62.66	91	2652.22±100.88
2005	280	3049.43± 52.90	67	2743.67±110.10
2006	344	2854.68± 51.44	128	2547.73±103.17
2007	271	2825.19± 53.83	34	2519.10±134.64
2008	175	2688.13± 61.58	15	2573.90±167.29
2009	71	2751.26± 84.86	26	2627.41±152.78
2010	104	2515.09± 77.49	22	2747.12±176.71
2011	260	2850.84± 66.64	32	2734.21±174.66
Season of calving				*
Winter	1101	2911.35± 36.16	224	2690.37± 77.76
Summer	1114	2845.56± 36.88	273	2594.28± 76.46
Rainy	636	2902.56± 39.46	234	2713.85± 78.05

**P<0.01 *P<0.05.

The common bulls used for testing at Military Farms and Field units were 32. BLUP estimates of the sires ranged from 2,824.28 to 2,919.19 kg in organized farms and from 2,650.41 to 2,758.81 kg under field conditions. The breeding values of the selected sires in the study in farms were comparatively higher than earlier reports (Mukherjee *et al.* 2007). The daughters' averages of all the bulls were also evaluated. Their daughters' average varied from 2,489.17 to 3,217.27 kg in farm conditions and from 2,290.79 to 3,150.93 kg in field conditions. The product moment (0.416±0.018 and 0.494±0.004) and rank correlations (0.398±0.023 and 0.404±0.022) of daughters average were

Table 2. Breeding value of Frieswal bulls for first lactation milk yield under farm and field conditions

Bull No./Name	Farm conditions				Field conditions			
	Progeny size (Accuracy)	Breeding value	Rank	Genetic superiority over population (%)	Progeny size (Accuracy)	Field	Rank	Genetic superiority over population (%)
SSB104/ ANTHONY	55(0.89)	2851.06	27	–1.23	8(0.59)	2720.63	7	2.04
CMT633/ BALWAN	73(0.91)	2878.31	12	–0.29	67(0.90)	2677.18	20	0.41
CMT851/ BHARAT	52(0.88)	2901.19	4	0.51	28(0.81)	2675.70	23	0.36
WAM622/ CHACHA	20(0.76)	2850.72	28	–1.24	54(0.88)	2677.05	21	0.41
WFP415/ CHAND	25(0.79)	2891.39	7	0.17	46(0.87)	2678.81	18	0.47
WAM457/ DIWANA	54(0.88)	2849.36	29	–1.29	33(0.83)	2698.93	13	1.23
SB638/ GAJRAJ	197(0.96)	2880.45	10	–0.21	51(0.88)	2706.58	12	1.52
WJR243/HAZAR	25(0.79)	2878.74	11	–0.27	19(0.75)	2669.36	26	0.12
SB519/ HIRA	196(0.96)	2876.29	16	–0.36	15(0.71)	2666.29	28	0.00
SB641/ JANI	39(0.85)	2848.07	30	–1.33	35(0.84)	2755.49	3	3.35
WAM986/ KALA	40(0.85)	2873.11	19	–0.47	20(0.76)	2683.48	16	0.65
CDD001/ KARAN	107(0.94)	2902.50	3	0.55	8(0.59)	2709.91	9	1.64
SPK548/ KOBRA	165(0.96)	2877.52	13	–0.31	5(0.50)	2663.87	29	–0.09
WAM461/ LAXMAN	6(0.53)	2863.25	23	–0.81	26(0.80)	2686.77	15	0.77
WAM875/ LOZAR	126(0.95)	2897.19	6	0.37	14(0.69)	2676.46	22	0.39
WAM388/ MADAN	48(0.87)	2876.96	14	–0.33	26(0.80)	2708.92	11	1.60
WAM652/ MADHAV	185(0.96)	2864.28	22	–0.77	15(0.71)	2690.20	14	0.90
CMT 230 / MAHAN	129(0.95)	2872.64	20	–0.48	17(0.73)	2669.28	27	0.12
WAM211/ MANGU	59(0.89)	2875.53	17	–0.38	20(0.76)	2757.40	2	3.42
WAM490/ NABHA	20(0.76)	2869.28	21	–0.60	8(0.59)	2677.52	19	0.43
WAM132/ NAZIR	38(0.85)	2903.14	2	0.57	18(0.74)	2715.58	8	1.85
SPK383/ PETERSON	39(0.85)	2898.00	5	0.39	9(0.61)	2650.41	32	–0.59
CMT516/ PURAN	119(0.94)	2824.28	32	-2.16	30(0.82)	2681.45	17	0.57
CMT802/ RANCHO	12(0.67)	2856.99	24	–1.03	37(0.84)	2746.89	5	3.03
WAM 265/ SALVI	208(0.97)	2876.91	15	–0.34	14(0.69)	2675.14	24	0.34
SAN009/ SUBHASH	330(0.98)	2856.15	25	–1.06	7(0.56)	2709.05	10	1.61
WAM303/ SWARAJ	21(0.76)	2885.77	9	–0.03	23(0.78)	2758.81	1	3.47
WJR159/ TIR	77(0.91)	2843.14	31	–1.51	16(0.72)	2735.97	6	2.62
WJR622/ TONY	71(0.91)	2853.50	26	–1.15	19(0.75)	2654.60	30	–0.43
WAM393/ TOOFAN	13(0.68)	2874.14	18	–0.43	26(0.80)	2747.10	4	3.04
WJR987/ TYSON	201(0.96)	2919.19	1	1.13	12(0.67)	2653.32	31	–0.48
CMT026/ BABAR	101(0.93)	2887.43	8	0.03	5(0.50)	2671.29	25	0.19

medium with the breeding values of bulls in both farm and field conditions. Similar trend of low to medium product moment and rank correlations daughters average with the breeding values of bulls were also observed in earlier studies (Gaur *et al.* 2006, 2008). The sires belonging to first and second group had better breeding values in farm and field conditions respectively. The number of daughters' per bull had no specific trend over the performance. But the accuracy of estimated breeding value is dependent on the number of progeny per sire. The estimates of accuracy in the present investigation corroborated with the findings of Gaur *et al.* (2006 and 2008).

Eight bulls (25%) under farm conditions and 27 bulls (84%) under field conditions exceeded their breeding value over the herd average of 2,886.60 and 2,666.17 kg, respectively (Table 2). Their superiority under farm and field conditions ranged from 0.90 (0.03%) to 32.15(1.11%) and 3.12 (0.12%) to 92.65 (3.47%) kg, respectively. None of the bulls used at Military Farms retained his rank at field units. The product moment correlation (–0.261) between breeding values of bulls for first lactation milk yield under farms and field conditions was negative, low and non-significant. The corresponding rank correlation (–0.296) was also negative, low and non-significant. Similar trend was observed in earlier studies too (Gaur *et al.* 2008), where the product moment and rank correlations were lower (–0.098 and –0.12) than the present study. In the present study, the ranking of genotypes was different in different environment, leading to the re ranking effect of G×E interaction, rather than scaling effect. Due to the occurrence of re-ranking, superior individuals in one environment will be inferior in other environments. In this case, breeding program has to be 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 to address the re-ranking (Hammami *et al.* 2009).

The efficiency of this selection will depend on the magnitude of the genetic correlation between the 2 environments and the heritability of the trait in each of the 2 environments. Selection of candidate animals with highest genetic variance (Togashi *et al*. 2002) and development of an optimum index (Togashi *et al*. 2001) are some other alternatives to address the problem.

Low product moment and rank correlation between breeding values of bulls under farm and field conditions revealed that bulls with higher ranks for milk production under farm conditions did not retain their superiority under field conditions. This implies that the performance of bulls can change according to the environmental conditions in which they are raised and selected. So it is recommended to use the bulls only in the environment where they are selected.

ACKNOWLEDGEMENT

The authors are thankful to Director, Central Institute for Research on Cattle, Meerut, India for providing necessary facilities for conducting the study. We also acknowledge Director, Frieswal and Officer In-charges of various Military Farms and Field Progeny Testing units to supply the information and data.

REFERENCES

Dickerson G E. 1962. Implications of genetic-environmental interaction in animal breeding. *Animal Production* **4:** 47.

Falconer D S and Mackay T F C. 1996. *Introduction to Quantitative Genetics*. 4th edn. Longman Group Ltd., Harlow, UK.

Gaur G K. 2007. Environmental Factors affecting various performance traits of Holstein Friesian × Sahiwal Cattle. *Indian Journal of Dairy Science* **54:** 209 –13.

Gaur G K, Kumar A, Beniwal B K and Praveen. 2008. Evaluation of Frieswal bulls under farm and field conditions. *Indian Journal of Animal Sciences* **78:** 218–21.

Gaur G K, Kumar A, Garg R C and Mehra M L. 2006. Evaluation of young crossbred bulls under field conditions. *Indian Journal of Animal Sciences* **76:** 154–55.

Hammami H, Rekik B and Gengler N. 2009. Genotype by environment interaction in dairy cattle. *Biotechnology, Agronomy, Society and Environment* **13**(1)**:** 155–64.

Harvey W R. 1990. User's Guide for LSMLMW and MIXMDL PC-2 Version Mixed Model Least-Squares and Maximum Likelihood Computer Program. Ohio State University, Columbus, USA.

Jain J P. 1982. *Statistical Techniques in Quantitative Genetics*. 1st edn. Tata McGraw-Hill Publishing Company Limited, NewDelhi.

Komatwar S J, Deshpande A D, Kulkarni M D, Kulkarni A P, Yadau G B, Ulemale A H and Shisode M G. 2010. Study on the production traits in Holstein Friesian × Sahiwal crossbreds. *Indian Journal of Animal Production and Management* **26** (3–4): 177–81.

Lengyel Z, Komlosi I, Balika S, Major T, Erdei I and Szabo F. 2003. Examination of reproduction and weaning results in Hungarian Limousin population. *Allattenyeszteses Takarmanyozas* **52:** 25–38.

Matter M, Silva L O C, Alencar M M and Cardoso F F. 2011. Genotype × environment interaction for long-yearling weight in Canchim cattle quantified by reaction norm analysis. *Journal of Animal Science* **89:** 2349–55.

Mukherjee S, Joshi, B K and Gaur G K. 2007. Comparison of sire evaluation methods in Frieswal cattle. *Indian Journal of Animal Sciences* **77** (8): 773–76.

Strandberg E, Brotherstone S, Wall E and Coffey M P. 2009. Genotype by environment interaction for first-lactation female fertility traits in UK dairy cattle. *Journal of Dairy Science* **92:** 3437–46.

Togashi K, Lin C Y and Moribe K. 2001. Construction of optimum index to maximize overall performance across countries in the presence of genotype-environment interaction. *Journal of Dairy Science* **84:** 1872–83.

Togashi K, Lin C Y, Yoshizawa T, Okamura Y, Moribe K, Nishiura A and Yamamoto N. 2002. Partition of sire effects for international sire evaluation in the presence of genotype-environment interaction. *Livestock Production Science* **73:** 225–35.

Williams J L, Lukaszewicz M, Bertrand J K, Misxtal I. 2012. Genotype by region and season interactions on weaning weight in United States Angus Cattle. *Journal of Animal Science* **90**: 3368–74.