GENETIC AND PHENOTYPIC TRENDS FOR LACTATION MILK YIELD IN THARPARKAR CATTLE UNDER ARID CONDITIONS OF BIKANER#

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ABSTRACT

A total of 284 performance records belonging to 63 Tharparkar cows in at least three lactations or more lactation spread over a period of fifteen years (2002 to 2016) were utilized to estimate the trends in lactation milk yield. Phenotypic trend was observed positive and significant (P≤0·05) for lactation milk yield and estimated as 19.42±7.21 kg/year (0.96% of HA). The estimates of Genetic trend for this trait by using SM1, SM2, LSMBL and BLUP were 2.301±24.84 (0.114% of HA), 8.62±29.6 (4.30% of HA), 11.97±19.63 (0.59% of HA) and 3.90±1.99 (0.194% of HA), respectively. Comparison of methods of estimation of genetic trend showed that the BLUP method should be used for estimation of genetic trends of economic traits because this method has lower magnitude of standard error in comparison to other methods. For overall improvement in production, emphasis should be given to some reproductive traits like Age at first calving and Service period along with lactation milk yield while planning selection strategies of sire and dam.

***Key words*:** Tharparkar cows, phenotypic trend, genetic trend, lactation milk yield, age at first calving and service period

Introduction

Animal breeders are primarily concerned with the genetic improvement of the animal by making suitable selection and breeding policies and their implementation. The ultimate goal in animal breeding is to rank the animals according to their genetic merit for the desired characters and to use them efficiently in breeding programmes. The genetic evaluation of animals is, therefore a key issue. For a breeding programme, it is pre-requisite to know about the changes occurring in a given population over the years to maximize genetic gain. Genetic and environmental trends provide information about herd improvement over time and are a reflection of the herd's progress compared to the breed as a whole (Hofgren and Schinckel, 1998). Genetic and environmental trends are measure of changes that take place in herd (Falconer and Mackay, 1996).The change or variation in average performance of a herd per unit of time is an indicator of the phenotypic trend and does not indicate the improvement in genetic potential of the animals. Genetic trend is the change in performance per unit time due to the change in mean breeding value (Harville and Henderson, 1967). The effectiveness of breeding programme implemented in herd and management practices are indicated by the positive or favourable genetic and environmental trends. Therefore, to determine the effectiveness of genetic selection, genetic trends in the herd can be considered. The phenotypic trend has two components these are the genetic and environmental trend. The environmental trend is the change in performance per unit time due to change in mean environment. The present study was undertaken keeping above mentioned facts in view on all available records of Tharparkar cattle at Beechwal Farm to estimate genetic, phenotypic and environmental trends in lactation milk yield.

Material and Methods

A study was conducted on 284 lactation records of 63 Tharparkar cows and 9 bulls maintained at the Livestock Research Station, Beechwal, Bikaner, pertaining to the period between 2002 to 2016 to estimate genetic, phenotypic and environmental trends in milk yield.

Estimation of phenotypic trend

The change in annual mean phenotypic effects over years represented the phenotypic trend over time. After standardization of data according the fixed effects, the phenotypic trend was calculated by taking regression of yearly mean performance of the population on the year as:

$$P = bP.T = \frac{\sum pt}{\sum t2}$$

Where,

bP.T = linear regression of population performance (P) on time (year) of calving (T)

∑pt = corrected sum of products for performance of trait and time

$$= \sum PT - \sum P \sum T/N$$

$\sum t^2$ = corrected sum of squares for time taken as deviation from its mean.

$$= \sum T2 - (\sum T)2/N$$

Standard error of phenotypic trend will be estimated as:

$$S.E. = [\sum p2 - bP.T(\sum pt) / (\sum t2)(N-2)]1/2$$

$\sum p^2$ = Corrected sum of square for trait performance

$$= \sum P2 - (\sum P)2/N$$

Where N= total number of records.

Estimation of Genetic trend

The genetic trends were estimated by following four methods.

Smith method1 (SM1) and Smith method 2 (SM2)

The regression of performance (P) on year of calving (T), $b_{P.T}$ consists of two component genetic trend and environmental trend. While expectation of intra-sire regression ($b_{P.T/S}$) is only 1/2g + t because the sire did not vary and only the dams contribute to

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genetic progress. The expected value of the regression of deviation from the contemporary average (P) on time (T), $b_{(p-P).T/S}$ is equal to (1/2 g + t) – (g + t) or –1/2g.The following expectations of regression have found the method of Smith (1962) or some modification of it

$E(b_{P.T})$ = g+t
$E(b_{P.T/S})$ = 0.5g+t
$E(b_{(p-P).T/S})$ = -0.5g
$E(b_{P.T/SD})$ = t

Where,

g = Genetic trends
t = environmental trend
$b^{P.T}$ = is regression of population performance on time
$b^{P.T/S}$ = is within sire regression of progeny performance on time
$b_{(p-P).T/S}$ = is within sire regression of progeny performance on time record being deviated from population mean.
$b_{P.T/SD}$ = regression of performance on time within sire and dam

The above expectations lead to the following two regressions

Methods (SM1 and SM2) for estimating the genetic trends:

(1) $\hat{g} = 2(b_{P.T} - b_{P.T/S})$ Smith method I

i.e. twice the difference in the regression performance on time and pooled intra_sire regression of sire progeny performance on time.

$$SE(g) = 2\sqrt{Vb_{P \cdot T} + Vb_{P \cdot T/S}}$$

(2) $\hat{g} = -2(b_{(p-P).T/S})$ Smith method II

i.e. negative twice the pooled intra-sire regression of the records of sire progeny on time, each record being expressed as a deviation from the herd mate average (the average of all records made in a year excluding the record of the animal and its paternal half-sibs i.e. contemporary, year average). This method avoids year to year fluctuations in the environment and hence it gives more realistic estimate as compared to the first method.

$$SE(g) = 2\sqrt{Vb(p-P) \cdot T/S}$$

Least squares method of burnside and legate (LSMBL)

In this method, b(ΔG/2 + ΔE) was obtained from the weighted regression of year constants on years and these year constants were obtained from least squares analysis making adjustment for sire, year and season. Differences in these year constants, which was adjusted for sires, reflected the differences in the dam effects and the environmental effects associated with different years, i.e. one half of genetic trend plus the environmental trend, b (ΔG/2 + ΔE).

$$\Delta G = 2(b\Delta G + \Delta E - b\Delta G/2 + \Delta E)$$

Where,

bΔG+ΔE = weighed regression of year constants on years which indicate the phenotypic change

bΔG/2+ΔE = weighed regression coefficient which expressed one half of genetic trend plus environmental trend.

bΔG/2+ΔE was estimated using the following model:

$Y^{ijkl} = \mu + S_i + M_j + P_k + b(X_{ijkl} - X) + e_{ijkl}$

Y_{ijkl} = Observation on the l^{th} progeny of i^{th} sire under j^{th} season and k^{th} period

μ = overall mean
s_i = random effect attributed to ith sire
M_j = fixed effect of jth season of calving
P_k = fixed effect of kth period of calving
b = regression coefficient of Y_{ijkl} on AFC
X_{ijkl} = age at first calving corresponding lth animal
X = mean of X_{ijkl}
e_{ijkl} = residual random error under standard assumption which make the analysis valid, i.e. NID $(0,\sigma^2)$

For estimation of genetic trends of age at first calving (AFC), the model was the same as that used for least squares analysis of AFC data taking year of birth and season of birth without regression effect in the model.

Best linear unbiased prediction (BLUP) method

The genetic trends will be estimated by calculating the transmitting ability (ETA) of sires. The transmitting ability of sire is half of additive genetic value and therefore genetic trends were obtained as 2 times regression of weighted average of sire's transmitting abilities (WAETA) for each year on year as: (Hintz et al., 1978)

$$WAETA = \sum nik\, si/n.k$$

Where,

n_{ik} = Number of daughter of sire i (i= 1, 2, … ..,m) in k^{th} year
S_i = Estimated Transmitting ability (ETA) of sire ith
n.k = Number of daughters of m sires in the kth year

Transmitting ability is half of the additive genetic value and additive genetic value calculated by BLUP (best linear unbiased prediction) method (Henderson, 1975).

Estimation of environmental trends

Environmental trend (ΔE) was obtained by subtracting the genetic trend (ΔG) from the overall phenotype trend (ΔP).

$$\Delta E = \Delta P - \Delta G$$

The standard error of environmental trend, SE (ΔE) was calculated as:

$$S.E.(\Delta E) = \sqrt{S.E.(\Delta P)2 + S.E.(\Delta G)2}$$

Results and Discussion

Genetic, phenotypic and environmental trends in lactation milk yield.

A positive and significant phenotypic trend of 19.42±7.21 kg/ year (0.96% of herd average) was estimated for lactation milk yield. Figure (1) showing positive and significant increase over the period which is in direction of improvement and milk yield fluctuate over the period and greater fluctuation is seen between 2010 to 2012.There was increase pattern observed after 2014, which is indication of good managemental practices and feeding management at farm.

Similar results were observed by Singh and Gurnani (2004) in Karan Swiss cattle and Kaygisiz (2010) in Brown Swiss cattle. On the other hand, Kumar and Narain (1979) reported negative phenotypic trend in lactation milk yield.

The estimates of Genetic trend for this trait by using SM1, SM2, LSMBL and BLUP were 2.301±24.84 (0.114% of HA), -8.62±29.6 (4.30% of HA), 11.97±19.63 (0.59% of HA) and 3.90±1.99 (0.194% of HA), respectively. Milk yield showed positive and significant genetic trend according to BLUP method which is indication of good managemental practices and feeding

management at farm. The negative genetic trends revealed that the sires used in later years were of inferior genetic worth to those used in early years. This might be because of lack of systematic breeding plans, effective selection and/or acclimatization of animals. Singh *et al.* (2002), Gaur *et al.* (2003) and Ambhore et al. (2017) also reported positive genetic trend in milk yield. However, Amimo et al. (2007) and Bakir and Kaygisiz (2009) carried out negative genetic trend in this trait.

The environmental trends for LMY were 17.11±25.86, 28.04±30.46, 7.45±20.91 and 15.52±7.47 kg per year by SM1, SM2, LSMBL and BLUP methods respectively. Positive environmental trends indicated that phenotypic improvement is higher to genetic gain in lactation milk yield.

Conclusion

For overall improvement and economic benefit emphasis should be given to some reproductive traits like Age at first calving and Service period along with LMY while planning selection strategies.

Based on the present investigation, it is suggested that the BLUP method should be used for estimation of genetic trends of economic traits because it give relatively lower sampling error compared to other methods and corrected for environmental factors more efficiently than other methods.

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Conflict of interest

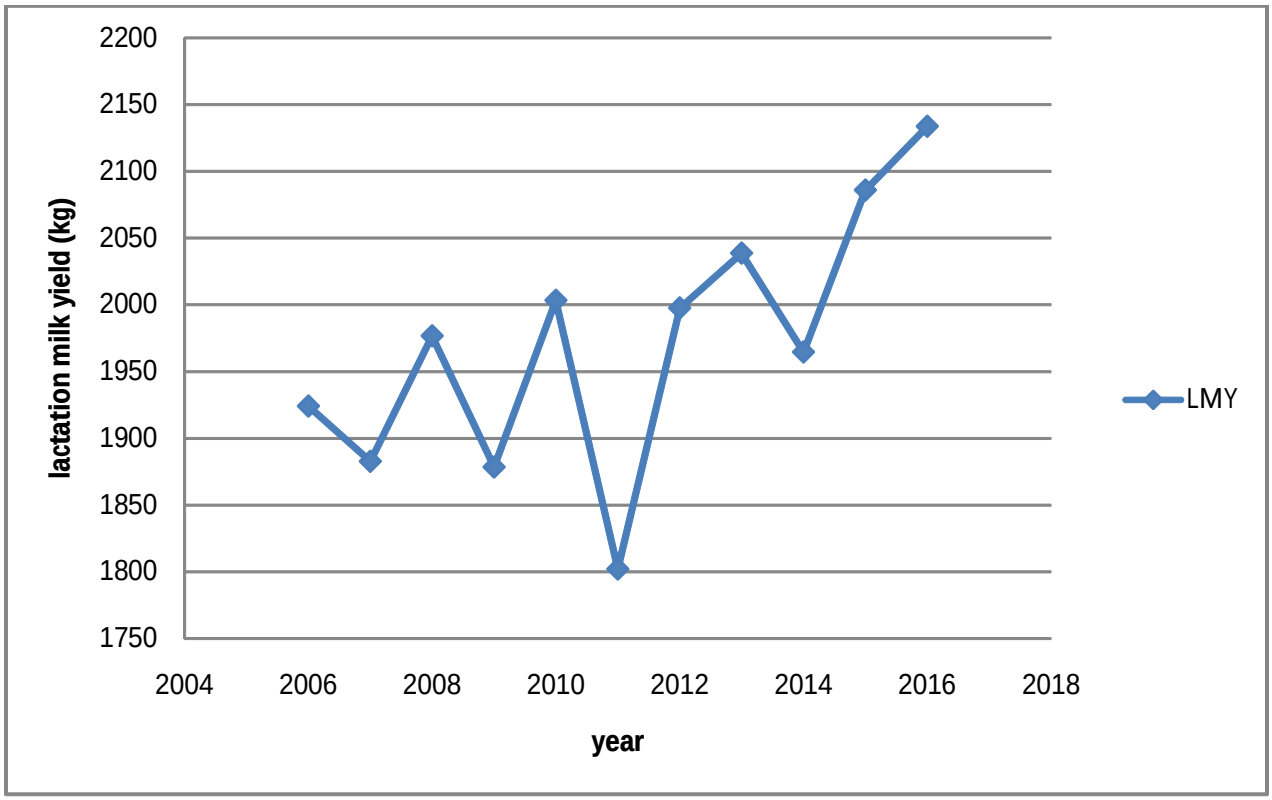
The authors report no conflicts of interest to disclose. All authors gave their consent for the publication of the results obtained in this study.

Table 1: Genetic and environmental trends for lactation milk yield of Tharparkar cattle by different methods

Trait	Trends	Smith method		LSMBL	BLUP
		SM1	SM2		
LMY	ΔG	2.301±24.84	-8.62±29.6	11.97±19.63	3.90±1.99*
	% of HA	0.114	4.30	0.59	0.194
	ΔE	17.11±25.86	28.04±30.46	7.45±20.91	15.52±7.47*

** - Highly significant (P≤0.01); * - Significant (P≤0.05); HA- herd average

Fig. 1 Annual Phenotypic trend for lactation milk yield in Tharparkar cattle (ΔP = 19.42±7.21* kg/year, 0.96% of HA)



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