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Research Article

GENETIC AND NON-GENETIC FACTORS AFFECTING FIRST LACTATION TEST-DAY MILK YIELD IN MEHSANA BUFFALOES, GUJARAT, INDIA

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Abstract- Data on various FLTDYs and FLY of Mehsana buffaloes were obtained during a period of 20 years (1993 to 2012) to observe the effect of genetic and non-genetic factors on various FLTDYs and FLY. The least squares mean for FLY was found to be 1708.62±32.50 liters. It was significantly ($P \leq 0.05$) affected by period of calving. Similarly, the least squares means of various FLTDYs ranged from 3.09±0.11 ($FLTDY_1$) to 7.31±0.13 ($FLTDY_4$) liters and were greatly ($P \leq 0.05$) influenced by the period of calvingexcept $FLTDY_5$ and $FLTDY_9$. Low to high heritability estimates (ranging from 0.05 for $FLTDY_5$ to 0.85 for $FLTDY_1$) were obtained in the present study. Further, the genetic correlations between FLY and FLTDYs ranged from moderate to high (0.28 to 0.98) whereas, the phenotypic correlations between these traits were found to be ranged from low to high (0.08 to 0.69). The high genetic correlations between FLTDYs ($FLTDY_2$, $FLTDY_3$, $FLTDY_9$ and $FLTDY_{10}$) and FLY implies that these test-day yields can very well be used as the criteria for selection of Mehsana buffaloes during its early lactation.

Keywords- Genetic and non-genetic factors, Mehsana buffaloes, First lactation yield, First test-day yield

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Introduction

The rearing of buffaloes is becoming an important source of income and employment for large number of farmers in India and it is considered as the main plank for the development of dairying in India by contributing major share in milk production. Now-a-days, dairy farmers are preferring buffalo husbandry over cow husbandry. The important breeds of buffaloes of Gujarat includes Jaffarabadi, Mehsana, Surti and Bunni. Among all these breeds, Mehsana buffalo is famous for its persistency and regular breeding.

Countries like India suffers mainly from inaccurate recording systems, poor data collection, storage and processing facilities etc. Besides all these, daily milk recording of dairy buffaloes is costly and time consuming under field conditions. Therefore, the use of test-day yield records is being advocated to reduce the time required for selection of sire and also to reduce the cost involved in daily milk recording. These test-day milk records in dairy animals are altered by many genetic and non-genetic factors. The findings of many workers have showed significant effect of period of calving, season of calving as well as parity of lactation on various test-day yield records [1-3].Further, the estimates of genetic parameters help in deciding the method of selection to predict response to selection and to choose breeding system for future improvement by increasing genetic gain. Variation in the range of genetic parameters for test-day milk yields have been observed by several workers [4-6].

Keeping in view of all these, the present study was planned to develop a base line information on non-genetic factors affecting FLTDYs and their genetic parameters.

Materials and Methods

Collection of data

Data on Mehsana buffaloes were collected from 257 records of first lactation during the period of 20 years (1993 to 2012) from Livestock Research Station (LRS), Sardarkrushinagar Dantiwada Agricultural University (SDAU), Sardarkrushinagar, Gujarat, India to study the effect of non-genetic factors (period and season of calving) on first lactation test-day yields (FLTDYs) and first lactation yield (FLY) records. Lactation recording begun from the fifth day of lactation and truncated at 275th day of lactation. Records of buffaloes with lactation yield of less than 900 liters and lactation length of 90 days and less were not considered in the analysis. Depending upon the calving of the animals, data were classified into four periods (each of five years duration) and 3 seasons (depending on climatic conditions).

Statistical methods

The following least square model was used for obtaining least square means of various FLTDYs and FLY [7]:

$$Y_{ijk} = \mu + A_i + B_j + e_{ijk}$$

Where, Y_{ijk} is the kth record of buffalo calved in ith period and jth season, μ is the population mean, A_i is the fixed effect of ith period where i = 1, 2, 3 and 4, B_j is the fixed effect of jth season where j = 1, 2 and 3, and e_{ijk} is the random error (NID, 0, σ^2). Duncan's modified multiple range test [8] was used for making all possible pair wise comparison of means.

Estimation of genetic parameters

After the adjustment of data, paternal half-sib correlation method [9] was used to estimate heritability for different traits (Only sires with five or more progenies were considered) whereas the standard error of heritability was also obtained by using the formula [10]. The genetic and phenotypic correlations were calculated from variance-covariance analysis and standard errors were also estimated [11].

Results

The least square model was used to obtain least squares means of various FLTDYs and FLY, which are given with their standard errors in [Table-1]. The highest FLTDY was observed in FLTDY$_4$ (7.31±0.13 liters) and lowest was observed in FLTDY$_1$ (3.09±0.11 liters). In general, FLTDY increased till FLTDY$_4$ with subsequent gradual decline till the end of lactation. The least squares mean for FLY was found to be 1708.62±32.50 liters.

Table-1 *Least Squares Means with their standard errors for various first lactation monthly test day yields and first lactation total milk yields in Mehsana buffaloes (in liters)*

Traits	FLY	FLTDY$_1$	FLTDY$_2$	FLTDY$_3$	FLTDY$_4$	FLTDY$_5$
μ	1708.62±32.50 (267)	3.09±0.11 (267)	6.13±0.12 (267)	6.99±0.14 (267)	7.31±0.13 (267)	7.23±0.31 (267)
Period	*	**	*	**	**	NS
1	1791.28±44.46^{a} (94)	4.16±0.15^{b} (94)	6.21±0.17^{a} (94)	6.73±0.19^{a} (94)	7.07±0.18^{a} (94)	6.74±0.43 (94)
2	1595.75±61.43^{b} (52)	2.73±0.21^{a} (52)	5.63±0.23^{b} (52)	6.33±0.26^{a} (52)	6.59±0.25^{a} (52)	7.64±0.59 (52)
3	1654.04±56.54^{b} (62)	2.78±0.19^{a} (62)	6.29±0.22^{a} (62)	7.40±0.24^{b} (62)	7.62±0.23^{b} (62)	7.21±0.55 (62)
4	1793.41±55.08^{a} (59)	2.68±0.19^{a} (59)	6.40±0.21^{a} (59)	7.51±0.23^{b} (59)	7.96±0.22^{b} (59)	7.34±0.53 (59)
Season	NS	**	*	NS	NS	NS
1	1743.17±56.44 (55)	3.33±0.19^{a} (55)	6.04±0.22^{ab} (55)	6.75±0.24 (55)	7.16±0.23 (55)	6.75±0.54 (55)
2	1740.83±71.64 (32)	3.23±0.24^{a} (32)	6.57±0.27^{a} (32)	7.34±0.30 (32)	7.56±0.29 (32)	7.48±0.69 (32)
3	1641.86±30.08 (180)	2.71±0.10^{b} (180)	5.78±0.11^{b} (180)	6.89±0.13 (180)	7.20±0.12 (180)	7.47±0.29 (180)

Figures within parentheses are the number of observations and coefficient of variation, ** = P≤0.01; * = P≤0.05; NS: Not significant
Superscripts may be read column wise for each effects for mean comparison. Similar superscript shows that the means do not differ significantly.

Table-1 Cont...

Traits	FLTDY$_6$	FLTDY$_7$	FLTDY$_8$	FLTDY$_9$	FLTDY$_{10}$
μ	6.80±0.12 (265)	6.07±0.12 (263)	5.56±0.13 (256)	4.67±0.15 (212)	3.77±0.18 (141)
Period	*	*	*	NS	**
1	6.59±0.16^{a} (93)	6.16±0.17^{ab} (93)	5.88±0.18^{a} (92)	5.04±0.19 (84)	4.42±0.22^{a} (63)
2	6.48±0.22^{a} (52)	5.77±0.24^{a} (50)	5.30±0.25^{c} (50)	4.75±0.30 (36)	3.65±0.38^{abc} (24)
3	6.99±0.21^{ab} (61)	5.86±0.21^{a} (62)	5.21±0.23^{c} (57)	4.27±0.28 (40)	3.03±0.41^{bc} (18)
4	7.14±0.20^{b} (59)	6.51±0.21^{b} (58)	5.85±0.22^{a} (57)	4.62±0.24 (52)	3.98±0.29^{ab} (36)
Season	NS	NS	NS	NS	NS
1	6.79±0.20 (55)	6.18±0.22 (53)	5.71±0.22 (54)	4.73±0.25 (49)	3.84±0.30 (35)
2	6.89±0.26 (31)	5.84±0.27 (32)	5.61±0.29 (30)	4.73±0.33 (25)	3.56±0.37 (23)
3	6.72±0.11 (179)	6.21±0.11 (78)	5.38±0.12 (172)	4.55±0.14 (138)	3.91±0.19 (83)

Figures within parentheses are the number of observations and coefficient of variation, ** = P≤0.01; * = P≤0.05; NS: Not significant
Superscripts may be read column wise for each effects for mean comparison. Similar superscript shows that the means do not differ significantly.

Table-2 *Genetic correlations among various first lactation monthly test-day yields*

TRAITS	TD5 (TD$_1$)	TD35 (TD$_2$)	TD65 (TD$_3$)	TD95 (TD$_4$)	TD125 (TD$_5$)	TD155 (TD$_6$)	TD185 (TD$_7$)	TD215 (TD$_8$)	TD245 (TD$_9$)	TD275 (TD$_{10}$)
TD5 (TD$_1$)	**0.85±0.32** (21, 8.70)**	0.66±0.19**	0.40±0.24	0.49±0.44	0.43±0.65	0.11±0.35	0.41±0.31	0.23±0.52	-0.28±0.31	0.52±0.33
TD35 (TD$_2$)	0.57±0.06**	**0.40±0.24 (21, 8.70)**	0.81±0.13**	0.85±0.21	0.24±0.98	0.44±0.38	0.44±0.39	-0.07±0.68	0.32±0.36	0.61±0.36
TD65 (TD$_3$)	0.40±0.07**	0.58±0.06**	**0.65±0.29* (21, 8.66)**	0.96±0.04**	0.80±0.31**	0.64±0.23**	0.12±0.38	0.31±0.53	0.74±0.15**	0.55±0.28*
TD95 (TD$_4$)	0.33±0.07**	0.48±0.06**	0.59±0.06**	**0.10±0.18 (21, 8.70)**	-0.99±0.04	>1.00	0.85±0.25**	0.61±0.62	0.75±0.18**	0.63±0.30*
TD125 (TD$_5$)	0.01±0.07	0.09±0.07	0.19±0.07*	0.22±0.07*	**0.05±0.17 (21, 8.70)**	0.85±0.31**	-0.86±0.37	<-1.00	0.99±0.01**	>1.00
TD155 (TD$_6$)	0.09±0.07	0.26±0.07**	0.32±0.07**	0.47±0.07**	0.04±0.07	**0.35±0.24 (21, 8.66)**	0.67±0.27*	>1.00	>1.00	0.99±0.01**
TD185 (TD$_7$)	0.13±0.07	0.29±0.07**	0.33±0.07**	0.43±0.07**	0.06±0.07	0.61±0.06**	**0.33±0.23 (21, 8.51)**	>1.00	0.57±0.27*	0.81±0.18**
TD215 (TD$_8$)	0.07±0.07	0.22±0.07*	0.16±0.07	0.29±0.07**	0.01±0.08	0.39±0.07**	0.62±0.06**	**0.12±0.19 (21, 8.37)**	0.79±0.18**	0.90±0.11**
TD245 (TD$_9$)	-0.03±0.08	0.18±0.09	0.24±0.08*	0.36±0.08**	0.32±0.08**	0.50±0.08**	0.48±0.08**	0.58±0.07**	**0.53±0.33 (18, 7.14)**	0.80±0.17**
TD275 (TD$_{10}$)	0.18±0.14	0.29±0.13**	0.19±0.14*	0.20±0.13*	0.38±0.13**	0.39±0.13**	0.46±0.12**	0.60±0.11**	0.62±0.11**	**0.79±0.59 (7, 7.67)**

Figures in parentheses indicate the number of sires and K-values, respectively; ** significant at 1% level (P≤0.01); * significant at 5% level (P≤0.05); NE: non estimable; NS: not significant; above diagonal = genetic correlations; below diagonal = phenotypic correlations; diagonal = heritability estimates

Effect of non-genetic factors

Period had significant (P≤0.05) to highly significant (P≤0.01) effects on all FLTDYs and FLY except FLTDY$_5$ and FLTDY$_9$. Further, non-significant effect of season of calving was observed for FLY and all FLTDYs except for FLTDY$_1$ and

$FLTDY_2$ [Table-1].

Genetic parameters

The heritability (h^2) estimates of FLTDYs along with genetic and phenotypic correlations are presented in [Table-2] whereas genetic and phenotypic correlations among FLY and various FLTDYs are presented in [Table-3]. The h^2 estimates of FLTDYs ranged from 0.05±0.17 for $FLTDY_5$ to 0.85±0.32 for $FLTDY_1$. Further, $FLTDY_2$, $FLTDY_6$ and $FLTDY_7$ had moderate estimates of heritability, which were all significantly different from zero. Moreover, moderate heritability estimate (0.42±0.05) for FLY was observed in the present study. The genetic correlations of FLY with $FLTDY_2$, $FLTDY_3$, $FLTDY_9$ and $FLTDY_{10}$ were highly significant ($P \le 0.01$). Further, the phenotypic correlations of FLY with all FLTDYs were highly significant ($P \le 0.01$) except with $FLTDY_5$. The estimates of both genetic and phenotypic correlations were estimated to be in the range of 0.26 to 0.98 and 0.08 to 0.69, respectively [Table-3].

Table-3 *Genetic correlations between various first lactation monthly test-day yields and first lactation yield*

Traits	Genetic correlations(r_g)	Phenotypic correlations (r_p)
$FLTDY_1$ and LY	0.26±0.31	0.26±0.08**
$FLTDY_2$ and LY	0.68±0.23**	0.35±0.07**
$FLTDY_3$ and LY	0.63±0.22**	0.31±0.07**
$FLTDY_4$ and LY	NE	0.50±0.06**
$FLTDY_5$ and LY	0.38±0.87	0.08±0.07
$FLTDY_6$ and LY	NE	0.57±0.06**
$FLTDY_7$ and LY	0.32±0.43	0.56±0.06**
$FLTDY_8$ and LY	0.41±0.60	0.59±0.06**
$FLTDY_9$ and LY	0.98±0.02**	0.63±0.07**
$FLTDY_{10}$ and LY	0.83±0.15**	0.69±0.09**

** significant at 1% level ($P \le 0.01$); * significant at 5% level ($P \le 0.05$); NE: non estimable

Discussion

Higher FLY in Murrah buffaloes were reported than that observed in the present study [12-14]. In corroboration to our study, significant effect of period of calving was observed on the first lactation monthly test-day yield in Murrah buffaloes [1, 12, 15]. Similar significant effects were also reported on FLY and all weekly FLTDYs in Murrah buffaloes [14]. However, no significant differences between various FLTDYs were observed due to the effect of period [13], which was not in line with the present finding. These differences observed in the present study during different periods might be due to many factors i.e. climatic, managemental, age and location differences as well as herd size differences during these periods. Higher $FLTDY_1$, $FLTDY_8$, $FLTDY_9$ and $FLTDY_{10}$ during first period and lower $FLTDY_2$, $FLTDY_3$, $FLTDY_4$, $FLTDY_6$ and $FLTDY_7$ during second period might be due to lower and higher environmental temperature recorded during these periods, respectively. Further, $FLTDY_1$ and $FLTDY_8$ were higher during winter season owing to lower temperature and humidity during this season.

Similar to the present findings, non-significant effects of season of calving on first lactation monthly test-day yield and FLY were observed in Murrah buffaloes [13, 16]. Though, Significant effect of season on first lactation monthly test-day yields was observed [15]. However, non-significant effect of season on FLTDYs in Murrah buffaloes was reported in field conditions [3].

Low to high heritability estimates for various first lactation monthly test-day yields were observed in the present study. However, low to moderate (0.13 to 0.38) heritability estimates for various first lactation recorded at fortnightly test-day yields were obtained in Surti buffaloes [6]. The present finding of moderate heritability estimates for FLY was in line with findings of some workers in Murrah buffaloes [1, 17]. The very low h^2 of some FLTDYs might be attributed to varying number of progeny under different sires available for the present study as well as pronounced environmental fluctuations. The high h^2 of some FLTDYs might be explained to some extent through small variation within the group of daughters of the sire and great variability between the sires.

The genetic correlations between various FLTDYs varied from very low to high in the present study. Moderate to high genetic correlations between various first lactation monthly test-day yields were reported in Murrah buffaloes, which were not in line with the present finding [4]. Moreover, the magnitude of genetic and phenotypic correlations between FLY and FLTDYs in this study were moderate to high and low to high, respectively. However, low to high genetic correlations and low to high but negative estimates of phenotypic correlations were observed between 305-day LY and FLTDYs in Murrah buffaloes [16].

Conclusion

Moderately high estimate of heritability of FLY in present study implies scope for further improvement through proper selection. It also indicates that direct selection of sires and dams based on their daughter's performance or own performance would be effective in bringing genetic improvement in these traits. The high genetic correlation between some first lactation test day yields and lactation yield suggest that the estimation of lactation yield based on first lactation test day yields would offer a solution to handle complex situations like lack of the infrastructural facilities, cost, time and accuracy in recording daily milk production especially under field conditions.

Conflict of Interest: None declared

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