The Pharma Innovation Journal 2023; SP-12(6): 445-450

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(6): 445-450

www.thepharmajournal.com
Received: 01-04-2023
Accepted: 02-05-2023

Dr. Tadavi Faruk Rubab
Subject Matter Specialist, Department of Animal Husbandry, KVK, Badnapur, Maharashtra, India

Dr. Dilip K Deokar
Associate Professor, Department of Animal Husbandry and Dairy science, MPKV Rahuri, Maharashtra, India

Pranjali Bhanudas Meshram
Ph.D. Scholar, Department of Animal Husbandry and Dairy Science, MPKV Rahuri, Maharashtra, India

Dr. Ulhas S Gaikwad
Assistant Professor, Department of Animal Husbandry and Dairy science College of Agriculture, Pune, Maharashtra, India

Corresponding Author:
Dr. Tadavi Faruk Rubab
Subject Matter Specialist, Department of Animal Husbandry, KVK, Badnapur, Maharashtra, India

Phule Triveni sires: Genetic evaluation by using Multitrait models

Dr. Tadavi Faruk Rubab, Dr. Dilip K Deokar, Pranjali Bhanudas Meshram and Dr. Ulhas S Gaikwad

Abstract
The performance recorded of 566 Triple cross (Phule Triveni) daughters of 53 sires maintained during the year 1972 to 2013 at Research Cum-Development Project on Cattle, Mahatma Phule Krishi Vidyapeeth, Rahuri were used to evaluate sires for first lactation and life time traits and to compare the effectiveness of multiple trait animal models over single trait models. The average least squares mean of first lactation were FL300DMY 2377.17±36.51 kg, FLPMY 11.55±0.65 kg, FLL 316.19±2.43 days, FCI 366.27±3.67 days, CAFS 105.69±5.79 days, IFLS 52.18±1.90 days and CACO 105.69±5.79 days. The effect period of calving had significant effect on FL300DMY, FLPMY, FLL and IFLS and non-significant effect on FCI, CAFS and CACO. Season of calving and age at first calving group had non-significant effect on all first lactation production and reproduction traits. The sire had significant effect on FL300DMY, FLPMY, FLL and CAFS and non-significant effect on FCI, IFLS, and CACO.

Keywords: Genetic correlation, heritability, fertility, multi-traits

Introduction
Impaired fertility in dairy cows is a major cause of involuntary culling in many countries. Dairy cow fertility is important both economically and ethically. To support future profitability in production system that penalise poor fertility, routine national sire or cow evaluation for fertility must be calculated and subsequently incorporated into multi-trait national profit index. This will enable farmers to select the best animal based on combination of production and fertility.
The purpose of any breeding programme in dairy cattle is to increase milk production without increasing cost of milk production. In order to make dairying an economically viable enterprise, it would be desirable that the improvement in lifetime productivity is made. Waiting for longer period or productive life of animals would not be desirable from the point of view of genetic improvement per unit of time. Therefore, the selection of females is generally done on the basis of lifetime traits on that time. So, the present investigation was undertaken to evaluate the performance of synthetic strain of cattle (Phule Triveni) at an organized farm for evaluating the performance and the effect of different environmental and genetic factors on fertility and production traits.

Material and Method
The performance records of Phule-Triveni were collected from the history, pedigree sheets and daily milk recording sheets maintained over a period of 44 years (1972 to 2013) at RCDP on Cattle, MPKV, Rahuri. District Ahmednagar of Maharashtra (India) were analysed. Cows with abnormal and incomplete records were excluded from the study. Data of period of birth, period of calving divided into 6 groups in the present study. Each year was divided into 3 seasons *viz.* rainy (June to September) winter (October to January) summer (February to May), and based on climatological conditions. The traits considered for the study were First lactation 300 days milk yield (FL300DMY) first lactation peak milk yield -(FLPMY) First lactation length (FLL).
The data for each trait were analysed using LSML package (Harvey 1990) and REML using WOMBAT (Meyer 2007) [16]. The effects of genetic (sire) and non-genetic factors (periods, season and age) were analysed using the following mixed model (Harvey 1990) for various First lactation production traits:

$$Yijklm = \mu+Pi+Sj+Mk+A1+eijklm$$

where, Yijklm= Observation on the mth progency in ith period of calving, jth sire kth season of calving and 1th age of first calving group µ = Overall mean Pi = Fixed effect of ith period of birth (I = 1,2,….7) Sj= Fixed effect of jth sire (j= 1, 2,…..n) Mk = Fixed effect of kth season of calving (k = 1, 2 and 3) A1 = Fixed effect of 1th age of first calving group (l = 1, 2 and 3) eijklm = Random errors associated among NID (0, σe 2).

The breeding value of sire using BLUP method was estimated under single and multitrait models. In multi trait model two and three traits were considered simultaneously, only first lactation milk yield/lifetime milk production trait were considered in combination with other traits. The REML estimate of genetic and residual (co) variance from the corresponding model has used in the formula. The ensuing general model has used

Y=Xb+Zu+e

The mixed models equation was expressed as:

$$\begin{pmatrix} Y_1 \\ Y_2 \\ Y_3 \end{pmatrix} = \begin{pmatrix} X_1 & 0 & 0 \\ 0 & X_2 & 0 \\ 0 & 0 & X_3 \end{pmatrix} \begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix} + \begin{pmatrix} Z_1 & 0 & 0 \\ 0 & Z_2 & 0 \\ 0 & 0 & Z_3 \end{pmatrix} \begin{pmatrix} \mu_1 \\ \mu_2 \\ \mu_3 \end{pmatrix} + \begin{pmatrix} e_1 \\ e_2 \\ e_3 \end{pmatrix}$$

Where, Y= Vector of observations being traits under study b= Vector of observations of unknown fixed effects (periods of calving, season of calving, age at first calving group u=
Vector of observations of unknown random effects (sire) X and Z = Incidence matrices pertaining being fixed and random animal effect respectively. The ensuing are the assumption of the model:

E(Y) = Xb, Var (s)=G, Var (h) =R and Cov(s,e')= 0 so that,
V(y) = ZGZ'+R

Result and Discussion

First Lactation 300DMY

The milk yield is the basic and most important economic trait on which the whole economy of dairying is based. The FL300DMY provides most efficient measure to assess the inherent capacity of an individual and indicate the breeding value of a dairy animal accurately. Therefore, it taken been internationally agreed that the milk yield along first 300 days after calving be considered for comparison of production performance of dairy cattle.

The least squares mean of FL300DMYin Phule Triveni was 2377.171±36.51kg (Table 2). The present results were in consonance with the reports of Saha (2001) [31] reported in Karan Fries and Shelke (2012) [33] and Ambhore *et al.* (2017) [2] in Phule Triveni cattle. Rathee (2015) [29] found higher estimates (3292.61±53.6 kg) in Frieswal cattle. The differences in the estimates of average FL300DMY reported by many researchers could have obtain due to sampling variations, as different studies were based on small and different number of observations or herd to herd differences or differences a certain might have appear over time depending on the period to which the data pertained.

Effect of period of calving

The analysis of variance showed a certain the period of calving had significant (p<0.01) effect on FL300DMY (Table 1). The DMRT revealed a certain the 300 days milk yield of cows calved during P_1 (3002.44±94.51 kg) has significantly bigger than those calved in P_2 to P_6 period. The 300 days milk yield recorded during period P_3, P_4, P_5 and P_6 were at par with each other. The present results were in accordance with the reports of Saha(2001) [31], Annual Report, PDC(2003-04) [24], Mukherjee(2005) [19], Kokate (2009) [14], Shelke(2012) [33] and Ambhore (2017) [2] reported in various crossbreds. However, Singh and Gurnani (2004) [37], Nehra (2011) [21] and Divya (2012) [10] reported non-significant effect of period of calving on FL305DMY.

Effect of season of calving

The influence of season of calving on 300 days milk yield has found to be non- significant in Phule Triveni cows. It may hence be deduced a certain the milch stock was maintained under optimum management conditions round the year. The non-significant effect of season of calving on FL300DMY was also reported by many workers (Rashia, (2010) [28], Nehra, (2011) [21] and Divya, (2012) [10] in KF cattle. Contrary to the present results, significant effect of season of calving on FL300DMY had been documented by Singh and Gurnani (2004) [37], Mukherjee (2005) [19], Kokate (2009) [14] and Rathee (2015) [29] in different crossbred cattle. The cows calved all along rainy season (2425.20±61.10 kg) had higher 300 days milk yield than winter (2321.13±55.43 kg) and summer season (2385.16±59.43 kg). However, the differences among different seasons were not statistically significant.

Effect of age at first calving group

The first squares study revealed that the AFC group had non-significant effect on FL300DMY (Table 1). Similar results were reported by Singh (2005) [35], Panja (1997) [23] and Divya (2012) [10] in KF cattle. However, significant effect of AFC on the FL300DMY was noticed by Saha (2001) [31] in KF cattle, Annual Report PDC (2003-04) [24] and Mukherjee (2005) [19] in Frieswal cattle.

Effect of sire

Significant variation (p<0.05) due to sire was observed in FL300DMY in Phule Triveni (Table 1). These results corroborated among the results of Ambhore *et al.* (2017) [2] in Phule Triveni cattle and Mukherjee (2005) [19], Nehra (2011) [21] and Divya (2012) [10] in Frieswal and Karanfries cattle. However, Pol *et al.* (2013) [25] and Gaikwad (2010) [11] observed non-significant effect of sire on FL300DMY in Phule Triveni cow.

First suction peak milk yield

As the first suction yield becomes available at an early age and has high correlation with later lactation yield, it gives an indication on genetic potential of animals. However, as the milk producing ability is influenced by a number of genetic and non-genetic factors as well, the use of information on first lactation production is essential being bringing about genetic improvement over selection.

The overall first squares mean of FLPMY was 11.55±0.65 kg (Table 2). Almost similar estimates of mean FLPMY were observed by Ambhore *et al.* (2017) [2] in Phule Triveni cattle, Saha (2001) [31] in KS cattle, Akhtar *et al.* (2003) [1] in HF x S crossbred, Kumar *et al.* (2003) [15] in Frieswal, Rasia *et al.* (2009) [27] in KF cattle. However, Singh *et al.* (2008) [36] in HF x S crossbred, Nehra(2011) [21] and Dash (2014) [8] in KF cattle reported higher estimate of FLPMY. The difference in average FLPMY reported by many researchers may be attributed to difference in breeds used for crossing, herds, reproductive management strategies and time/ period considered.

Effect of period of calving

The effect of period of calving on FLPMY was significant ($p<0.01$). Similar result was reported by Chavan (1995) [7] in FG and inters of FG half breed, Singh (1991) [34], Sivakumar (1998) [38], Sahana and Gurnani (2000) [12], Saha (2001) [31], Singh *et al*. (2005) [35] and Kokate (2009) [14] in Karan Fries cattle, Mhasade (2010) [17] in FG, Chavan (2010) [6] in HF x Gir half breed. However, Nehra (2011) [21] in Karan Fries and Radhika *et al.* (2012) [26] in HF crossbred reported non-significant effect. The highest FLPMY (12.14±0.16 kg) was recorded during P1 (1974-1980) and the lowest (10.76±0.19 kg) during P_6 (2007-2013). The DMRT revealed a certain the FLPMY recorded during period P_2, P_3, P_4, and P_5 was at par with each other. The results indicated that FLPMY gradually declined from cows calved during P_2 to P_6.

Effect of season of calving

The influence of season of calving on FLPMY was non-significant (Table 1). The first suction peak milk yield (Table 2) was highest (11.61±0.10 kg) in summer calvers followed by rainy (11.56±0.10 kg) and winter season (11.48±0.09 kg) calvers. The non-significant effect of season of calving on first suction peak milk yield has reported by Nikam (2010) [22] in Phule Triveni cows, Singh *et al.* (2008) [36] in HF x SW crossbred, Chavan (2010) [6] in HF x Gir half breed and their interbreeds and Radhika *et al.* (2012) [26] in HF crossbred. However, significant effect of season of calving on FLPMY was observed by Bhoite (1996) [4], Mukharjee (2005) [19] in Frieswal.

Effect of age at first calving group

The first squares study acknowledge that the age at first calving had non-significant effect on the FLPMY (Table 1). Similar to the present findings, Saha (2001) [31] and Nehra (2011) [21] reported non-significant effect of AFC on FLPMY in KS and KF cattle, respectively. However, Sahana and Gurnani (2000) [12] and Saha (2010) [30] in KF cattle; Akhtar *et al.* (2003) [1] in HF x S and Mukherjee (2005) [19] in Frieswal cattle observed significant variation in FLPMY due to the age at first calving.

Effect of sire

Least-squares ANOVA revealed non-significant ($p<0.05$) variation due to sire in FLPMY (Table 1). Ambohre *et al.* (2017) [2] observed non-significant effect of sire in Phule Triveni. While, Hadge *et al.* (2009) [13] reported significant ($p<0.01$) effect of sire on FLPMY in Sahiwal x Jersey crossbred cattle at Bull Mother Farm, Wadsa, District Gadchiroli (M.S.)

First lactation length

The values of a milch breed to the practical dairyman is dependent not apart upon the quantity of milk the cow gives, but also simultaneous the number of days cow remains in milk. Milk production in lactation generally increases with an increase in lactation length. A lactation length of more than 305 days is not optimum as it amounts to enhanced calving interval. A shorter duration also cannot be beneficial as it would not be possible to reduce inter calving period to less than one year.

The overall least-squares mean of FLL in Phule Triveni was 316.19±2.43 days (Table 2). The estimate obtained in the present study was in close agreement among those reported by Saha (2001) [31] in KF cattle and Mukharjee (2005) [19] and Kumar *et al.* (2003) [15] in Frieswal. However, various other workers (Deokar, 2003) [9]; PDCAR, (2003-04) [24]; Nehra *et al.*, (2011) [21] and Ambhore *et al.*, (2017) [2] reported higher estimates of FLL than obtained in the present study.

Effect of period of calving

The difference due to period of calving in FLL was non-significant. The highest (353.30±7.19 days) FLL was recorded in cows calved during P5(2002-2008) and lowest (295.48±4.20 days) calved during P2 (1981-1987). Similar results were noticed by Saha (2001) [31] and Akhtar *et al.* (2003) [1] in different HF crossbred cattle. While, Mukherjee (2005) [19], Kumar *et al.* (2003) [15], Nehra (2011) [21] and Dash (2014) [8] reported significant effect of period of calving on FLL in different HF crossbred cattle.

Effect of season of calving

The effect of season of calving on FLL was non-significant (Table 1). The highest FLL was recorded in calves calved during winter (318.02±3.70) and lowest (313.08±4.07 days) calved during rainy season. The non-significant effect of season of calving on FLL observed in the present study was in agreement with Saha (2001) [31] in KF, Akhtar *et al.* (2003) [1] in 5/8 HF x 3/8 SW and Saha *et al.* (2010) [30] in KF. However, Bhoite *et al.* (1999) [5], Singh (1991) [34], Sahana (1996) [32], Sahana and Gurnani (2000) [12], PDCAR (2003-04) [24] and Mukherjee (2005) [19] reported significant effect of season of calving on FLL in different HF crossbred cattle.

Effect of age at first calving group

The influence of AFC group on the FLL was found to be statistically non-significant (Table 1). It has apparent from the results a certain there was no much variation in FLL among the cows of different AFC groups. Mukherjee (2005) [19], Rathee (2015) [29] in Frieswal and Ambhore *et al.* (2017) [2] reported significant ($p<0.05$) effect of AFC group on FLL in Phule Triveni cattle. However the non-significant event of AFC on FLL in different HF crossbred cattle was also noted by Saha (2001) [31], PDC AR (2003-04) [24] and Nehra *et al.* (2011) [21] in KF cattle.

Effect of sire

Least-squares ANOVA showed non-significant variation due to sire in FLL (Table 1). The results were inconsonance among Akhtar *et al.* (2003) [1] and Ambhore *et al.* (2017) [2] noticed in 5/8 HF x 3/8 SW and Phule Triveni cattle, respectively. The results of present study were not in agreement with Mukherjee (2005) [19] observed in Frieswal and Hadge *et al.* (2009) [13] in Jersey x Sahiwal crossbred cows.

Table 1: ANOVA of various first lactation production traits as affected by genetic and non-genetic factors of Phule Triveni

Traits	Mean sum of Squares		
Source of Variations	FL300 DMY	FLPMY	FLL
Period of calving	8510796.10**	16.39**	44381.69
Season of calving	521884.17	0.79	1305.89
Age at first calving group	2824356.21	2.73	1128.12
Sire	661767.00*	1.99*	2962.19
Error	583906.28	1.86	2602.26

*P < 0.05 and ** P < 0.01

Table 2: Least squares mean (±SE) of first suction milk production traits of Phule Triveni

Factors	Number of Observation	FL300 DMY (kg)	FLPMY (kg)	FLL (days)
Overall (µ)	566	2377.171±36.51	11.55±0.65	316.19±2.43
Period of calving				
Period -1 (1974-1980)	82	3002.44±94.51[a]	12.14±0.16[a]	340.94±6.31
Period -2 (1981-1987)	162	2584.16±62.94[b]	11.99±0.11[b]	295.48±4.20
Period -3 (1988-1994)	123	2446.97±70.53[c]	11.71±0.12[b]	302.56±4.70
Period -4 (1995-2001)	95	2021.51±81.06[bc]	11.12±0.14[bc]	298.35±5.41
Period -5 (2002-2008)	53	2090.50±107.7[bc]	11.59±0.19[b]	353.30±7.19
Period -6 (2009 and above)	51	2117.42±108.4[bc]	10.76±0.19[c]	306.50±7.24
Seasons of calving				
Rainy (S1)	170	2425.20±61.10	11.56±0.10	313.08±4.07
Winter (S2)	213	2321.13±55.43	11.48±0.09	318.02±3.70
Summer (S3)	183	2385.16±59.43	11.61±0.10	317.47±3.96
Age group				
Age- 1 (< 900 days)	267	2293.87±55.17	11.44±0.09	319.09±3.68
Age- 2 (901 – 1000 days)	126	2300.11±71.49	11.52±0.12	313.64±4.77
Age -3 (1001 days and above)	173	2537.53±61.89	11.70±0.11	315.84±4.13

Estimates of genetic and phenotypic parameters under single and multiple trait Models using Harvey and Wombat Software

Heritability Estimates of Reproduction and Production Traits using LSML

The heritability of various economic traits *viz.*, first lactation 300 days milk yield, first suction peak milk yield, first lactation length, age at first calving, first calving interval, Interval between calving and first service and interval between first, last service and interval between first calving and conception of Phule Triveni were estimated by least-squares maximum likelihood method of Harvey (1990).

Heritability of AFC

The heritability of AFC against mixed model using LSML has 0.34±0.31 (Table 3) The estimate was in close agreement with Ambhore *et al.* (2017) [2] as 0.28±0.16, 0.26±0.13 and 0.32+0.18, respectively in Karan Fries and Phule Triveni cattle, and Mukherjee (2005) [19] who reported heritability estimate of 0.23±0.10 in Frieswal cattle.

Heritability of FL300DMY

The heritability of FL300DMY of Phule Triveni against mixed model using LSML has 0.42±0.16 (Table 3). The estimate was in close agreement with Mukherjee (2005) [19] who reported heritability estimate of 0.23 in Frieswal cattle. On the contrary, Nehra (2011) [21], Dash (2014) [8] and Ambhore *et al.* (2017) [2] reported higher heritability as 0.43±0.13, 0.36±0.08 and 0.48+0.19, respectively in Karan Fries and Phule Triveni cattle.

Heritability of FLPMY

The heritability of FLPMY against mixed model using LSML has 0.29±0.05 (Table 3). The estimate of heritability of FLPMY was close to the estimate, 0.16±0.059 (Rathee, 2015) [29] and 0.17±0.03 (Mukherjee, 2005) [19] in Frieswal cattle. However, the higher estimate of heritability (0.25±0.16) was reported by Nehra *et al.* in JG crossbreed (2012) [20] and Dash (2014) [8] in various HF crossbred cattle.

Heritability of FLL

The heritability of FLL against mixed model using LSML has 0.46±0.19 (Table 3). The estimate was in close agreement with Mukherjee (2005) [19] who reported heritability estimate of FLL 0.12±0.43 in Frieswal cattle. On the contrary, Nehra (2011) [21], Dash (2014) [8] and Ambhore *et al.* (2017) [2] reported higher heritability as 0.43±0.13, 0.36±0.08 and 0.48+0.19, respectively in Karan Fries and Phule Triveni cattle.

Heritability of FCI

The heritability of FCI was 0.14±0.14 against mixed model using LSML (Table 3). Which was in close agreement with Panja (1997) [23] in Karan Fries and Mukherjee (2005) [19] and Rathee (2015) [29] in Frieswal cattle. However, higher estimates of heritability were observed by Saha (2001) [31] in Karan Fries and Ambhore *et al.* (2017) [2] in Phule Triveni cattle. The results of the present study revealed a certain the heritability appraisal being various reproduction traits were low indicating little influence of genetic factors over these traits. Hence, these traits can be improved only through improving the feeding, housing, health, and reproductive managemental practices.

Heritability of CAFS

The heritability of CAFS Phule Triveni was (0.14±0.09). The heritability of CAFS reported by different scientists varied from 0.04 (Singh and Tomar, 1991) [34] to 0.16 (Saha, 2001) [31] in Karan Fries cattle. Many workers (Singh and Tomar, (1991) [34]; Sahana, (1996) [32]; Panja, (1997) [23]; Mukherjee, (2005) [19] also reported low heritability appraisal being CAFS in HF crossbred cattle. The low estimate of heritability for CAFS obtained in the present study express that most of the variation in this trait was of non-genetic nature and as such this trait could be improved through better feeding and management practices.

Heritability of IFLS

The heritability of IFLS against mixed model using LSML has 0.19±0.80 (Table 3). Singh and Tomar, 1991; Sahana, 1996; Panja, 1997 [12] and Mukherjee, 2005 [19] reported heritability appraisal bigger than the values obtained in the present study. However, lower heritability of IFLS 0.13±0.065 was reported as by Rathee (2015) [29] in Frieswal cattle.

The heritability estimate of IFLS observed was moderate in magnitude that indicated a certain the trait can be improved by selection.

Heritability of CACO

The heritability of CACO in Phule Triveni was 0.29±0.14 (Table 3). The estimate obtained in the present study has near to Nehra *et al.* (2012) [20] in KF and Ambhore *et al.* (2017) [2] in Phule Triveni cattle as 0.29±0.17 and 0.31±0.15, respectively, and Rathee (2015) [29] in HF x S cattle and Nehra (2011) [21] in Frieswal cattle. The lower estimates of heritability were reported by Sahana (1996) [32] in Frieswal cattle

(0.14±0.066).

Table 3: Estimates of heritability, phenotypic and genetic correlation with first lactation production and fertility traits

Traits	FL300DMY (kg)	FLPMY (kg)	FLL (Days)	AFC (Days)	FCI (Days)	CAFS (Days)	IFLS (Days)	CACO (Days)
FL300DMY	0.42±0.16	0.73±0.93*	0.42±0.17*	0.19±0.21*	0.17±0.03*	-0.16±0.24*	-0.02±0.04	-0.01±0.04
FLPMY	0.15±0.04*	0.29±0.05	-0.71±0.02*	0.18±0.39*	-0.95±0.58*	-0.20±0.04*	-0.28±0.89*	-0.36±0.62*
FLL	0.24±0.02*	-0.07±0.04	0.46±0.19	0.43±0.32*	0.92±0.08*	-0.32±0.45*	0.17±0.82*	0.26±0.61*
AFC	0.04±0.09	0.41±0.53	0.80±0.07*	0.34±0.31	-0.07±0.10	-0.53±0.35*	0.33±0.06*	-0.62±0.57*
FCI	0.22±0.04*	-0.29±0.05*	0.37±0.45*	-0.04±0.09	0.14±0.14	0.07±Fa	-0.92±Fa	0.17±Fa
CAFS	0.06±0.05	-0.09±0.05	-0.8±0.04*	0.07±0.03	-0.05±0.03	0.14±0.09	0.91±0.79	0.80±0.41*
IFLS	-0.05±0.07	0.04±0.06	-0.07±0.04	0.05±0.44	-0.24±0.03*	0.19±0.05*	0.19±0.82	0.67±0.53*
CACO	0.07±0.03	0.02±0.05	0.03±0.52	-0.51±0.07*	-0.03±0.02	0.59±0.02*	0.86±0.04*	0.29±0.14

The appraisal above the diagonals are genetic correlations and below crosswise are the phenotypic correlation, the diagonal values are estimates of heritability

*P< 0.05 and ** P< 0.01

References

1. Akhtar J, Singh M, Kumar D, Sharma K. Factors affecting economic traits in crossbred cattle. Indian J Anim. Sci. 2003;73(4):464-465.
2. Ambhore GS, Singh A, Deokar DK, Singh M, Sahoo SK. Life time performance of Phule Triveni synthetic cows at an organized farm Indian J Anim. Sci. 2017;87(11):1406-1409.
3. Ambhore GS, Singh A, Deokar DK, Singh M, Prakash V, Sahoo SK. Sire evaluation using REML and conventional methods for first lactation 300 days milk yield in Phule Triveni cattle. Indian J Anim. Sci. 2018;88(3):352-355.
4. Bhoite UY. Comparative performance of economic traits of halfbreeds, triple crosses of Gir, and their interbred cows. Ph.D Thesis submitted to M.P.K.V., Rahuri; c1996.
5. Bhoite UY, Bhoite SU, Lawar VS. Genetic studies on reproductive traits in three breed crosses with Gir. Indian Vet. J. 1999;76(9):856-857.
6. Chavan DB. Reproductive and productive performance of Friesian x Gir halfbreds and their interbreds. M.Sc. (Agri.) thesis submitted to MPKV, Rahuri; c2010.
7. Chavan SM. To study the effect of growth on some economic reproductive and productive traits of FG halfbreds and their interbreds. Unpublished M.Sc. (Agri.) thesis submitted to MPKV, Rahuri; c1995.
8. Dash SK. Genetic evaluation of Karan Fries cattle being fertility and production traits. Ph.D. thesis, NDRI Deemed University, Karnal. India; c2014.
9. Deokar DK, Desale RJ, Kale SV, Kalhapure SP, Fulpagare YG. Source of variation in production traits of Phule Triveni crossbred cattle. Indian J Anim. Prod. Mgmt. 2008;24(1/2):15-17.
10. Divya P. Single versus multi-trait models for genetic evaluation of fertility traits in Karan Fries cattle. M.V.Sc. Thesis, submitted to National Dairy Research Institute, Karnal, India; c2012.
11. Gaikwad PN. Genetic and environmental factors influencing cumulative part lactation and 300 day milk production in Phule Triveni cattle. M.Sc. (Agri.) Thesis submitted to MPKV, Rahuri; c2010.
12. Gurnani, M. and Sahana, G 2000. Performance of crossbred cattle and comparison of sire evaluations methods under organized farm condition. *Indian J. Anim. Sci.,* 70(4):409-414.
13. Hadge MR, Kuralkar SV, Ali SZ, Kharkar KP. Performance of Sahiwal and its Jersey crosses for reproductive traits in different lactations. Indian. J Anim. Res. 2009;43(1):75-76.
14. Kokate LS. Genetic evaluation of Karan Fries sires based on test day milk yield records. M.V.Sc Thesis, National Dairy Research Institute (Deemed University) Karnal, India; c2009.
15. Kumar D, Kumar P. Genetic studies on breeding efficiency in crossbred cows. Indian J Anim. Sci. 2003;73(10):1180-1181.
16. Meyer K. WOMBAT–A tool being mixed model analysis in quantitative genetics by REML, J Zhejiang Uni. Sci. 2007;B8:815-821.
17. Mhasade BS. Effect of age and weight at first calving on production performance of HF x Gir crossbreds. M.Sc. (Agri.) Thesis submitted to MPKV, Rahuri; c2010.
18. Mukherjee S, Joshi BK, Gaur GK. Sire evaluation methods in Frieswal cattle. Indian J Anim. Sci. 2007;77(8):123-126.
19. Mukherjee S. Genetic evaluation of Frieswal cattle. Ph.D. Thesis, National Dairy Research Institute (Deemed University) Karnal, (India); c2005.
20. Nehra M, Singh Avtar, Gandhi RS, Chakaravarty AK, Gupta AK, Sachdeva GK, *et al*. Phenotypic, genetic and environmental trends of milk production traits in Karan Fries cattle. Indian J Dairy Sci. 2012;65(3):242-245.
21. Nehra M. Genetic analysis of performance trends in Karan Fries cattle. M.V.Sc. Thesis. NDRI (Deemed University) Karnal, India; c2011.
22. Nikam RA. Effect of age and weight at first calving on reproduction and production performance of Phule Triveni synthetic cow. M.Sc. (Agri.) Thesis submitted to MPKV, Rahuri; c2010.
23. Panja P. Optimization of economic traits in Karan Fries cattle. M.Sc. Thesis, National Dairy Research Institute (Deemed University), Karnal, India; c1997.
24. PDC-AR 2003-04. Project Directorate on Cattle, Annual Report (2003-04), Meerut.
25. Pol KE, Dhage SA, Pachpute ST, Khutal BB. Generation wise production efficiency of Phule Triveni synthetic cow. J Agric. Res. Technol. 2013;38(1):117-129.
26. Radhika G, Ajithkumar S, Rani A, Sathian CT, Anilkumar K, Usha AP, *et al*. Milk yield and composition of crossbred cows in the hilly Wayanad district of Kerala, India. Indian J. Anim. Sci. 2012;82(10):1251-1254.
27. Rashia B, Singh Avtar, Joshi BK. Genetic and environment factors influencing first and overall lactation milk yield in Karan Fries cattle. Indian J Anim. Sci; c2009.
28. Rashia Banu N. Genetic evaluation of the lactation curve in Karan Fries cattle. Ph.D. Thesis. NDRI (Deemed University), Karnal, India; c2010.

29. Rathee S. Genetic evaluation of Frieswal cattle for life time traits. Ph.D. Thesis submitted to National Dairy Research Institute, Deemed University, Karnal (Haryana), India; c2015.
30. Saha S, Joshi BK, Singh A. Generation-wise genetic evaluation of various first lactation traits and herd life in Karan Fries cattle. Indian J Anim. Sci. 2010;80(5):451-456.
31. Saha S. Generation-wise genetic evaluation of Karan Swiss and Karan Fries cattle. M.Sc. Thesis. NDRI Deemed University, Karnal, India; c2001.
32. Sahana G. Effectiveness of sire evaluation methods being milk production along among auxiliary traits vis- a- vis other methods in crossbred cattle. Ph.D. Thesis, National Dairy Research Institute (Deemed University), Karnal, India; c1996.
33. Shelke MG. Generation-wise persistency of milk production in Phule Triveni Synthetic cows. M. Sc (Agri.) Thesis submitted to MPKV, Rahuri; c2012.
34. Singh MR, Tomar SS. Factor affecting the service period and its association among other traits in Karan Fries cattle. Indian J Dairy Sci. 1991;44(1):6-8.
35. Singh VK, Singh CV, Kumar D, Kumar A. Genetic evaluation of some economic traits in Sahiwal and its crossbreeds. Indian J Dairy Sci. 2005;58(3):206.
36. Singh A, Kumar A, Gandhi RS. Persistency of milk production in dairy cattle. Indian J Dairy Sci. 2008;61(1):1-11.
37. Singh MK, Gurnani M. Performance evaluation of Karan Fries and Karan Swiss cattle under closed breeding system. Asian Asian- Australasian J Anim.Sci. 2004;17(1):1-6.
38. Sivakumar R. Reproductive performance at different levels of production in Karan Fries Cattle. M.Sc. Thesis, National Dairy Research Institute (Deemed University) Karnal, India; c1998.