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Genetic and non-genetic factors affecting monthly test day milk yields in Karan Fries cattle

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ABSTRACT

The present investigation was carried out using data of first lactation monthly (MTDY) test day milk yields and 305-day milk yield records of 1345 Karan Fries cows sired by 84 bulls from 1984–2006 maintained at NDRI, Karnal. The effect of season of calving on all the monthly test day (MTDY) milk yields was highly significant.The monthly test day milk yields were highest in winter followed by summer in MTDY-1. However in MTDY-2 and MTDY-3, the highest milk yield was observed in winter followed by autumn, from MTDY-4 to MTDY-6; MTDY-7 to MTDY-8 and MTDY-9 to MTDY-11 the highest milk yield was observed in autumn, rainy season and summer respectively. No definite trend for other seasons was observed in this trait. The effect of periods of calving on all the monthly test day yields was highly significant.The effect of period of calving on monthly test day milk yields showed no definite trend till IV period. However, the monthly test day milk yields exhibited an increasing trend from V period onwards till VIII period for MTDY-4 to MTDY-11. The effect of age at first calving on MTDY-2 and MTDY-3 was significant and on remaining monthly test day milk yields, it was nonsignificant. The h^2 estimate of monthly test day milk yield was lowest for MTDY-1 and the highest for MTDY-6. The phenotypic correlations among monthly test day milk yields and with 305-day milk yield were highly significant. The estimates of phenotypic and genetic correlations among all the monthly test day milk yields ranged from 0.17 to 0.82 and from 0.46 to 0.99 respectively. The magnitude of phenotypic correlations among monthly test-day milk yields decreased with increasing time interval between test day milk yields. The estimates of phenotypic and genetic correlation of monthly test day yields with 305-day milk yield ranged from 0.42 to 0.78 and 0.80 to 0.99, respectively, and the estimates was generally higher in the middle segment of lactation.

Key words: Genetic factors, Karan Fries cattle, Non-genetic factors, Test day milk yield

India has about 63.01 million breeding cows including 12.05 million crossbred cows. Population of crossbred cows is small in comparison to indigenous cows, but their contribution to total milk production of the country is almost equal (20%) to the indigenous (21%) cows. The poor performance is due to direct effect of climate as well as poor quality of roughage, low concentrate feed inputs, high incidence of diseases and parasites, poor economic environment and infrastructure. Improvements targeted towards any of these areas have realized substantial improvement in dairy performance (Singh 1992, Machado *et al.* 1999). Therefore, adjusting records for non-genetic effects is essential to define appropriate models for estimation of variance components and improving selection procedures. Generally production traits have a medium to high repeatability and low to medium heritability hence there exists opportunity for improvement through selection. Phenotypic, genetic and environmental trends in performance traits are important as these allow for evaluation of efficacy of selection and management schemes. Authors estimating effect of genetic and non-genetic factors on test day yields (Singh 1992, Appannayar 1997, Iype 2005, Rana 2008, Monalisa *et al.* 2010, Dongre *et al.* 2011) reported that selection based on some test day records is as efficient as on all. This may reduce the number of tests in routine milk recording. There is therefore, a need to continuously evaluate the genetic, non-genetic parameters in dairy cattle, to monitor whether the parameters are desirable for each trait. The purpose of this study was to evaluate the effects of genetic and non-genetic factors affecting monthly test day milk yield.

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MATERIALS AND METHODS

Data: 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 1345 KF cattle sired by 84 bulls maintained at Dairy Cattle Breeding Division, National Dairy Research Institute, Karnal from 1984 to 2006. For first lactation 305-day milk yield, only those Karan Fries cattle were considered for study which had produced milk for at least 100 days. Culling in the middle of lactation, abortion, still-birth or any other pathological causes which affected the lactation yield were considered as abnormalities and thus, such records were not taken for the study. The data were classified into different seasons and periods. Each year was divided into 4 seasons on the basis of rainfall, temperature and humidity over the years — winter, December -– March; summer, April – June; rainy, July – September; and autumn, October – November. The data spread over 23 years (1984–2006) were classified into 8 periods in which first period had 2 years duration and remaining seven periods had three years duration.

Statistical methods: Data were first analyzed by least squares analysis of variance (Harvey 1987) to identify the significant effects and to standardize the data using least squares constants. The model used was:

$$Y_{ijk} = \mu + S_i + P_j + b\,(x_k - \bar{X}) + e_{ijk}$$

where, $Y_{ijk,}$ observation on the k^{th} individual in j^{th} period and i^{th} season; μ, population mean; $S_{i,}$ effect of i^{th} season (I-1 to 4); P_j, effect of j^{th} period (j-1 to 8); b, regression of Y_{ijk} on age at first calving, $x_{k,}$ age of first calving of the k^{th} individual; $\bar{X}$, average age at first calving; e_{ijk}, random error, NID (0, σ^2_e).

For significant effects, the differences between pairs of levels of effects were tested by Duncan's multiple range test as modified by Kramer (1957).

Estimation of heritability: Paternal half-sib correlation method (Becker 1975) was used to estimate the heritability of different characters and their genetic correlations. The sires with 5 or more than 5 progeny were included for the estimation of heritability. The data adjusted for significant effects of non-genetic factors was used for estimation of heritability. The standard error of heritability was estimated after Swiger *et al.* (1994).

Genetic and phenotypic correlations: The genetic and phenotypic correlations along with the standard errors among test day milk yield (monthly) with 305-day milk yield was calculated from the analysis of variance and covariance among sire groups as given by Becker (1975). The standard error of phenotypic correlations was obtained according to formula given by Panse and Sukhatme (1961). The statistical significance of correlations was tested by 't' test as given by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The highest monthly test day milk yield was observed in MTDY-2 (12.88 kg) and the lowest was observed in MTDY-11 (5.50 kg). In general, monthly test day milk yield increased till MTDY-2 and thereafter a gradual decline was noticed till the end of lactation. The coefficient of variation for monthly test day milk yields ranged from 27.17% (MTDY-2) to 92.72% (MTDY-11) and exhibited a consistently increasing trend with advancement of lactation. The average 305-day or less milk yield was 3068±23 kg with coefficient of variation 25.3%. Singh (2006) also observed that the average 305-day milk yield was 3197±43 kg with coefficient of variation 24.98% in Karan Fries cattle.

Effect of non-genetic factors

Season: The effect of season of calving on all the monthly test day (MTDY) milk yields was highly significant (P<0.01) (Table 1). Machado *et al.* (1999) and Rose (2008) in crossbred cattle also observed significant effect of seasons on all the monthly test day milk yields. The least squares mean along with their standard errors for seasons affecting monthly test day milk yield are presented in Table 2. The monthly test day milk yields were highest in winter followed by summer in MTDY-1. However in MTDY-2 and MTDY-3, the highest milk yield was observed in winter followed by autumn season, from MTDY-4 to MTDY-6; MTDY-7 to MTDY-8 and MTDY-9 to MTDY-11 the highest milk yield was observed in autumn, rainy and summer season respectively. No definite trend for other seasons was observed in this trait.

Period: The effect of period of calving on all the monthly test day yields was highly significant (P<0.01) (Table 1). Rana (2008) also reported highly significant effect of period of calving on the monthly test day milk yields in Murrah buffaloes. The least squares means along with their standard errors for the effect of periods on MTDY are presented in Table 2. The effect of period of calving on monthly test day milk yields showed no definite trend till IV period. However, the monthly test day milk yields exhibited an increasing trend

Table 1. Mixed model ANOVA showing mean sum of squares for factors affecting monthly test day milk yields

Source and variation	df	MTDY-1	MTDY-2	MTDY-3	MTDY-4	MTDY-5	MTDY-6	MTDY-7	MTDY-8	MTDY-9	MTDY-10	MTDY-11
Sire	83	16.10	17.53	20.47	17.59	16.61	21.85	22.90	25.89	29.74	39.11	42.06
Season	3	56.80**	428.15**	439.11**	378.22**	294.05**	216.28**	110.43**	156.91**	261.04**	336.36**	197.07**
Period	7	47.50**	46.19**	56.00**	66.69**	44.55**	36.75**	24.39**	38.43**	28.84**	15.74**	56.11**
AFC	1	177.69^{NS}	436.31*	340.80*	180.72^{NS}	144.33^{NS}	69.28^{NS}	76.79^{NS}	24.26^{NS}	10.75^{NS}	0.40^{NS}	19.31^{NS}
Error	1146	11.81	9.43	9.55	9.29	8.40	9.26	10.85	12.71	14.66	19.24	24.66

*P≤0.05; **P≤0.01; NS, nonsignificant.

Table 2. Least squares means along with their standard errors for non-genetic factors affecting monthly test day milk yields

Items	MTDY-1	MTDY-2	MTDY-3	MTDY-4	MTDY-5	MTDY-6	MTDY-7	MTDY-8	MTDY-9	MTDY-10	MTDY-11
Overall (1243)	9.85 ± 0.11	12.39 ± 0.10	12.96 ± 0.10	11.72 ± 0.10	11.28 ± 0.10	10.80 ± 0.10	10.36 ± 0.1	9.96 ± 0.1	9.47 ± 0.1	9.14 ± 0.1	8.85 ± 0.12
					Season						
Winter (581)	$10.34^{a}\pm0.14$	$13.97^{a}\pm0.13$	$13.52^{a}\pm0.13$	$12.49^{a}\pm0.13$	$11.29^{a}\pm0.12$	$10.20^{a}\pm0.12$	$9.44^{a}\pm0.12$	$8.70^{a}\pm0.12$	$8.50^{a}\pm0.12$	$8.70^{a}\pm0.13$	$9.27^{a}\pm0.16$
Summer (340)	$10.17^{ad}\pm0.19$	$12.09^{be}\pm0.17$	$11.45^{b}\pm0.17$	$10.53^{be}\pm0.17$	$9.81^{b}\pm0.16$	$9.52^{b}\pm0.16$	$9.67^{a}\pm0.16$	$10.22b^{e}\pm0.16$	$10.54^{bd}\pm0.16$	$10.48^{b}\pm0.17$	$10.07^{b}\pm0.20$
Rainy (190)	$9.62^{bd}\pm0.25$	$10.96^{c}\pm0.23$	$10.73^{c}\pm0.23$	$10.51^{ce}\pm0.23$	$10.91^{a}\pm0.23$	$11.36^{c}\pm0.23$	$11.49^{bc}\pm0.22$	$10.82^{c}\pm0.22$	$10.19^{cd}\pm0.22$	$9.44^{c}\pm0.23$	$8.73^{a}\pm0.29$
Autumn (132)	$9.28^{bc}\pm0.30$	$12.52^{de}\pm0.28$	$13.35^{a}\pm0.28$	$13.37^{d}\pm0.28$	$13.12^{c}\pm0.26$	$12.12^{d}\pm0.26$	$10.89^{cd}\pm0.27$	$9.92^{de}\pm0.26$	$8.65^{a}\pm0.26$	$7.95^{d}\pm0.29$	$7.34^{c}\pm0.33$
					Periods						
I Period (1984-85)	$10.51^{ab}\pm0.28$	$12.71^{ab}\pm0.25$	$12.13^{abc}\pm0.26$	$11.79^{abcd}\pm0.25$	$11.34^{abcd}\pm0.24$	$11.17^{af}\pm0.24$	$10.78^{a}\pm0.24$	$10.49^{a}\pm0.24$	$10.00^{a}\pm0.24$	$9.91^{a}\pm0.25$	$9.51^{a}\pm0.30$
II Period (1986–88)	$10.67^{a}\pm0.26$	$10.75^{a}\pm0.24$	$12.47^{ac}\pm0.24$	$11.8^{abcd}\pm0.24$	$11.42^{acd}\pm0.22$	$11.09^{ace}\pm0.22$	$10.42^{a}\pm0.22$	$10.13^{ab}\pm0.22$	$9.70^{abc}\pm0.22$	$9.33^{ac}\pm0.24$	$9.25^{ac}\pm0.20$
III Period (1989–91)	$9.87^{bc}\pm0.29$	$12.43^{acd}\pm0.26$	$12.46^{ac}\pm0.26$	$11.90^{abcd}\pm0.26$	$11.48^{acd}\pm0.24$	$11.09^{acde}\pm0.22$	$10.45^{a}\pm0.24$	$9.82^{ab}\pm0.29$	$9.65^{ab}\pm0.29$	$9.16^{ac}\pm0.26$	$8.95^{ac}\pm0.32$
IV Period (1992–94)	$10.83^{a}\pm0.27$	$13.00_{a}\pm0.24$	$12.94^{c}\pm0.25$	$12.15^{be}\pm0.24$	$11.73^{ad}\pm0.23$	$11.55^{a}\pm0.23$	$10.01^{a}\pm0.23$	$10.25^{ab}\pm0.23$	$9.58^{ab}\pm0.23$	$9.17^{ac}\pm0.26$	$8.72^{abc}\pm0.3$
V Period (1995-97)	$9.55^{c}\pm0.25$	$11.90^{cd}\pm0.23$	$11.92^{ab}\pm0.24$	$11.37^{acf}\pm0.23$	$10.68^{b}\pm0.22$	$10.08^{bd}\pm0.22$	$9.66^{b}\pm0.22$	$9.05\ ^{c}\pm0.22$	$8.52\ ^{c}\pm0.22$	$8.23\ ^{b}\pm0.24$	$7.87\ ^{b}\pm0.29$
VI Period (1998-2000)	$8.63^{d}\pm0.26$	$11.70^{c}\pm0.19$	$11.82^{b}\pm0.17$	$11.39^{bdf}\pm0.15$	$11.03^{bc}\pm0.13$	$10.63^{e}\pm0.13$	10.24 ± 0.13	9.83 ± 0.13	9.39 ± 0.12	9.11 ± 0.12	8.82 ± 0.14
VII Period (2001–03)	$9.70^{cd}\pm0.23$	$12.16^{bd}\pm0.17$	$12.04^{ab}\pm0.15$	$11.61^{cf}\pm0.14$	$11.21^{ce}\pm0.13$	$10.74^{ef}\pm0.12$	$10.33^{a}\pm0.12$	$9.91^{b}\pm0.12$	$9.45^{b}\pm0.11$	$9.13^{c}\pm0.12$	$8.83^{c}\pm0.14$
VIII Period (2004–06)	$9.59^{c}\pm0.24$	$12.46^{ad}\pm0.17$	$12.30^{a}\pm0.16$	$11.77^{ce}\pm0.14$	$11.50^{dc}\pm0.13$	$10.80^{af}\pm0.12$	$10.41^{a}\pm0.12$	$9.98^{b}\pm0.12$	$9.50^{b}\pm0.11$	$9.17^{c}\pm0.12$	$8.87^{c}\pm0.14$

Table 3. Heritability estimates along with their standard error for monthly test day milk yields

Test day milk yield	$h^2\pm SE$
MTDY-1	0.11 ± 0.16
MTDY-2	0.24 ± 0.08
MTDY-3	0.32 ± 0.08
MTDY-4	0.25 ± 0.08
MTDY-5	0.27 ± 0.08
MTDY-6	0.37 ± 0.08
MTDY-7	0.31 ± 0.09
MTDY-8	0.28 ± 0.07
MTDY-9	0.28 ± 0.08
MTDY-10	0.29 ± 0.08
MTDY-11	0.20 ± 0.08

from V period onwards till VIII period in MTDY-4 to MTDY-11.

Age at first calving: The effect of age at first calving on monthly test day milk yields (MTDY) presented in Table 1. The effect of age at first calving on MTDY-2 and MTDY-3 was significant ($P<0.05$) and on remaining monthly test day milk yields, it was nonsignificant. Rana (2008) also reported the effect of age at first calving on monthly test day milk yields to be highly significant in Murrah buffaloes. Rose (2008), however, reported that the age at first calving had no significant effect on any of the monthly test day milk yields in the first lactation in Karan Fries cattle.

Genetic and phenotypic parameters

Heritability: The heritability of the monthly test day milk yields is presented in Table 3. The h^2 estimate of monthly test day milk yield was the lowest (0.11±0.16) for MTDY-1 and the highest (0.37±0.08) for MTDY-6. Swalve (1994) also reported that the heritability estimates was lowest for the MTDY-1(0.18) and highest for MTDY-6 (0.36) in Holstein-Friesian cows.

Genetic and phenotypic correlations: The estimates of genetic and phenotypic correlations among monthly test day milk yields and with 305-day milk yield are presented in Table 4. The phenotypic correlations among monthly test day milk yields and with 305-day milk yield were highly significant ($P\leq0.01$). The estimates of phenotypic and genetic correlation among all the monthly test day milk yields ranged from 0.17 to 0.82 and from 0.46 to 0.99 respectively. The magnitude of phenotypic correlations among monthly test-day milk yields decreased with increasing time interval between test day milk yields. Meyer *et al.* (1989) also reported that the value of phenotypic correlations among monthly test-day milk yields decreased with increasing time interval between tests in Australian Black and White cows. The estimates of phenotypic and genetic correlation of monthly test day yields with 305-day milk yield ranged from 0.42 to 0.78 and 0.80 to 0.99, respectively, and the estimates

Table 4. Genetic and phenotypic correlations among monthly test day milk yields and with 305-day milk yield

Item	MTDY-1	MTDY-2	MTDY-3	MTDY-4	MTDY-5	MTDY-6	MTDY-7	MTDY-8	MTDY-9	MTDY-10	MTDY-11	305-DMY
MTDY-1		0.50±0.03	0.42±0.12	0.34±0.06	0.31±0.08	0.29±0.19	0.27±0.03	0.24±0.07	0.24±0.03	0.22±0.04	0.17±0.70	0.42±0.13
MTDY-2	0.75±0.20		0.73±0.11	0.62±0.21	0.56±0.06	0.48±0.16	0.43±0.15	0.38±0.07	0.35±0.09	0.28±0.11	0.23±0.09	0.65±0.06
MTDY-3	0.65±0.06	0.99±0.05		0.75±0.11	0.63±0.16	0.56±0.03	0.48±0.16	0.42±0.11	0.38±0.05	0.30±0.13	0.23±0.04	0.70±0.10
MTDY-4	0.88±0.22	0.99±0.07	0.99±0.03		0.72±0.07	0.61±0.11	0.55±0.07	0.48±0.18	0.42±0.16	0.35±0.19	0.25±0.24	0.73±0.10
MTDY-5	0.92±0.23	0.86±0.10	0.95±0.07	0.99±0.05		0.73±0.17	0.63±0.11	0.56±0.16	0.51±0.05	0.42±0.16	0.32±0.21	0.77±0.02
MTDY-6	0.86±0.21	0.70±0.13	0.82±0.09	0.92±0.07	0.93±0.05		0.78±0.03	0.67±0.11	0.59±0.16	0.50±0.07	0.37±0.03	0.78±0.16
MTDY-7	0.58±0.25	0.71±0.14	0.79±0.11	0.86±0.10	0.85±0.09	0.93±0.05		0.78±0.11	0.70±0.10	0.57±0.07	0.42±0.16	0.78±0.05
MTDY-8	0.46±0.26	0.63±0.16	0.71±0.13	0.90±0.11	0.92±0.09	0.81±0.08	0.99±0.04		0.82±0.03	0.68±0.14	0.50±0.07	0.77±0.09
MTDY-9	0.66±0.25	0.56±0.17	0.67±0.14	0.79±0.13	0.92±0.09	0.84±0.09	0.97±0.05	0.95±0.04		0.76±0.05	0.57±0.03	0.76±0.21
MTDY-10	0.64±0.26	0.62±0.17	0.72±0.14	0.87±0.13	0.95±0.11	0.91±0.09	0.92±0.08	0.97±0.06	0.92±0.05		0.72±0.07	0.69±0.03
MTDY-11	0.60±0.29	0.64±0.19	0.60±0.18	0.67±0.19	0.78±0.16	0.73±0.14	0.76±0.14	0.88±0.11	0.79±0.12	0.89±0.07		0.57±0.03
305-DMY	0.82±0.19	0.86±0.08	0.92±0.05	0.98±0.05	0.99±0.04	0.96±0.04	0.95±0.04	0.92±0.05	0.88±0.06	0.93±0.06	0.80±0.10	

The value above and below the diagonal are phenotypic and genetic correlation respectively which are highly significant.

were generally higher in the middle segment of lactation.

This study showed that the effect of season and period of calving was highly significant ($P \leq 0.01$) and of age at first calving was significant on all the monthly test day milk yields (MTDY). The h^2 estimate of monthly test day milk yield was the lowest (0.11±0.16) for MTDY-1 and the highest (0.37±0.08) for MTDY-6. The estimates of phenotypic and genetic correlation of monthly test day yields with 305-day milk yield was generally higher in the middle segment of lactation suggested that these test day yields could be used as the selection criteria, leading to a reduction in generation interval.

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