Original Research

Genetic Studies on Lifetime Traits of Tharparkar Cattle at Beechwal Farm in Bikaner

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Abstract

Data consisting of 284 lactation records from Tharparkar herd maintained at Beechwal farm spread over a period of eleven years (2006 to 2016) were utilized to examine environmental and genetic factors affecting lifetime traits viz. herd life (HL), productive life (PL), lifetime parity, number of days in milk (NDM), lifetime milk yield (LTMY) and milk yield per day of lactating life (MYPDLL) and consequently estimate genetic and phenotypic parameters. The overall means and standard errors for HL, PL, NDM, LTMY and MYPDLL were 3080.55 ± 84.34 days, 1903.17 ± 77.17 days, 1279.52 ± 55.48 days, 9414.55 ± 406.5 kg and 5.32 ± 0.30 kg, respectively. The respective heritability estimates were 0.80±0.44, 0.73±0.32, 0.76±0.41, 0.50±0.39 and 0.69±0.37. Highly significant (P≤0.01) effect of period of first calving was observed on lifetime traits except lifetime parity and milk yield per day of lactating life. Non-significant (P>0.05) effect of season of first calving was reported on all lifetime traits. The regression of these traits on age at first calving was non-significant. Sire had significant (P≤0.05) effect on herd life and number of days in milk.

Key words: Genetic and Phenotypic Parameters, Heritability, Period of First Calving, Season of First Calving, Sire

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Introduction

The over-all productivity of dairy animal depends on its life time performance rather than on a single lactation performance. The lifetime milk production efficiency can be measured by herd life, productive life, lifetime milk yield, number of days in milk and milk yield per day of lactating life. Herd life expectancy is primary interest to individuals associated with dairy production. There are many genetic and non-genetic

factors which determine the life time milk production of an animal. The effect of year, season, age of first calving are the identifiable factors which account for most of the environmental variation in milk production. The potential for genetic improvement of a trait largely depends upon genetic variation existing in a herd or population of interest. The variability for a particular trait in a population is measured in form of heritability estimate of a trait under given environmental conditions.Hence, present study was undertaken to estimate the genetic and phenotypic parameters *viz.*, heritability, genetic and phenotypic correlations for various lifetime 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

Data consisting of 284 lactation records from 63 Tharparkar cows maintained at Beechwal farm spread over a period of eleven years (2006 to 2016) were collected to present study. 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) which are coded 1, 2 and 3 respectively. Traits included in the present study were lifetime traits *viz.* herd life (HL), productive life (PL), number of days in milk (NDM), lifetime parity, lifetime milk yield (LTMY) and lifetime milk yield per day of lactating life (LTMYPDLL), respectively. The data were adjusted for the effect of non-genetic factors viz. period of first calving, season of first calving as fixed effects. Sires were considered as random genetic effect for all traits.

Least-Squares Analysis

In order to overcome the problem of non-orthogonality of various effects due to inequality and disproportionate sub-class frequencies least- squares procedure was discussed by Harvey (1990) was used for analysis of data.

Mathematical Model for Analysis of Lifetime Traits

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

Where,

Y_{ijklm} = Observation on the m^{th} cow of i^{th} sire, calved in j^{th} period and k^{th} season,
μ = overall mean
s_i = random effect attributed to i^{th} sire
A_j = fixed effect of j^{th} period of first calving
B_k = fixed effect of k^{th} season of first calving
b = regression of variable on age at first calving
X_{ijklm} = age at first calving corresponding to Y_{ijklm}
X = average age at first calving
e_{ijklm} = residual random error under standard assumption which make the analysis valid, i.e. NID $(0,\sigma^2)$

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Heritability Estimation

Heritability of traits was estimated using paternal half sib analysis (Becker, 1968) 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} = measurement of a particular trait,
μ = population mean,
s_i = Random effect of the i^{th} sire and
e_{ij} = Random error NID (0, σ^2).

Estimation of Genetic and Phenotypic Correlations among Reproduction 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 overall least-squares means were observed to be 3080.55 ± 84.34 days, 1903.17 ± 77.17 days, 1279.52 ± 55.48 days, 4.19 ± 0.15, 9414.55 ± 406.5 kg and 5.32 ± 0.30 kg for HL, PL, NDM, lifetime parity, LTMY and LTMYPDLL, respectively (Table1).

Factors Affecting Lifetime Traits

The least-squares analysis were performed to estimate least-squares mean and determine the magnitude of the influence of various factors such as period of first calving, season of first calving, sire effect and age at first calving in various traits.

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Table 1: Least-squares means with standard error of lifetime performance traits

Traits/ Factors	HL	PL	NDM	PARITY	LTMY	LTMYPLL
Overall Mean (μ)	3080.55 ± 84.34 (63)	1903.17± 77.17 (63)	1279.52 ± 55.48 (63)	4.97±0.17(63)	9414.55± 406.5 (63)	5.32± 0.30 (63)
Sire	*	NS	*	**	NS	NS
Period	**	**	**	NS	**	NS
P1 (2006-2008)	3639.61 ± 202.26^{c} (18)	2320.55±188.11^{bc} (18)	1579.48±152.84^{a} (18)	5.41±0.32 (18)	11346.41± 1003.96^{b} (1)	4.61±0.866 (18)
P2 (2009-2011)	3409.66 ± 211.40^{b} (14)	2006.30± 197.03^{b} (14)	1262.07 ± 159.95^{ab} (14)	4.96±0.38 (14)	9371.033±1060.43^{ab} (14)	5.50±0.909 (14)
P3 (2012-2014)	2605.34± 171.80^{a} (31)	1514.81± 158.22^{a} (31)	1087.60 ± 129.10^{c} (31)	3.88±0.41 (31)	7992.26± 810.39^{a} (31)	5.76±0.723 (31)
Season	NS	NS	NS	NS	NS	NS
S1(summer)	3053.89± 187.01 (22)	1917.70± 173.17 (22)	1266.78 ± 14.09 (22)	4.87± 0.31 (22)	8842.96± 908.23 (22)	5.64±0.79 (22)
S2 (monsoon)	3285.74± 238.87 (10)	1813.09± 223.74 (10)	1290.27± 181.25 (10)	4.60± 0.43 (10)	9408.74± 1227.15 (10)	5.32± 1.03 (10)
S3(winter)	3314.99 ± 177.40 (31)	2110.8 ± 163..73 (31)	1372.08 ± 133.47 (31)	5.31±0.37 (31)	10458.01±846.75 (31)	4.92±0.75 (31)
Age At First Calving	NS	NS	NS	NS	NS	NS
Regression coefficient	0.076±0.321	-0.484± 0.298	-0.351± 0.241	-0.0010±0.00	-2.51±1.74	-0.00086±0.0014

*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*

Genetic Factors

Effect of Sire on Lifetime Traits

Sire had a significant effect (P≤ 0.05) on herd life, number of days in milk and parity but non-significant effect on PL, TMY and MYPDLL. Similar results were observed by Mukherjee *et al*. (1999) and Kumar (1999). However, non-significant effect of sire on productive herd life was found by Comacho *et al*. (1995) in Brahman herd.

Non-Genetic Factors

Effect of Period of First Calving

The highly significant (P≤ 0.01) variation was caused by period of first calving in HL, PL, NDM and LTMY while lifetime parity and LTMYPLL did not affected by period of first calving in present study. Reddy and Basu (1985) in Sahiwal crossbred, Nehra (2004) and Prajapati (2013) in Rathi reported significant effect of period of first calving on herd life and productive life while, contrary results observed by Singh (1996) in Rathi and Chand (2011) in Tharparkar. Gandhi and Gurnani (1990a) in Sahiwal, Gahlot (2001) in Tharparkar reported significant effect of period on lifetime milk yield. But Gahlot (1990) in Tharparkar, Singh (1997) and Prajapati (2013) in Rathi did not observe statistically significant effect of period of first calving on this trait. Herd life and productive life declined over the period in present study from first to third period. It is might be due to changes occur in managemental and feeding schedule and cows of period third did not show complete herd life i.e. these cows are still in productive stage and are not disposed off. So we can improve in herd life of cows of period third by good managemental and feeding practices. Cows, that calved first time during first period produced higher lifetime milk yield than others. Because these cows had longer productive life than other cows belongs to other period.

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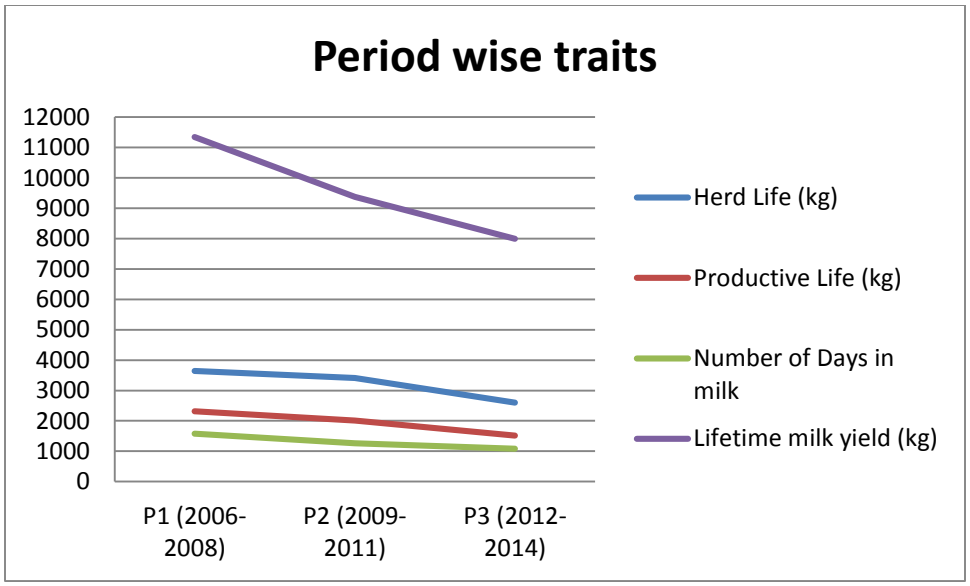

Fig. 1: Period wise traits

Effect of Season of First Calving

All traits were not influenced by season of first calving in present study. It might be due to the managemental practices were effective during various season followed at organized farm to reduce the seasonal variation. Singh (1997) in Rathi cows cattle also reported non-significant effect of season of first calving on herd life and productive life. Reddy and Basu (1985) in Sahiwal crossbred, Gahlot (1990) in Tharparkar and Gupta (1993) in Rathi viewed that season of first calving did not find any significant influence on lifetime milk yield. Gahlot (2001) is not in line with the present finding, who concluded that cows calving in winter season give higher milk yield in her life.

Regression of Lifetime Traits on Age at First Calving

The effect of regression of herd life, productive life, number of days in milk, lifetime parity, total milk yield and milk yield per day of lactating life on age at first calving was non-significant in present study. The results of the study of Singh (1995) support the present findings but diverge from the reports of Jadhav *et al.* (1992) and Rao *et al.* (1996). The regression coefficient was negative for all lifetime traits except for herd life. The positive regression coefficient for herd life (0.076±0.32) indicated that if age at first calving was reduced by selection the herd life would also be reduced.

Heritability and Correlation among Traits

In the present investigation the estimate of heritability, genetic and phenotypic correlations among various lifetime traits are presented in Table 2.

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Table 2: Heritability, phenotypic and genotypic correlation with standard error of lifetime performance traits

	HL	PL	NDM	LTMY	LTMYPLL
HL	**0.80 ± 0.54**	0.172 ±0.61	0.86±0.21**	0.514±0.391*	0.140 ±0.656
PL	0.655 ±0.097*	**0.73 ±0.53**	-0.12±0.14	0.632±0.392**	-0.687±0.36**
NDM	0.715 ±0.089**	0.690 ±0.092**	**0.76 ±0.53**	0.473±0.216**	0.620±0.324**
LTMY	0.707 ± 0.090**	0.845 ±0.068**	0.802 ±0.076**	**0.50 ±0.49**	-0.536±0.327 **
LTMYPLL	-0.098±0.12	-0.312 ±0.118*	-0.054 ±0.126	-0.25±0.122*	**0.69 ±0.52**

*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)*

Heritability estimate indicated that the lifetime production performance traits were moderate to high heritable. It showed that considerable amount of additive genetic variance existed and suggested that the direct selection for these traits could be successful if environmental conditions are more tightly controlled or accounted for the selection programme. Heritability of HL (0.80±0.24) was close to estimates reported by Singh and Dubey (2005) as 0.80 ±0.13 in Red Sindhi cattle. Estimate of heritability of HL and PL was higher to estimates reported by Basu *et al*. (1983) as 0.69 ± 0.10 and 0.63±0.13 in Tharparkar, respectively. Basu *et al*. (1983) reported approx similar heritability of NDM in Tharparkar cattle as 0.67±0.13 as observed in present investigation. Estimate of heritability of LTMY was close to the estimates reported by Taneja *et al*. (1982) as 0.51 ± 0.22 and Basu *et al*. (1983) as 0.51 ± 0.12 in Tharparkar cattle.

Among lifetime traits, genetic correlation of herd life was found positive and non-significant with PL and TMYPLL and significant with NDM and TMY. The genetic correlation of PL was low, negative and non-significant with NDM, negative and significant with MYPDLL, positive and significant with TMY. Positive and significant genetic correlation was found for NDM with TMY and MYPDLL which is favourable. Phenotypic correlation for HL with PL, NDM and TMY was observed positive and significant. Phenotypic correlation of PL with NDM and TMY was high, positive and significant.

Conclusion

In this study, sire affects significantly the lifetime traits which suggested that by sire selection we can bring genetic improvement in these traits. Few cows are still in productive stage and are not disposed off in present study as shown in Table 1. So we can improve in herd life and productive life of cows of period third by good managemental and feeding practices at farm. In present investigation the heritability estimate indicated that lifetime performance traits were moderate to high heritable. So we can improve these traits by selection programmes. Genetic correlation of herd life was found positive and significant with NDM and TMY in present study. So, we can improve these traits by improving in one trait only. Positive and significant genetic correlation was found for NDM with TMY and MYPDLL which is favourable for farm.

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