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First lactation production and reproduction performance of Phule Triveni cattle in hot arid region of Maharashtra

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ABSTRACT

The present investigation was carried out to study the effects of genetic and non-genetic factors on first lactation production and reproduction traits of 493 Phule Triveni cattle sired by 55 bulls during 1976–2012 maintained at Research-Cum Development Project on Cattle, Mahatma Phule Krishi Vidyapeeth Rahuri, District Ahmadnagar, Maharashtra, India. The average FLTMY was 2855.40±42.67 kg with an average FLL 331.03±3.01 days and the FL300DMY was found to be 2646.77±39.30 kg. The average AFC, FCI, FSP and FDP was 985.41±1.93, 430.32±4.01, 151.07±5.10 and 93.45±2.84 days, respectively. The effect of season of calving was found to be non-significant on all production and reproduction traits except FL300DMY which was affected significantly. However, the effect of period of calving was found to be highly significant on all production and reproduction traits except FSP on which effect was found to be significant. The effect of the sire was found to be significant on FL300DMY, FDP and AFC. The heritability (h^2) estimates for production and reproduction traits were found to be moderate to high. The highly significant genetic and phenotypic correlation was found between production and reproduction traits. The present investigation revealed that FLTMY, FL300DMY and AFC could be improved through selection and can be used for further improvement programmes.

Key words: First lactation traits, Genetic parameters, LSML, Phule Triveni cattle

Over the last 40–50 years, attempts have been made to synthesize new crossbred strains of cattle in India by crossing indigenous cattle breeds with temperate exotic cattle breeds. These attempts were intensified only after 1970 when the Indian Council of Agricultural Research (ICAR) focused on it and establish major project on crossbreeding of indigenous cattle (AICRP), development of Phule Triveni cattle (Holstein Friseian 50% + 25% Jersey + 25% Gir) was one of the outcome from all these efforts towards the augmenting the country's milk production. The extent of genetic variation existing in herd helps in deciding appropriate selection and mating procedure. The estimates of phenotypic and genetic parameters are required to evaluate the variation in performance with respect to genetic and non-genetic factors, so that genetically determined variation can be utilized for improvement of traits and to investigate any association that exist between traits. Present study, therefore, was aimed to evaluate first lactation traits and estimates their genetic parameters in closed herd of Phule Triveni cattle.

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MATERIALS AND METHODS

The investigation was carried out on first lactation records of 493 Phule Triveni cows sired by 55 bulls developed at the Mahatma Phule Krishi Vidyapeeth, Rahuri District, Ahmadnagar, (Maharashtra, India) born during 1974 to 2009 and calved during 1976 to 2012. First lactation data with lactation length less than 150 days/incomplete or abnormal records were excluded from the analysis. Various first lactation traits were considered for the study which were first lactation 300 day or less milk yield (FL300DMY), first lactation total milk yield (FLTMY), first lactation length (FLL), first dry period (FDP), age at first calving (AFC), first service period (FSP) and first calving interval (FCI).

Depending upon the varying climate conditions of the region, each year was divided into 3 groups of seasons, viz. winter (October – January); summer (February – May) and rainy (June – September). The entire period (calving and birth) were classified into 7 periods by cumulative square method and also the data were classified into 5 different groups according to the age at first calving (Sturges 1926). For accurate estimation of genetic variation present in traits as well as to account for the effects of non-genetic

factors, both the genetic and non-genetic factors were considered simultaneously.

Statistical analysis: The Mixed model analysis using Least Squares Maximum Likelihood (LSML) Program (Harvey 1990) was used for determining the influence of genetic and non-genetic factors on first lactation production and reproduction traits and estimation of genetic parameters simultaneously. The model incorporated seasons, periods, age at first calving as fixed effects and sires as random effect.

The statistical significance of various fixed effects in the least squares model was determined by 'F' test. For significant effects, the differences between pairs of levels of effects were tested by Duncan's multiple range test as modified by Kramer (1957). The heritability, genetic and phenotypic correlations were obtained from the above LSML software.

RESULTS AND DISCUSSION

The overall least-squares means and coefficient of variation of productive and reproductive traits are presented in Table 1.

Effect of season of calving/birth on first lactation production and reproduction traits

The FL300DMY was significantly affected by season of calving. Winter calvers produced significantly higher milk than rainy and summer calvers (Table 1). The significant effect of season of calving on FL300DMY was reported by Pol *et al*. (2013) in Phule Triveni cow. The cool season of calving seemed to be significantly better than other seasons for milk production. FLTMY, FLL and FDP were not influenced by season of calving. This corroborates with those reported by Chavan (2010) in HF × Gir crossbreds and Pol (2011) in Phule Triveni cow. The effect of season of calving/birth was found to be non-significant on first lactation reproduction traits (FSP, FCI and AFC) in the present study.

Effect of period of calving/birth on first lactation production and reproduction traits

Period of calving have a highly significant (P≤0.01) effect on all the production traits viz. FLTMY, FL300DMY, FLL and FDP. Higher estimates for FLTMY were found in

Table 1. Least squares means along with their standard errors for non-genetic factors affecting first lactation milk production and reproduction traits

Factor	N	FLTMY (kg)	FL300DMY (kg)	FLL (days)	FDP (days)	FSP (days)	FCI (days)	AFC (days)
Overall (μ)	493	2855 ± 43	2647 ± 39	331 ± 3	93 ± 3	151 ± 5	430 ± 4	985 ± 2
CV (%)	493	29.54	26.53	17.97	56.34	55.61	17.91	17.34
Seasons of Calving/Birth								
SEASON-1 (Winter)	170	2899 ± 37	2707 ± 56^{a}	331 ± 5	94 ± 4	149 ± 7	423 ± 7	984 ± 2
SEASON-2 (Summer)	159	2801 ± 70	2553 ± 58^{c}	338 ± 5	88 ± 4	143 ± 8	425 ± 7	984 ± 3
SEASON-3 (Rainy)	164	2866 ± 68	2681 ± 57^{b}	324 ± 5	99 ± 4	142 ± 8	436 ± 7	988 ± 3
Periods of Calving/Birth								
PERIOD-1 (≤1980)	56	3020 ± 411^{ab}	2809 ± 320^{b}	346 ± 31^{a}	57 ± 24^{e}	123 ± 42^{c}	403 ± 41^{c}	972 ± 22^{c}
PERIOD-2 (1981-1983)	81	2381 ± 336^{d}	2246 ± 262^{c}	338 ± 26^{a}	57 ± 20^{e}	115 ± 35^{c}	395 ± 34^{c}	974 ± 18^{c}
PERIOD-3 (1984-1988)	106	3287 ± 286^{a}	2928 ± 224^{b}	360 ± 22^{a}	50 ± 17^{e}	130 ± 30^{c}	410 ± 29^{c}	954 ± 15^{d}
PERIOD-4 (1989-1993)	83	2801 ± 241^{bc}	2477 ± 189^{c}	339 ± 18^{a}	77 ± 14^{d}	142 ± 25^{c}	415 ± 24^{c}	956 ± 12^{d}
PERIOD-5 (1994-1998)	63	2707 ± 267^{c}	2394 ± 208^{c}	357 ± 20^{a}	96 ± 16^{c}	171 ± 28^{ab}	451 ± 27^{ab}	981 ± 14^{c}
PERIOD-6 (1999-2004)	56	2550 ± 343^{cd}	2478 ± 267^{c}	302 ± 26^{b}	123 ± 20^{b}	146 ± 35^{bc}	425 ± 34^{bc}	998 ± 18^{b}
PERIOD-7 (≥2005)	48	3243 ± 463^{a}	3195 ± 315^{a}	275 ± 31^{c}	194 ± 24^{a}	189 ± 42^{a}	469 ± 40^{a}	1063 ± 21^{a}
Age Groups								
AGE-1 (≤803 days)	106	2839 ± 91	2650 ± 74^{b}	323 ± 7^{ab}	94 ± 6	134 ± 10	419 ± 9	
AGE-2 (804-901days)	119	2800 ± 81	2562 ± 67^{c}	331 ± 6^{ab}	94 ± 5	143 ± 9	422 ± 8	
AGE-3 (902-1011days)	117	2917 ± 82	2661 ± 67^{ab}	342 ± 6^{a}	97 ± 5	155 ± 9	436 ± 8	
AGE-4 (1012-1147days)	83	2818 ± 94	2646 ± 76^{b}	318 ± 7^{b}	98 ± 6	148 ± 10	416 ± 9	
AGE-5 (≥1148 days)	68	2904 ± 112	2714 ± 90^{a}	342 ± 8^{a}	89 ± 7	148 ± 12	434 ± 11	

Table 2. Estimates of heritability, genetic and phenotypic correlations among first lactation production and reproduction traits

Trait	FLTMY	FL300DMY	FLL	AFC	FCI	FSP	FDP
FLTMY	**0.35 ± 0.16**	0.97 ± 0.04**	-0.19 ± 0.71	0.25 ± 0.67	-0.21 ± 0.45	-0.41 ± 0.90	0.33 ± 0.68
FL300DMY	0.90 ± 0.01**	**0.32 ± 0.15**	-0.44 ± 0.72	-0.85 ± 0.41*	-0.31 ± 0.66	-0.71 ± 0.99	0.16 ± 0.36
FLL	0.49 ± 0.02**	0.22 ± 0.10**	**0.07 ± 0.11**	0.93 ± 0.36**	0.67 ± 0.49	0.65 ± 0.89	0.30 ± 0.88
AFC	0.11 ± 0.12	-0.06 ± 0.39	0.03 ± 0. 41	**0.48 ± 0.19**	-0.24 ± 0.42	-0.37 ± 0.44	0.09 ± 0.32
FCI	0.35 ± 0.02**	0.18 ± 0.09*	0.54 ± 0.16**	0.04 ± 0.37	**0.28 ± 0.17**	0.91 ± 0.43*	0.77 ± 0.47
FSP	0.24 ± 0.02**	0.13 ± 0.03*	0.33 ± 0.11*	0.03 ± 0.25	0.81 ± 0. 25**	**0.25 ± 0.17**	0.84 ± 0.19
FDP	-0.02 ± 0.02	-0.01 ± 0.23	-0.13 ± 0.08	0.11 ± 0.09*	0.59 ± 0. 19**	0.60 ± 0.22**	**0.22 ± 0.13**

Figures along the diagonal in bold scripts are heritability estimates. The values above and below diagonal are genetic and phenotypic correlations, respectively. * P≤ 0.05 and ** P≤ 0.01 level of significance.

third and seventh period of calving than other periods (Table 1). FL300DMY were found higher in seventh and third period and the FLL was found highest in third and fifth period of calving, whereas, higher estimates for FDP were found in seventh and sixth period of calving compared to other periods. Similar results were reported by Garudkar (2011), Shelke (2012) and Pol *et al.* (2013) in Phule Triveni cows. Reproduction traits were also significantly affected by period of calving/birth. The better performance of FSP and FCI were observed in second period due to better managemental conditions, whereas, higher estimates for FSP and FCI were found in seventh period of calving group. Statistically good AFC estimate was found in third period of birth group and highest AFC was observed in seventh period of birth group. Similar results were reported by Zol *et al.* (2009) in Phule Triveni cows.

Effect of sire on first lactation production and reproduction traits

Effect of sire on FL300DMY was found to be significant (P < 0.05). Pol *et al.* (2013), however, reported nonsignificant effect of sire on FL300DMY in Phule Triveni cows which was contrary to present study. The sire had significant (P < 0.05) effect on FDP and AFC. The significant effect of sire on AFC was also reported by Nehra (2011) and Divya (2012) in Karan Fries cattle at ICAR-NDRI farm. The non-significant effect of sire was also found on FLTMY, FLL, FSP and FCI.

Effect of age at first calving on first lactation production and reproduction traits

Effect of AFC groups was found to be significant (P < 0.05) on FL300DMY and FLL, whereas, non-significant effect of AFC groups were found on FLTMY, FDP, FSP, FCI and AFC. The FL300DMY was significantly affected by AFC but non-significant effect was observed on FLTMY, this could be due to higher variation in the research data. Nikam (2010) in Phule Triveni cows reported significant effect (P < 0.05) of AFC on FLTMY, contrary to the present study. Divya (2012) reported nonsignificant effect of AFC on FSP in Karan Fries cattle. Non-significant effect of AFC on FCI was reported by Nehra (2011) in Karan Fries cattle which collaborated with present study.

Heritability estimates of production and reproduction traits

The heritability (h^2) estimates of FLTMY, FL300DMY, AFC, FCI, FSP and FDP were moderate to high (Table 2), which indicates that these traits were more influenced by additive genetic variability and could be improved by selection and improved management. The high magnitude of h^2 of AFC in Phule Triveni herd indicates that selection based on AFC would result in higher genetic gain than for FLTMY/FL300DMY (Table 2). The FLTMY and FL300DMY are also a good choice for making selection index, as both traits have higher h^2 than other traits. Moderate h^2 of FCI, FSP and FDP indicates that for these traits both management and selection are important. The h^2 estimate of FLL in Phule Triveni cow was low and associated with high standard error, indicating that performance of this trait could be enhanced by improving management and environmental factors (Table 2). The present results were in agreement with the findings reported by Nehra (2011) and Shelke (2012).

Genetic and phenotypic correlations of milk production and reproduction traits

The genetic (rg) and the phenotypic (rp) correlations of first lactation production and reproduction traits using LSML are presented in Table 2.

The genetic and phenotypic correlations between FLTMY and FL300DMY was 0.97±0.04 and 0.90±0.01, between FLTMY and FLL was –0.19±0.71 and 0.49±0.02, between FLTMY and FDP was 0.33±0.68 and –0.02±0.02, between FLTMY and AFC was 0.25±0.67 and 0.11 ±0.12, between FLTMY and FCI was –0.21±0.45 and 0.35±0.02 and between FLTMY and FSP was –0.41±0.90 and 0.24±0.02. The standard errors of genetic correlations were quite high between different traits except between FLTMY and FL300DMY. Positively significant rp of FLTMY with AFC, FSP and FCI indicated that increase in first lactation total milk yield also tend to increase service period and calving interval. However, at genetic scale (rg), its association with FDP, FSP and FCI was negative and desirable indicating that cows producing more milk tended to have shorter dry period, service period and calving interval. The results of the present study were in conformity to the findings of Nikam (2010) and Pol *et al.* (2013).

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