Original Research

Influence of Genetic and Non-Genetic Factors on Production Traits of Tharparkar Cattle at Organized Farm

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Abstract

Data consisted of 284 performance records belonging to 63 Tharparkar cows completing at least three lactations spread over a period of fifteen years (2002 to 2016) for genetic analysis of milk production traits viz. dry period, lactation length, lactation milk yield, 300 days milk yield, milk yield per day of lactation length and milk yield per day of calving interval. The overall least-squares means for above traits were 138.47 ± 3.02 days, 281.71 ± 3.43 days, 2003.29 ± 13.40 kg, 1885.81 ± 23.07 kg, 6.65± 0.10 kg and 4.03 ± 0.04 kg, respectively. Heritability's were ranged from 0.08 to 0.59 for above traits, genetic correlations between the milk production traits ranged from 0.57 to 0.93 and phenotypic correlations ranged from 0.02 to 0.56. The effect of period of calving on service period, lactation milk yield, three hundred days milk yield and milk yield per day of lactation length were significant and effect of season of calving on lactation length were also significant. The random effect of sire was observed to be highly significant (P≤ 0.01) on all the production traits.

Key words: Genetic Correlation, Heritability, Phenotypic Correlations, Tharparkar

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Introduction

India is known as an agricultural country. The economy of India is largely dependent on livestock and dairy farming. The ultimate criterion which decides economic efficiency of a herd is the production performance in the form of lactation yield and lactation length of an animal. Overall production efficiency of a cow is measured through lactation length, dry period, lactation milk yield, lactation milk yield per day of lactation length and per day of calving interval (Dematawewa and Berger, 1998). There are several genetic and non-genetic factors that influence the phenotypic expression of these production traits. In the absence of reliable information regarding these traits, it becomes difficult to estimate genetic parameters of the traits that provide the base to determine the optimum criterion of selection and breeding policies for improving overall performance of the animals. Hence, present study was carried out to assess the influence of important genetic and non-genetic factors like period of calving, season of calving and parity and to estimate the genetic and phenotypic parameters *viz.*, heritability, genetic and phenotypic correlations for various production traits in Tharparkar cattle, so as to generate information that will be helpful in developing future breeding plans for genetic improvement of the breed.

Material and Methods

Genetic analysis of Tharparkar cattle herds was carried out on the data collected from the Livestock Research Station, Beechwal, Bikaner. A total of 284 performance records belonging to 63 Tharparkar cows completing at least three lactations spread over a period of fifteen years (2002 to 2016) were utilized. Data were classified into four classes according to period of calving *viz*. P1 (2006-2008), P2 (2009-2011), P3 (2012-2014) and P4 (2015-2016). According to season of calving data were classified into three season viz. summer (March to June), monsoon (July to October) and winter (November to February). Parity-wise data were grouped into six classes as L1, L2, L3, L4, L5 and higher parity grouped together with L6 class. Production traits were adjusted for effect of non-genetic factors viz. period of calving, season of calving and parity as fixed effects and sire as random effect, prior to estimation of genetic and phenotypic parameters. Various production traits were included in the present study *viz.*, dry period (DP), lactation length (LL), lactation milk yield (LMY), three hundred days milk yield (300 days MY), milk yield per day of lactation length (MYPD) and milk yield per day of calving interval (MYCI).

Statistical Analysis

To find the effect of various genetic and non-genetic factors on production traits, computer package programme, LSMLMW, MODEL2 designed by Harvey (1990) was used for data analysis.

Mathematical Model for Analysis of Traits

$$Y_{ijklm} = \mu + s_i + A_j + B_k + C_l + b\,(X_{ijklm} - X) + e_{ijklm}$$

Where,
Y_{ijklm} = Observation on the m^{th} cow of i^{th} sire, calved in j^{th} period, k^{th} season and l^{th} parity,
μ = overall mean
s_i = random effect attributed to i^{th} sire
A_j = fixed effect of j^{th} period of calving

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B_k = fixed effect of k^{th} season of calving
C_l = fixed effect of l^{th} parity
b = regression of variable on age at first calving
X_{ijklm} = age at first calving corresponding to Y_{ijklm}
$\bar{X}$ = average age at first calving
e_{ijklm} = residual random error under standard assumption which make the analysis valid, i.e. NID $(0,\sigma^2)$

Heritability Estimation

Paternal half sib analysis (Becker, 1968) method was used to estimate heritability using model 2 of LSMLMW programme (Harvey, 1990). The sires with less than three progeny were excluded for the estimation of heritability. The variance components for estimation of heritability were obtained from the following model:

$$Y_{ij} = \mu + s_i + e_{ij}$$

Where,
Y_{ij} is the measurement of a particular trait, μ is the population mean,
s_i = Random effect of the i^{th} sire and
e_{ij} = Random error NID $(0, \sigma^2)$

Estimation of Genetic and Phenotypic Correlations among Production Traits

Genetic correlation calculated by using following formula-

$$rg_{(XY)} = Cov_{S(XY)} / \sqrt{(\sigma^2_{S(X)})(\sigma^2_{S(Y)})}]$$

Where,
X and Y are traits of the same individual
$Cov_{S(XY)}$ = Sire component of covariance between traits X and Y
$\sigma^2_{S(X)}$ and $\sigma^2_{S(Y)}$ = Sire components of variance for traits X and Y, respectively

Phenotypic correlation was estimated by using the following formula-

$$rp_{(XY)} = \frac{Cov_{S(XY)} + Cov_{e(XY)}}{\sqrt{(\sigma^2_{s(X)} + \sigma^2_{e(X)})(\sigma^2_{s(Y)} + \sigma^2_{e(Y)})}}$$

Where,

$Cov_{e(XY)}$ = Error component of covariance between traits X and Y.

$\sigma^2_{e(X)}$ and $\sigma^2_{e(Y)}$ = Error components of variance for traits X and Y.

Results and Discussion

The data structure, least squares mean (LSM), standard error (SE) and effect of genetic and non-genetic factors for different traits under study are shown in Table 1. The overall least-squares means for DP, LL, LMY, 300 days MY, MYPD and MYCI were 138.47 ± 3.02 days, 281.71 ± 3.43 days, 2003.29 ± 13.40 kg, 1885.81 ± 23.07 kg, 6.65± 0.10 kg and 4.037 ± 0.04 kg, respectively.

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Genetic Factors

Effect of Sire on Production Traits

The random effect of sire was observed to be highly significant (P≤ 0.01) on all the production traits under study, which indicated that sire selection for these traits can bring further genetic improvement in these traits. These findings are in agreement with the results of Singh (2012) and Dangi *et al*. (2013) in Rathi cattle.

Non-Genetic Factors

Effect of Period of Calving

Lactation milk yield, three hundred days milk yield and milk yield per day were significantly (P≤ 0.05) affected by season of calving in present study. Variation in milk yield across different years of calving reflected the availability of financial resources like profitability and liquidity and management practices adopted during different years at the farm. This result is supported by the findings of Kachwaha (1993), Chand (2011) and Kishore (2016) in Tharparkar, Rehman *et al.* (2006) in Sahiwal and Japheth *et al.* (2015) in Karan Fries who observed significant effect of period of calving on LMY. Whereas, non-significant effect of period of calving on lactation milk yield was observed by Nehra (2004); Singh (2012) and Sohal (2016) in Rathi cattle.

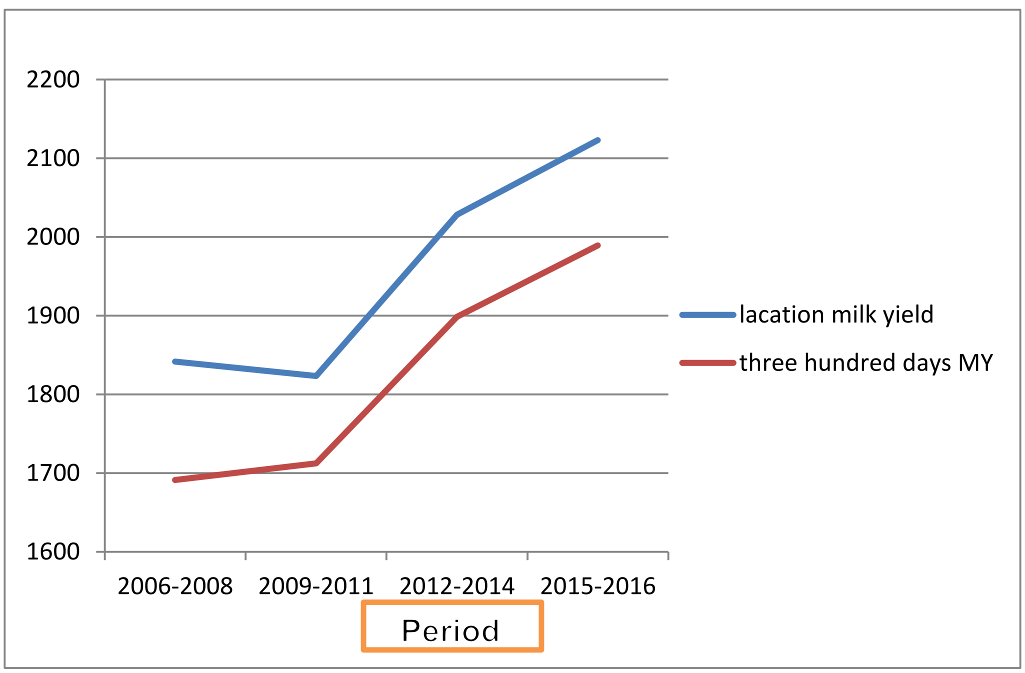

Fig.1: Period wise LMY and three hundred days MY

Non-significant effect of period was also observed by Joshi (1989) and Nehra (2004) in Rathi for lactation length. While significant effect reported by Singh (2012) in Rathi, Raja and Gandhi (2015) in Sahiwal for

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L. L. Dangi *et al.* (2013) reported non- significant effect of period on dry period, while significant was Kachwaha (1993) and Chand (2011) in Tharparkar cattle.

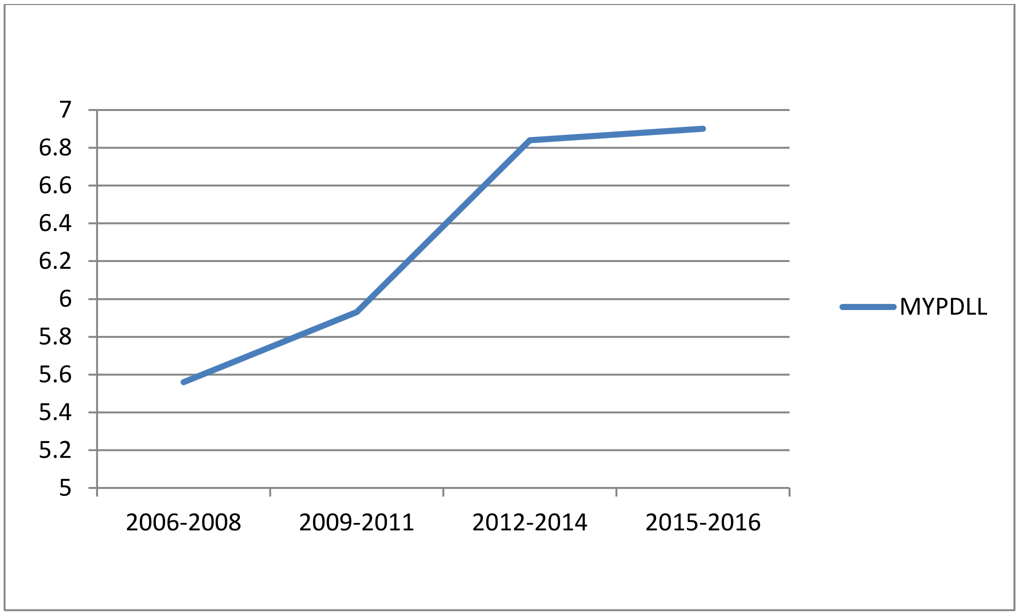

Fig. 2: Period wise MYPDLL

Effect of Season of Calving

Season of calving had non-significant effect on all traits except on lactation length. Gupta *et al.* (1986); Kachwaha (1993) and Gahlot (1999) in Tharparkar and Sohal (2016) in Rathi also reported significant effect of season on LL. Although, Sharma *et al.* (1972); Pareek (1991) and Chand (2011) and Kishore (2016) in Tharparkar, Singh (2012) in Rathi, Raja and Gandhi (2015) in Sahiwal and Japheth *et al*. (2015) in Karan Fries cattle reported non-significant effect of season of calving on lactation length. In the present study the lactation length of the monsoon season (S_2) was significantly higher than other seasons. This might be due to favorable climatic conditions at the farm during monsoon season. The environmental and managemental practices at organized farm can be maintained throughout the year so reduced the seasonal variation and non-significant effect of season was observed on dry period. Chand (2011) and Kishore (2016) in Tharparkar cattle also reported non-significant effect of season on dry period and lactation milk yield, while significant effect was observed by Nehra (2004) and Dangi *et al*. (2013) in Rathi cattle.

Effect of Parity

The present study revealed non-significant effect of parity on all the production traits. This could be due to the fact that physiological maturity and cyclic rhythm in reproduction of cows is well attended after the completion of first lactation as the age advances.

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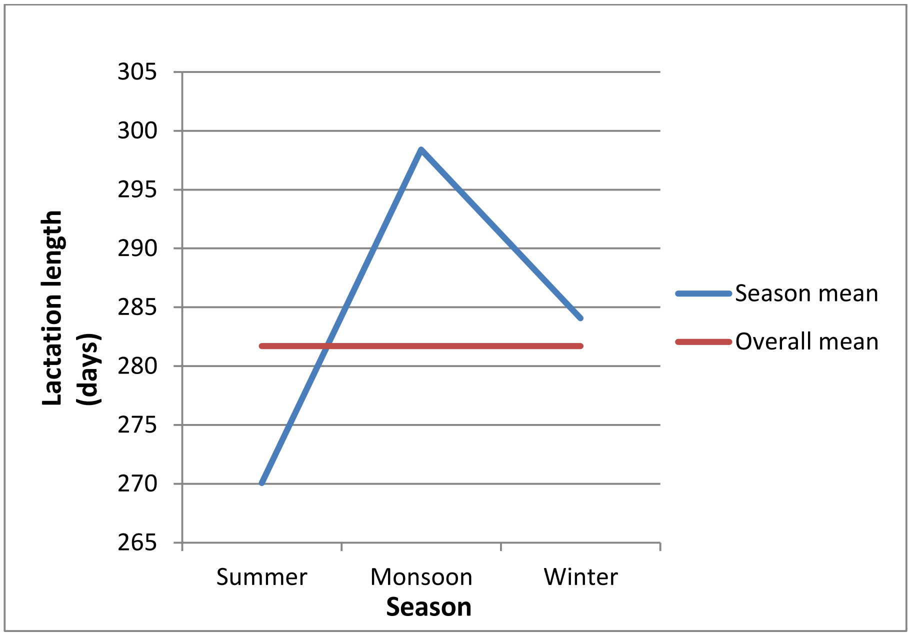

Fig. 3: Season wise lactation length (days)

Table 1: Descriptive statistics and data structure for production traits in Tharparkar cattle

Traits/ Factors	LL	DP	LMY	300 LMY	MYPD	MYCI
Overall Mean(µ)	281.71 ± 3.43 (274)	138.47 ± 3.02 (274)	2003.29 ± 13.40 (274)	1885.81 ±23.07 (274)	6.65 ±0.10 (274)	4.037 ±0.04 (274)
SIRE	**	*	**	**	*	*
PERIOD	NS	NS	**	**	**	NS
P1 (2006-2008)	289.57 ± 16.92 (33)	118.59 ± 13.11 (33)	1841.58 ± 95.03^{ac} (33)	1691.27 ±107.47a (33)	5.56 ±0.54a (33)	3.68 ±0.44 (33)
P2(2009-2011)	288.67 ± 14.64 (47)	125.66 ± 10.75 (47)	1823.17 ± 99.64^{a} (47)	1712.46± 72.90ac (47)	5.93±0.37b (47)	3.52±0.35 (47)
P3(2012-2014)	275.16± 13.12 (122)	143.31 ± 9.10 (122)	2028.37 ± 109.71^{bc} (122)	1898.37 ± 106.41^{bc} (122)	6.84±0.32bc (122)	4.15 ±0.29 (122)
P4 (2015-2016)	283.32 ± 13.87 (72)	143.27± 9.33 (72)	2123.23 ± 84.56^{b} (72)	1989.27 ± 98.05b (72)	6.90 ± 0.35b (72)	4.08 ±0.32 (72)
SEASON	*	NS	NS	NS	NS	NS
S1 (Summer)	270.07 ± 13.87^{a} (111)	130.44 ± 9.09 (111)	1891.33 ± 109.63 (111)	1770.11 ±83.34 (111)	6.47±0.34 (111)	3.74 ±0.29 (111)
S2 (Monsoon)	298.41 ± 14.05^{b} (60)	140.26 ± 10.13 (60)	1999.21 ± 95.77 (60)	1847.38±79.21 (60)	5.98 ±0.37 (60)	3.98 ±0.33 (60)
S3 (Winter)	284.06 ± 13.27^{ab} (103)	127.48 ± 9.27 (103)	1971.72 ±80.67 (103)	1851.04±94.33 (103)	6.47 ±0.34 (103)	3.86±0.29 (103)
PARITY	NS	NS	NS	NS	NS	NS
L1	292.67 ± 13.92 (63)	144.96 ± 10.01 (63)	2001.39 ± 105.03 (63)	1909.10 ±108.51 (63)	6.29 ±0.36 (63)	4.02 ±0.32 (63)
L2	298.60 ± 13.80 (63)	135.45 ± 9.85 (63)	2019.93 ± 124.11 (63)	1888.85 ±107.62 (63)	6.10 ±0.36 (63)	4.14 ±0.32 (63)
L3	284.60 ± 13.71 (63)	133.13 ± 9.75 (63)	1956.24 ±93.53 (63)	1855.03 ±87.62 (63)	6.26±0.36 (63)	4.07±0.31 (63)
L4	277.61± 15.28 (35)	140.27 ± 11.42 (35)	1970.75 ± 103.91 (35)	1828.10±86.90 (35)	6.54 ±0.40 (35)	3.77 ± 0.38(35)
L5	283.20±16.47 (25)	122.61 ± 12.65 (25)	1878.34 ±81.98 (25)	1693.25 ±94.60 (25)	6.03± 0.44(25)	3.04±0.42 (25)
L6	268.39±16.69 (25)	119.81 ± 12.86 (25)	1897.87± 103.45 (25)	1762.72±105.98 (25)	6.64±0.45 (25)	4.11±0.43 (25)
AFC	NS	NS	**	*	NS	NS
Regression coefficient	0.028±0.015	-0.026 ± 0.01	0.434 ± 0.121	0.238±0.110	-0.000006± 0.0007	0.00045± 0.0004

*No. of observations are given in parenthesis. Figure with different superscripts differ significantly; ** - Highly significant (P≤ 0.01); * - Significant (P≤0.05); NS - Non-significant*

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Regression of Production Traits on AFC

Positive and highly significant (P ≤ 0.01) regression was shown by lactation milk yield and three hundred days milk yield on AFC. The present results indicated that production traits could be controlled by manipulating the age at first calving, which could be achieved by proper post-partum care of cows, early detection of heat and timely insemination. This resulted in to narrow down the unproductive part of life; hence, the cost of rearing of the cow would be reduced. Results of present investigation were in the line of the reports of Chand (2011) and Kishore (2016) in Tharparkar, Pirlo *et al*. (2000) and Dahiya (2002) in Hariana cattle but in contradiction with the reports of Singh (2012) and Sohal (2016) in Rathi cattle.

Heritability and Correlation among Traits

The moderate heritability obtained for these traits (Table 2) shows the existence of considerable component of sire variance and high genetic variability in the herd. This could be as a result of selection of sires mainly on the basis of dam's milk yield leading to variability in breeding values of sires.

Table 2: Estimates of heritability, genetic and phenotypic correlation using sire model for production traits in Tharparkar cattle

	LL	DP	LMY	MYPD
LL	**0.44 ± 0.23**	-0.809 ± 0.44**	0.934 ± 0.10**	0.570 ± 0.48**
DP	-0.519 ± 0.05**	**0.24 ± 0.17**	-0.928 ± 0.32**	-0.99 ± 0.38**
LMY	0.566 ± 0.04**	-0.33 ± 0.05**	**0.59 ± 0.29**	0.802 ± 0.36**
MYPD	0.026± 0.06	0.103 ±0.06	0.131± 0.06*	**0.08 ± 0.11**

*Values at the diagonal are heritability estimates, and values above and below the diagonal are genetic and phenotypic correlations, respectively; **Highly significant (P≤ 0.01); *Significant (P≤0.05)*

Thus effective selection can be exercised in exploiting genetic variability for improvement in milk production. The estimates of heritability for production traits like LL, DP, LMY, 300 days MY, MYPD and MYCI were estimated as 0.44±0.14, 0.24±0.17, 0.59±0.29, 0.57±0.28, 0.08±0.05 and 0.18±0.11, respectively. Heritability of DP was close to estimates reported by Singh (2012) as 0.27±0.160 in Rathi and higher than results reported by Gahlot (1999), Chand (2011) and Kishore (2016) in Tharparkar cattle. Kachwaha (1993) and Gahlot (1999) reported lower heritability estimate for lactation length as 0.08 ± 0.03 and 0.11 ± 0.04, respectively. Estimate of heritability of LMY were close to the estimates reported by Chand (2011) in Tharparkar as 0.59 ± 0.21. Lower value of heritability of MYPD and MYCI indicated that the major part of the variation in these traits was governed by environmental factors; therefore, efficient management of animals during adverse conditions is a key to enhance the milk production efficiency of herd. Estimates of genetic and phenotypic correlations among wool traits are presented in Table 2. Genetic correlations among different production traits ranged from 0.57 to 0.93 and phenotypic correlations ranged from 0.02 to 0.56. Genetic correlation of LL with DP was found negative and highly significant and positive

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and significant with MYPD and LMY which is desirable. Negative and highly significant phenotypic correlation was observed between LL and DP which is favourable.

Conclusion

Sire affects significantly the production traits in this study, suggesting that sire selection can bring genetic improvement in these traits. For overall improvement and economic benefit emphasis should be given to some reproductive trait like Age at First Calving along with LMY while planning selection strategies. Because positive and highly significant regression was shown by lactation milk yield and three hundred days milk yield on AFC. Efficient management of animals during adverse conditions is a key to enhance the milk production efficiency of herd.

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