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Enhancement of Production Performance of Tharparkar Cattle using Lactation Persistency as A Selection Tool

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ABSTRACT

Background: Lactation persistency of cattle is the ability to maintain constant milk production after the peak milk yield. This work was conducted using a total of 372 daily milk yield records of all parities of 190 Tharparkar cattle sired by 38 bulls from 1990 to 2019 (29 years), collected from Animal Genetics and Breeding Division, maintained in Livestock Research centre of NDRI, Karnal.

Methods: The lactation persistency was estimated using Mahadevan's method (1951) based on the ratio of milk production in first 28 weeks to milk production in 10 weeks. Standard error as percentage of mean was used to test the efficiency of persistency indices. To study the effect of non-genetic factors Least-squares analysis was carried out by Harvey (1990) model.

Result: The least squares mean of total milk yield (TMY), lactation length (LL), peak yield (PY), days to attain peak yield (DAPY) and lactation persistency (LP) were 1633.40±45.79Kg, 272.55±4.64 days, 10.83±0.17kg, 41.48±2.34 days and 1.27±0.02 respectively. First calvers had highest LL, DAPY and persistency. Rainy calvers had more TMY, LL, DAPY and LP and winter calvers were the low performers. Correlation of persistency with TMY, LL and DAPY were highly significant and positive. There was negative correlation with PY and LP. The estimated heritability for TMY, LL and PY was 0.16±0.34, 0.49±0.38 and 0.84±0.41 respectively. The heritability estimate of lactation persistency was very low with high standard error which revealed the significance of environmental effect in persistency.

Key words: Correlation, Heritability, Lactation persistency, Least squares means.

INTRODUCTION

Indian cattle have high tolerance to heat, inherent disease resistance and ability to succeed under adverse climatic conditions. Among the indigenous cattle population in India, Tharparkar is a well-known breed of dairy cattle that adjusted itself over the years to desert conditions. As a dual purpose breed Tharparkar cattle produce reasonable amount of milk with an average yield of 1749 kilograms per lactation (ranging from 913 to 2147 Kg per lactation) (Dairy knowledge.in). In view of importance of this breed, efforts need to be made for their maintenance and various criteria of selection can be used to make genetic improvement for the increased milk production and overall performance of Tharparkar cattle.

One of the important criteria for productivity of any lactating cow is maintenance of peak yield for a longer period (Rakes *et al*. 1963). Persistent animals produce more milk which is attributed to the uniform milk production throughout its lactation (Gengler *et al*. 1995). Persistency can be explained as number of days during which the high level of milk production is maintained after the peak milk yield (Gengler, 1996). High degree of persistency during the first lactation is desirable and it can be taken as one of the selection strategy for dairy animals. The advantage of highly persistent cows are, they are relatively high lactation yielders and have prolonged productive life, reduced health problems, reduced stress from peak milk yield, better utilization of feed and low reproductive costs (Cole and Null, 2009; Strabel *et al*. 2001; Gengler, 1996). Tharparkar cattle considered as a dairy breed, persistency of production is considered as an important factor for improving the production performance of the cattle as it enhances the economic milk production and generates more return to the farmers. So, persistency can be used as a selection criteria for better performance of Tharparkar cattle.

The non-genetic factors and environment have great influence on production performance of cattle. Still now less tries to study the effect of non-genetic factors and environmental influence on persistency of lactation and its effects on production traits like total milk yield (TMY), lactation length (LL), peak yield (PY) and days to attain peak yield (DAPY) in Tharparkar cattle. Accordingly a study has been made to know the effect of lactation persistency in production performance and how the non-genetic factors influence the production traits and persistency of lactation in Tharparkar cattle.

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MATERIALS AND METHODS

A total of 372 milk yield records (305-day or less) of all the lactations at daily milk yield basis from 1990 to 2019 (29 years) were collected for 190 Tharparkar cows sired by 38 bulls from history sheets and daily milk records maintained at Animal Genetics and Breeding Division of National Dairy Research Institute, Karnal. The normal lactation considered as the period of milk production by a cow for atleast 100 days and more than 500 kg milk yield. Each year was classified into four seasons namely winter (December-March), summer (April-June), rainy (July-September) and autumn (October-November) based on agro-climatic conditions. Period of calving was classified into six groups each with four years.

Calculation of persistency

Lactation persistency was estimated by Mahadevan's method (1951):

$$P = \frac{A - B}{B}$$

Where,

A = Lactation milk yield during the first 26 week of lactation.

B = Lactation milk yield during the first 10 weeks of lactation.

The data used in the present study had unequal sub-class frequencies. Disproportionate sub-class frequencies caused the different classes of effects to be non-orthogonal. The data was adjusted for the effect of non-genetic factors like parity, season, period of calving on persistency of milk yield. Least-squares analysis was carried out for non-orthogonal data as described by Harvey (1990) model:

$$Y_{ijk} = \mu + P_i + S_j + PC_k + e_{ijk}$$

Where,

Y_{ijk} = Observation on the n^{th} individual born in i^{th} parity, j^{th} season and k^{th} period of calving

μ = Overall population mean

P_i = Effect of i^{th} parity

S_j = Effect of j^{th} season

PC_k = Effect of k^{th} period of calving

e_{ijk} = Random error, assumed to be normally and independently distributed with mean zero and constant variance *i.e.* NID (0, σ^2_e)

Difference among least squares means was tested by using DMRT modified by Kramer (1957). The heritability of persistency and production traits was estimated by paternal half-sib correlation method (Becker, 1986). The correlation of persistency of lactation with peak yield, lactation length and total milk production was estimated by standard correlation formula.

RESULTS AND DISCUSSION

The overall least squares mean for TMY, LL, PY, DAPY and lactation persistency (LP) estimated using Mahadevan's method are given in Table 1

Based on the data total milk yield of Tharparkar cattle was 1633.40 ± 45.79kg coming under the range of milk production of milch cattle breeds (range from 1600) and was showing average lactation length of 272.55 days and average peak yield of about 10.83 ± 0 .17 Kg. Persistency was estimated using Mahadevan's method, persistency of 1.27 ± 0.023. Standard error (SE) as percentage of mean was used to test the efficiency of persistency indices. The lower the SE expressed as percent of population mean, higher would be efficiency of the persistency parameters (Kaushal *et al.* 2016). For Mahadevan's method SE as percentage of mean value was 1.5%, which shows that it had good efficiency.

Least squares analysis of variance using mixed model (model-1) was used to study the effect of various non-genetic factors such as parity, season and period of calving by taking as the fixed effect. The mean sum of squares of each fixed effect is shown in Table 2.

The effect of parity was highly significant (P<0.01) on all production traits and lactation persistency except TMY (Table 2). When comparing different lactation orders, found that first lactation was showing highest lactation length, DAPY and LP, but peak yield was high in later parities (Table 3). When consider TMY, there was no such trend of decline or progress in production. The first parity differed significantly from other parities in all the traits. Whereas, the differences in PY and LP between third, fourth and above were statistically non-significant (P>0.05) (Table 3). When compared the LP, similar inferences were drawn by Singh and Shukla (1985) in Gir and Yadav *et al*. (1994) in

Table 1: Overall mean and simple mean of production traits and lactation persistency estimate.

Production traits	Simple means ± SE (kg)	Least square means ± SE (kg)
TMY	1638.57 ± 37.86	1633.40 ± 45.79
LL	276.89 ± 3.89	272.55 ± 4.64
PY	10.72 ± 0.16	10.83 ± 0 .17
DAPY	42.55 ± 2.06	41.48 ± 2.34
LP	1.31 ± 0.02	1.27 ± 0.02

Table 2: Mean sum of squares of production traits and lactation persistency estimate.

Source of variation	Degree of freedom	TMY	LL	PY	DAPY	LP
Parity	4	433844.20	21597.34**	139.20**	16108.21**	2.3309**
Season	3	266744.67	2202.27	44.21**	6656.31**	0.9598**
Period of calving	5	1388436.51*	16102.79*	51.30**	3111.22*	0.1415
Error	362	527891.40	5427.99	7.93	1389.39	0.112541

** Highly significant (P < 0.01), *Significant (P < 0.05) and Non- Significant (P > 0.05).

Tharparkar cattle. The increase in lactation length, lactation persistency and days to attain peak yield might be due to positive energy balance and continued differentiation of secreting cells up to the peak lactation in the mammary gland which maintain secretion for more duration in first lactation when compared with later lactations. In udder by the action of apoptosis the proportion of number of secretory cells were reduced in later stages of production and milk production decreases (Stefanon *et al.* 2002).

The season of calving had highly significant (P<0.01) effect on PY, DAPY and LP (Table 3). The best performance of Tharparkar cattle was seen in rainy season with high LP, TMY and DAPY. In summer and rainy season more lactation length was seen. In winter season early attainment of DAPY with highest peak yield and showing shortest LL. When comparing seasons, each season was showing statistical difference in PY, DAPY and LP (Table 3). Plenty of green fodder, favourable climatic conditions and managemental practices made the rainy calvers more persistent. Sudden decline in milk production after the peak yield in winter calvers was seen due to the unfavourable environmental effect and deficiency of nutritive feed, which had shown that the availability of nutritious feed and fodder, temperature have significant influence in the production performance of Tharparkar cattle. Sachan *et al*. (2020), Kaushal *et al.* (2016) and Zurwan *et al*. (2017) reported significance of season of calving in Sahiwal cattle. Kumar and Singh (2006) observed significance of season of calving in Karan Fries cattle.

The effect of period of calving was highly significant (P<0.01) in PY and significant (P < 0.05) in TMY, LL and DAPY (Table 3). Due to the environmental variations and changes in managmental practices the period of calving become significant for different production traits and measures of persistency estimation. One of the other reason for the significance of period of calving was the change in genetic constitution of herd which changes over the years. No regular trend in production traits and measures of persistency over periods were observed. Period of calving had significant effect on Mahadevan method of persistency estimation was reported in HF, HF crossbred, Phule Triveni, Sahiwal and Karan Fries cattle described by Sharma *et al.* (2018), Fadlelmoula *et al.* (2007), Guler and Yanar (2009), Garudkar *et al.* (2018), Sachan *et al*. (2020) Kaushal *et al.* (2016), Zurwan *et al.* (2017) and Kumar and Singh (2006) respectively.

Table 3: Parity, Season and period of calving wise least square means and their standard errors for different production traits and persistency.

Class	No. of observation	TMY	LL	PY	DAPY	LP
Mean	375	1633.40 ± 45.79	272.55 ± 4.64	10.83 ± 0 .17	41.48 ± 2.34	1.301 ± 0.023
Lactation order						
1	114	1538.60 ± 79.53	300.72^{a}± 8.06	8.39^{c} ± 0.30	67.58^{a} ± 4.08	1.61^{a} ±0 .03
2	88	1708.29 ± 80.50	278.21^{b} ± 8.16	10.98^{b} ± 0.31	40.70^{b} ± 4.13	1.3^{b} ± 0.03
3	47	1662.44 ± 108.68	263.20^{c}± 11.02	11.42^{a} ± 0.42	27.73^{d} ± 5.57	1.17^{c} ± 0.05
4	45	1569.21 ± 112.99	249.16^{d}± 11.45	11.57^{a} ± 0.43	33.92^{c}± 5.79	1.12^{c} ± 0.05
5 to 8	81	1688.49 ± 90.41	271.46^{bc}± 9.16	11.77^{a} ± 0.35	37.50^{bc} ± 4.63	1.15^{c} ± 0.04
Season						
Winter	168	1666.27 ± 59.13	268.07± 5.99	11.73^{a} ± 0.22	32.23^{c} ± 3.03	1.15^{a} ± 0.02
Summer	109	1645.96 ± 72.47	277.73± 7.34	10.70^{b} ± 0.28	39.99^{b} ± 3.71	1.31^{b}± 0.03
Rainy	54	1696.91 ± 100.94	274.48± 10.23	10.19^{c} ± 0.39	54.16^{a} ± 5.17	1.40^{c} ± 0.04
Autumn	44	1524.47 ± 112.31	269.91± 11.38	10.69^{b} ± 0.43	39.55^{b} ± 5.76	1.23^{d}± 0.05
Period of calving						
1990-1994	54	1656.93^{b} ± 117.80	261.49^{c}± 11.94	11.35 ^{b}± 0.45	30.99^{d} ± 6.04	1.16 ± 0.05
1995-1999	59	1860.44^{a} ± 100.15	305.18^{a}± 10.15	10.72^{c} ± 0.38	40.14^{bc}± 5.13	1.31 ± 0.04
2000-2004	54	1502.58^{c}± 103.14	280.58^{b}± 10.45	10.11^{d} ± 0.39	54.50^{a} ± 5.29	1.29 ± 0.04
2005-2009	64	1631.60^{b} ± 94.97	266.64^{c}± 9.63	11.13^{b} ± 0.36	44.07^{b} ± 4.87	1.26 ± 0.04
2010-2014	67	1704.73^{b} ± 93.93	258.60^{c}± 9.52	12.05^{a} ± 0.36	42.51^{b} ± 4.81	1.31 ± 0.04
2015-2019	77	1444.14^{c}± 87.56	262.80^{c}±8.87	9.60^{e} ± 0.33	36.69^{cd} ± 4.49	1.32 ± 0.04

Table 4: Estimates of correlation between production traits and lactation persistency.

Traits	LP	TMY	LL	PY	DAPY
LP	1	0.137*	0.280**	-0.319**	0.609**
TMY	0.137*	1	0.627**	0.686**	0.055
LL	0.280**	0.627**	1	0.173**	0.173**
PY	-0.319**	0.686**	0.173**	1	-0.210**
DAPY	0.609**	0.055	0.173**	-0.210**	1

** Highly significant (P < 0.01), *Significant (P < 0.05) and Non- Significant (P > 0.05).

There was highly significant (P<0.01) positive correlation between lactation persistency with LL and DAPY and positive significant (P<0.05) correlation with TMY (Table 4). In indigenous breeds, positive correlation was reported by Saxena and Kumar (1960), Gill *et al.* (1971), Singh *et al*. (1965), Sharma and Bhatnagar (1972), Shingare *et al.* (2015) and Sachan *et al*. (2020). However, lactation persistency had negative highly significant (P<0.01) correlation with peak yield in Tharparkar cattle. But peak yield had positive highly significant correlation with TMY and LL. The positive correlation of persistency with DAPY shows the significance of late peak yield day in prolonged production life (Table 4). In Hariana cattle Gill, (1971) and Singh *et al*. (1965) reported negative correlation with peak yield. The positive correlation of lactation persistency with production traits shows that the lactation persistency of Tharparkar cattle can be used as an indirect selection tool for the selection of good productive Tharparkar cattle. The positive significant correlation between LP and LL shows that highly persistent animal should have prolonged productive life. Shingare *et al.* (2015), Sachan *et al*. (2020) and Seangjun *et al*. (2009) found positive correlation.

The estimates of heritability for TMY, LL and PY was 0.16 ± 0.34, 0.49 ± 0.38 and 0.84 ± 0.41 respectively. The heritability estimate of lactation persistency was very low with high standard error which shows the significance of environmental effect in persistency.

CONCLUSION

From the analysis of production performance of Tharparkar cattle, it is found that Tharparkar cattle is a good milch breed than a dual purpose breed. An average milk production of 1638.57 kg, lactation length of 277 days and peak yield of 10 kg showing its good performance. Mahadevan's method of lactation persistency estimate showed that the better persistency of 1.27 in Tharparkar cattle. All the non-genetic factors had significant effect on production traits and in persistency estimate also. In Tharparkar cattle first parity had more lactation length and persistency. Rainy season calvers had more production than any other season calvers. When comparing different period of calving, due to the management and environmental changes there was wide variation in TMY, LL and PY from 1990 to 2019. The positive significant correlation of lactation persistency with production traits shows the usefulness of persistency as a selection tool for the selection of Tharparkar cattle.

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