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Effect of genetic and non-genetic factors on first lactation reproduction and production traits in Phule Triveni cattle

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Abstract

The present investigation was carried out with the objective of performance appraisal of Phule Triveni cattle with respect to reproduction and production traits. The performance records of 324 Phule Triveni cattle sired by 44 bulls were collected for reproduction and production traits spread over a period of 43 years (1975-2017) from Research Cum Development Project on Cattle, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra State). The overall least squares means for age at first calving (AFC), first service period (FSP), first dry period (FDP), first calving interval (FCI) and first lactation 300 days milk yield (FL300DMY) were 956.00 ± 11.37 days, 134.32 ± 5.12 days, 84.91 ± 3.89 days, 421.63 ± 5.65 days and 2410.61 ± 55.87 kg, respectively in Phule Triveni cattle. Further, the least square analysis revealed on non-significant effect of season of calving. The effect of period of calving was found to be highly significant on AFC, FSP, FL300DMY, FDP and FCI. However, the sire was found to be significant ($P < 0.05$) effect on FSP, FCI, FL300DMY and FDP. The heritability of all traits was moderate in magnitude which indicated these traits are more influenced by selection. The highly significant genetic and phenotypic correlation was found between production and reproduction traits.

Keywords: Phule Triveni cattle, genetic parameter, first lactation traits

Introduction

India is predominantly an agricultural country with nearly two third of its population being involved in agriculture and rearing of livestock. Livestock is part and parcel of agricultural system. In dairy cattle milk production is the most important economic trait. Low milk production in India is probably due to low genetic potential of animals for milk production, poor nutrition, farm management, unfavourable agro climatic conditions, poor veterinary and extension services (Dhara, *et al.*, 2006) [5]. The success of dairy industry is much dependent on level of reproduction and production performance of animals. Information on first lactation traits enables the breeder to predict the later lactation performance of animals as it is highly correlated with the future performance traits (Jairath, *et al.*, 1995) [8]. Economic traits are generally controlled by genetic factors. These environmental factors may suppress the animal's true genetic ability and create a bias in the selection of animals.

Heritability is required to calculate genetic evaluations to predict response to selection and to help producers decide if it is more efficient to improve traits through management or through selection. Therefore, present study was aimed to evaluate first lactation traits and estimates their genetic parameters in Phule Triveni cattle.

Material and Methods

The data for present investigation were collected for a period of 43 years (1975 to 2017) from history sheet of 43 years of Phule Triveni cows born from 44 sires maintained at Research Cum Development Project on Cattle, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra State). Only the sires having records at least 3 daughters were included in the present study. First lactation milk yield less than 1000 kg was not considered for the present investigation. The total duration of the present study was divided into 6 periods. Each year divided into three namely Rainy (S₁), Winter (S₂), and Summer (S₃) seasons various first lactation traits considered for the study which are age of first calving (AFC), first service period (FSP), first dry period (FDP), first calving interval (FCI) and first lactation 300 days milk yield (FL300DMY). For accurate estimation of genetic variation in present traits as well as to account for the effect of non-genetic factors, both the genetic and non-genetic factors were considered.

Statistical analysis

The mixed model analysis using least squares maximum likelihood (LSML) programme (Harvey, 1990) [17] was used for determining the influence of genetic and non-genetic factors on first lactation reproduction and production traits and estimation of genetic parameters, simultaneously. The model incorporated seasons, period's, age at first calving as

fixed effects and sires as random effects. The statistical significance of various fixed effects in the least squares model was determined by F test for significant effects the difference between pairs of levels of effects were tested by Duncan's multiple range test as modified by Kramer (1957) [9]. The heritability, genetic and phenotypic correlations were obtained from the above LSML software.

Table 1: Analysis of variance of various first lactation reproduction and production traits as affected by genetic and non-genetic factors in phule triveni cattle

Source of variation	AFC	FSP	FL300DMY	FDP	FCI
Period of birth for AFC/Period of calving	166457.52**	10302.02**	5913899.81**	8189.63**	12404.85**
Season of birth for AFC/Season of calving	38068.95	1220.91	305908.91	1950.01	6231.36
Age at first calving group	—	19949.21**	163811.42	1062.27	8354.19
Sire	18679.17	4806.85*	1529838.46**	3190.65*	7090.39**
Error	15440.13	3117.12	371241.20	1800.30	3805.81

** $P < 0.01$

Table 2: Least squares means of age at first calving as affected by various factors in phule triveni cattle

Source of variation	N	Mean + S.E.
Overall mean (μ)	324	956.00 \pm 11.37
Periods of birth		
P ₁ (1975-1981)	141	858.20 \pm 10.50 ^c
P ₂ (1982-1988)	89	916.33 \pm 13.17 ^{bc}
P ₃ (1989-1995)	60	929.17 \pm 16.10 ^{bc}
P ₄ (1996-2002)	12	1030.51 \pm 35.89 ^{ab}
P ₅ (2003-2009)	11	936.95 \pm 37.47 ^{bc}
P ₆ (2010-2016)	11	1064.86 \pm 37.47 ^a
Season of birth		
S ₁ : Rainy	98	938.14 \pm 15.24
S ₂ : Winter	122	975.35 \pm 14.37
S ₃ : Summer	104	954.52 \pm 15.45

Means under each class in the same column with different super scripts differ significantly

Table 3: Least squares means of first lactation reproduction and production traits in phule triveni cattle

Source of variation	N	FSP (Days)	FCI (Days)	FDP (Days)	FL300DMY (kg)
		Mean \pm S.E.	Mean \pm S.E.	Mean \pm S.E.	Mean \pm S.E.
Overall mean (μ)	324	134.32 \pm 5.12	421.63 \pm 5.65	84.91 \pm 3.89	2410.61 \pm 55.87
Periods of calving					
P ₁ (1977-1983)	130	124.75 \pm 5.79 ^b	408.78 \pm 6.39 ^b	78.46 \pm 4.40 ^b	2768.28 \pm 63.18 ^a
P ₂ (1984-1990)	96	132.32 \pm 5.80 ^b	405.88 \pm 6.40 ^b	65.44 \pm 4.40 ^b	2893.39 \pm 63.29 ^a
P ₃ (1991-1997)	64	124.69 \pm 7.02 ^b	420.67 \pm 7.76 ^b	75.93 \pm 5.33 ^b	2163.17 \pm 76.65 ^{bc}
P ₄ (1998-2004)	12	119.46 \pm 16.34 ^b	387.87 \pm 18.05 ^b	82.92 \pm 12.42 ^b	2174.94 \pm 178.34 ^{bc}
P ₅ (2005-2011)	10	113.64 \pm 17.82 ^b	434.90 \pm 19.69 ^{ab}	81.35 \pm 13.54 ^b	2541.15 \pm 194.54 ^{ab}
P ₆ (2012 -2017)	12	161.25 \pm 16.31 ^a	451.68 \pm 18.02 ^a	105.36 \pm 12.39 ^a	1922.15 \pm 178.01 ^c
Season of birth					
S ₁ (Rainy)	107	133.59 \pm 7.01	418.00 \pm 7.75	81.92 \pm 5.33	2454.96 \pm 76.59
S ₂ (Winter)	114	131.35 \pm 6.68	416.36 \pm 7.38	82.88 \pm 5.07	2352.01 \pm 72.90
S ₃ (Summer)	103	138.02 \pm 6.64	430.53 \pm 7.34	89.93 \pm 5.04	2424.87 \pm 72.49
Age group					
A ₁ (<900 days)	179	130.29 \pm 6.69 ^b	420.43 \pm 7.39	85.84 \pm 5.08	2367.62 \pm 73.04
A ₂ (901-1000 days)	73	152.69 \pm 7.44 ^a	433.17 \pm 8.22	88.33 \pm 5.66	2449.49 \pm 81.27
A ₃ (1001 days and above)	72	119.98 \pm 7.48 ^b	411.29 \pm 8.26	80.56 \pm 5.68	2414.73 \pm 81.63

Means under each class in the same column with different super scripts differ significantly

Table 4: Estimates of heritability, phenotypic and genetic correlations among first lactation reproduction and production traits in phule triveni cattle

Traits	AFC	FSP	FL300DMY	FDP	FCI
AFC	0.34 \pm 0.14	0.04 \pm 0.05	-0.55 \pm 0.05**	0.05 \pm 0.06	0.23 \pm 0.05**
FSP	0.05 \pm 0.05	0.24 \pm 0.17	0.07 \pm 0.06	0.44 \pm 0.05**	0.55 \pm 0.05**
FL300DMY	-0.10 \pm 0.06	-0.03 \pm 0.06	0.66 \pm 0.05	-0.14 \pm 0.06*	-0.06 \pm 0.06
FDP	0.03 \pm 0.06	0.37 \pm 0.05**	-0.14 \pm 0.06*	0.17 \pm 0.16	0.66 \pm 0.04**
FCI	0.01 \pm 0.06	0.43 \pm 0.05**	-0.30 \pm 0.05**	0.94 \pm 0.02**	0.19 \pm 0.16

Estimates above the diagonal are the genetic correlations and below diagonal are phenotypic correlations. The diagonal values are the estimates of heritability * $P < 0.05$ and ** $P < 0.01$

Results and Discussion

The overall least squares means of AFC, FSP, FDP, FCI, and FL300DMY were 956.00 ± 11.37 , 134.32 ± 5.12 , 84.91 ± 3.89 , 421.63 ± 5.65 days and 2410.61 ± 55.87 kg respectively (Table 2 and Table 3).

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

Period of birth/calving had a significant influence on age at first calving, first lactation 300 days milk yield (FL300DMY), first service period (FSP), first dry period (FDP) and first calving interval (FCI) (Table 1). The lowest AFC lowest AFC were found in period first (Table 2). Higher estimates of for FL300 day's milk yield were found in period second (Table 2). The present results were in accordance with the reports of Bhoite (1996) [3] reported in FJG, JFG and BFG triple crosses. Reproduction traits were significantly affected by period of calving. These significant finding were in accordance with Saha (2001) [13], Singh and Gurani (2004) [1, 2, 14-16] in KF cattle, Rathi (2015) in Frieswal and Ambhore (2017) [2, 10, 12] in Phule Triveni.

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

The influence of season of calving was found to be non-significant on all production and reproduction traits of first lactation in Phule Triveni cows. The non-significant effect of season of calving on first lactation traits was also reported by many workers (Rashid, 2010; Nehra, 2011 and Divya, 2012) [6, 11] in KF cattle. Contradictory to the present study significant effect of season of calving of FL300DMY has been documented by Mukhrjee (2005) and Rathee (2015) [12] in frieswal.

Effect of sire on first lactation reproduction and production traits

The sire had significant ($P < 0.05$) effect on FSP, FDP, FCI, FL300DMY and while non-significant in AFC. Similar results were reported by Akhtar *et al.*, (2003) [1] in 5/8 HF x 3/8 SW cattle, Singh *et al.*, (2004) [1, 2, 14-16] in frieswal and Divya (2012) [6, 11] in Karan fries cattle.

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

The non-significant effects of AFC groups were found on all first lactation reproduction and production traits (Except FSP). This finding was similar to the results reported by Singh (1995) [1, 2, 14-16], Divya (2012) [6, 11] and Singh (2013) [1, 2, 14-16] in Karan fries cattle. Whereas, the significant effect of age of groups on FL300 DMY were reported by Ambhore (2017) [2] in Phule Triveni cattle.

Heritability estimates of reproduction and production traits

The heritability of AFC and FL300DMY were moderate. This indicates that these traits were more influenced by additive genetic variability and could be improved by selection and improved management. Whereas, the heritability (h^2) of FDP, FSP and FCI were very low and associated with high slandered error indicating that performance of this traits could be enhanced by improving management and environments factors. The higher heritability of AFC and FL300DMY in Phule Triveni cattle indicates that selections based on these two traits are more desirable than other traits. The present results were in agreement with the finding reported by

Mukhujee (2005) in Frieswal cattle, Nehra (2011) and Dash (2004) [11] in KF cattle and Ambhore (2017) [2] in Phule Triveni cattle.

Phenotypic and genetic correlations among reproduction and milk production traits

The genetic (r_g) and phenotypic (r_p) correlation of first lactation production and reproduction traits are presented in Table 4. In Phule Triveni, genetic correlation of FL300DMY with FDP and AFC were negative (-0.14 ± 0.06 and -0.55 ± 0.05) and significant. However, the genetic correlation of FSP and FCI with FL300DMY were positive and non-significant (0.07 ± 0.06 and -0.06 ± 0.06), respectively. In Phule Triveni, phenotypic correlation of FL300DMY with FDP and FCI were negative (-0.14 ± 0.06 and -0.30 ± 0.05) and significant. However, the phenotypic correlation of FL300DMY with AFC and FSP were negative and non-significant (-0.10 ± 0.06 and -0.03 ± 0.06). Similar to the present findings, Mukherjee (2005) and Nehra (2011) [11] also reported higher genetic and phenotypic correlation.

Conclusion

The average least squares means of first lactation were AFC 956.00 ± 11.37 days, FSP 134.32 ± 5.12 days, FDP 84.91 ± 3.89 days, FCI 421.63 ± 5.65 days and FL300DMY 2410.61 ± 55 kg in Phule Triveni cattle.

In Phule Triveni cattle positive and significant correlations were noticed among most of the traits under study. However, negative genetic and phenotypic association between AFC and FL300DMY indicated that selection of animal on the basis of for AFC can improve the FL300DMY in Phule Triveni cattle. The high magnitude of heritability was noticed for FL300DMY in Phule Triveni. However, it was low to medium for the AFC, FSP, FDP and FCI. The heritability estimates of AFC, FSP, FDP, FCI and FL300DMY were 0.34 ± 0.14 , 0.24 ± 0.17 , 0.17 ± 0.16 , 0.19 ± 0.16 and 0.66 ± 0.05 respectively. The heritability of all traits except FDP from mixed model using LSML was moderate in magnitude which indicated that trait are more influenced by additive genetic variability and hence there is more scope for improvement by selection. The low heritability of estimates of FDP trait indicated that it's influenced more by managerial and environmental factors than by genetic factors.

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