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Effects of Non-genetic Factors on Production and Reproduction Traits in Tharparkar Cattle under Arid Region of Rajasthan

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ABSTRACT

Background: Tharparkar is one of the important milch breed of cattle for the arid western region of India, which has the capacity to withstand harsh desert climatic conditions and has high thermo-tolerance gene (Bhat *et al.,* 2016) with better reproductive efficiency and milk production.

Methods: The present investigation was undertaken on 422 lactation record of 95 cows spread over 30 years from 1990 to 2020, available at ICAR-Central Arid Zone Research Institute, Jodhpur (Rajasthan). Various lactation and reproduction traits in Tharparkar cattle were analysed by using Linear Mixed Model methodology.

Result: The overall least-square means were 1803.05±31.59 litre for 305-days lactation yield, 1915.38±36.87 litre for total lactation yield (TLY) in 313.12±4.28 days of lactation length (LL). The peak yield (PY) was 10.29±0.12 litre and days to attain peak yield was 68.12±2.16 days of calving. The least-square means of dry period (DP) and calving interval (CI) were 114.23±4.81 and 427.01±5.49 days, respectively. Significant improvement in production and reproduction traits was observed may be due to selection of high yielding animals and improving management condition of herd. Rigid culling of animals should be followed after 5th lactation onwards to make the dairy farm profitability. Non-significant effect of season of calving indicated the adaptive character against the extreme climatic conditions of the arid zone.

Key words: Arid zone, Non-genetic factors, Production traits, Reproduction traits, Tharparkar.

INTRODUCTION

The western arid region of the country possesses a vast resource of milch cattle (*Bos-indicus*) and these animals play a vital role in the socio-economic upliftment of rural masses. In Rajasthan, dairying is the most promising sector for sustaining and enhancing income of dairy farmers. This sector is contributing about 35% of the income of the small and marginal farmers and alone contributes 8-10% in the state GDP (Sharma and Sharma, 2021). Tharparkar is one of the important milch breed of western arid part of India, it is also known as a *White Sindhi* breed in the Tharparkar district of Sindh province in Pakistan (Khan and Isani, 1994). In India, animals of this breed are found in Jodhpur, Barmer, Jaisalmer districts of Rajasthan and Kutch region of Gujarat. This breed is medium sized, strong with straight limbs and good feet, alert and is quite docile. The usual colour of the cattle is white or grey. The grey colour may be deepened during winter season to absorb more solar radiations. This breed is well adapted against harsh climatic conditions and can tolerate extreme environmental temperature from very low (freezing) to high (48°C). This breed has also capacity to thrive on poor quality forage and local non-conventional feed (Mathur *et al.,* 1989). The success of dairy cows with indigenous breeds depends on the level of production and reproduction performance of animals. This can be increased through management and genetic improvement. The external environmental stimuli, including physical, chemical, climatic and biological to which animals respond interacts with their genotypes to determine level of performance. Better management and control of environmental factors (non-genetic) can provide ideal conditions for dairy cattle. Knowledge of non-genetic factors affecting milk production and reproductive efficiency are essential to improve the management and productivity level. Therefore, the present investigation was carried out to assess the effect of non-genetic factors on different production and reproduction traits in Tharparkar cattle.

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MATERIALS AND METHODS

The data were collected on Tharparkar cattle from the history sheets maintained over the period from 1990 to 2020 in the Division of Livestock Production and Range Management, ICAR-Central Arid Zone Research Institute, Jodhpur. The nutritional requirements of animals were met out by 5 to 6 hours grazing and stall feeding with dry fodder of crop residues and concentrate feed in the form of pellets (Saras Gold) available in market with 18-20% CP as per standard

norms. The Saras Gold is composed mainly of grass powder, oats, legume, rape powder and cotton seed for protein supplements. The cows were milked by hand milking twice a day and some amount of concentrate feed was provided in milking byre. The weaning was not practiced on the farm and the calves were allowed to suckle their dams for initiation of the let-down of milk. The production traits studied were total lactation milk yield (LMY), 305 days or less lactation milk yield (305-LMY), lactation length (LL), lactation peak yield (PY), days to attend peak yield (DPY), milk yield per day of lactation length (MY/LL), milk yield per day of calving interval (MY/CI) and reproductive traits like dry period (DP) and calving interval (CI). A total of 422 lactation records of 95 cows spread over 30 years were collected. Abnormal lactation records due to specific causes like abortion, any ailment, lactation length less than 100 days were excluded. The entire duration of 30 years from 1990 to 2020 was divided into 6 periods on the basis of climate of arid region and sire used in herd. Each year was divided into three seasons *viz*. winter (November to February), summer (March to June) and Rainy and Autumn (July to October) on the basis of fluctuations in atmospheric temperature and relative humidity. The effect of parity for economic traits was analysed from 1 to 7 and above parities. The data were assigned to linear mixed model equation (LMME) analysis using IBM SPSS (2019) version 25.0. With the following model:

$$Y_{ijkl} = \mu + P_i + S_j + L_k + e_{ijkl}$$

Where,

Y_{ijkl} = i^{th} observation in K^{th} parity, j^{th} season and i^{th} period of calving.

μ = Overall mean.

P_i = Effect of the ith period (i= 1-6).

S_j = Effect of the jth season (j= 1 to 3).

L_k = Effect of the kth parity (k= 1 to 7)

E_{ijkl} = Random error, distributed as, NID (0, σ_e^2).

Duncan's multiple range test (Kramer, 1957) was used for analysing subclass differences.

RESULTS AND DISCUSSION

The production and reproduction performance are the important economic traits of a dairy animal governing the economic viability of dairy farming. The study of these economic traits is not only essential for genetic improvement, but also critical for overall improvement of productive efficiency. The least-square means of overall lactation were 1803.05±31.59 litre for 305-days lactation yield (305-d LY), 1915.38±36.87 litre for total lactation yield (TLY) in 313.12±4.28 days of lactation length (LL) (Table 1). Higher lactation yield was reported in Tharparkar cows by Chand, 2011 (2064.6 kg) and Kishore, 2012 (2021.0 kg). Which could be due to differences in selection intensity for milk production trait and feeding management among the farms. However, lower lactation yield was reported by Patel *et al.* (2000) (1504.5 litre) and Bhattacharya *et al.* (2002) (1525.06 kg). The peak yield (PY) was 10.29±0.12 litre/d and days to attain peak yield was 68.12±2.16 days of calving. Khadda *et al*. (2011) observed higher peak yield of 11.86±0.15 kg/d in early lactation days at 29.28±0.32 days in Tharparkar cows of Livestock Research Station, Chandan farm, Jaisalmer, Rajasthan. The production efficiency traits were 6.07±0.08 and 4.62±0.09 litre for milk yield per day of lactation length (MY/LL) and per day of calving interval (MY/CI), respectively. Similarly, the least-square means for different reproduction traits were 114.23±4.81 and 427.01±5.49 days for dry period (DP) and calving interval (CI), respectively (Table 1). Mishra *et al*. (2018) observed lower dry period (105.03±2.09 days) and calving interval (399.97±2.44 days) of Tharparkar cattle in comparison to the present study.

Effect of season of calving

All the milk production and reproduction traits of Tharparkar cows in the present study were not influenced significantly by season of calving (Table 1), however, comparatively higher milk yield was observed in lactation and peak yield in cows which calved during winter and summer season than rainy and autumn season (July to October). The lower milk yield during July to October months could be due to prevailing hot humid weather conditions in arid zone, which created uncomfortable climatic conditions affecting physiology and production capacity of animals. Similar to the present findings, the non-significant effect of season of calving was also observed in several studies in Tharparkar cattle by Patel *et al*. (2000) for lactation yield, dry period and calving interval, Khadda *et al*. (2011) for peak yield and days to attain peak yield. The calving interval was also not significantly affected by season of calving as reported (Kishore *et al.,* 2016 and Choudhary *et al.,* 2019). The reason for non-significant effect of season of calving on most of the production and reproduction traits in present studies could be due to adaptability of this breed against climatic variation from very high to low environmental temperature in arid zone and better feeding management in herd which might have supported animals' physiology to cope up against extremes of weather conditions. On the contrary, the significant effect of calving season was also reported on calving interval of cows by Gahlot (1999) and Hammoud *et al.* (2010).

Effect of period of calving

Milk production of Tharparkar cows in 305 days and total lactation period was significantly influenced by the period of calving, the milk production performance of cows was continuously increased over the period up to 5th period (Table 1). Similarly, the milk yield efficiency traits MY/LL and MY/CI and peak yield during lactation were also increased up to the 5th period (2011-2015). Overall, 21% improvement of milk yield of Tharparkar cows was observed in total lactation, this could be due to the selection of cows and use of higher breeding value bulls for milk production traits in herd. Secondly, the management conditions were improved for health care, feeding practices and housing facilities in cattle herd in the last 30 year period. Similar to the present study,

Table 1: Least-squares means with their standard errors of various production and reproduction traits of Tharparkar cattle.

Effect/ trait	Lactation length (day)	305 LY (litre)	TLY (litre)	MY/LL (litre)	MY/CL (litre)	DP (day)	CL (day)	PY (litre)	DAPY (day)
Overall	313.12±4.28 (422)	1803.05±31.59 (422)	1915.38±36.87 (422)	6.07±0.08 (422)	4.62±0.09 (370)	114.23±4.81 (370)	427.01±5.49 (370)	10.29±0.12 (422)	68.12±2.16 (413)
Season of calving	NS	NS	NS	NS	NS	NS	NS	NS	NS
Rainy and autumn (July-Oct)	307.25±8.27 (101)	1763.42±61.03 (101)	1866.69±71.21 (101)	5.93±0.15 (101)	4.61±0.17 (88)	111.96±9.30 (88)	422.93±10.61 (88)	10.14±0.24 (101)	69.16±4.14 (100)
Summer (Mar-June)	317.67±7.00 (137)	1808.10±51.63 (137)	1940.99±60.25 (137)	6.11±0.13 (137)	4.58±0.14 (117)	115.07±7.88 (117)	429.50±8.98 (117)	10.38±0.20 (137)	68.40±3.54 (133)
Winter (Nov- Feb)	314.43±6.07 (184)	1837.64±44.79 (184)	1938.46±52.26 (184)	6.17±0.11 (184)	4.66±0.12 (165)	115.65±6.70 (165)	428.60±7.64 (165)	10.35±0.17 (184)	66.82±3.05 (180)
Period of calving	*	**	**	**	**	NS	NS	**	**
1990-95	328.97±11.86^{b} (51)	1599.14±87.47^{a} (51)	1777.30+10.07^{a} (51)	5.35±0.22^{a} (51)	4.10±0.24^{a} (46)	124.93±13.13 (46)	454.83±14.97 (46)	9.66±0.35^{a} (51)	64.63±6.22^{a} (45)
1996-2000	305.46±10.24^{ab} (61)	1565.24±75.54^{ab} (61)	1654.01±88.15^{a} (61)	5.37±0.19^{ab} (61)	3.84±0.21^{a} (54)	132.95±11.34 (54)	422.92±12.93 (54)	9.38±0.30^{ab} (61)	58.76±5.23^{a} (58)
2001-05	282.50±9.85^{a} (70)	1785.92±72.68^{abc} (70)	1864.22±84.81^{ab} (70)	6.50±0.18^{cd} (70)	4.77±0.20^{b} (62)	109.77+11.05 (62)	400.93+12.60 (62)	10.67±0.29^{c} (70)	62.19±4.90^{a} (70)
2006-10	320.41±9.72^{ab} (69)	2021.54±71.72^{cd} (69)	2149.87±83.69^{b} (69)	6.64±0.18^{d} (69)	5.20±0.19^{b} (64)	108.35±10.55 (64)	431.89±12.03 (64)	10.93±0.28^{c} (69)	63.24±4.84^{a} (69)
2011-15	317.61±8.61^{ab} (88)	2060.78±63.54^{d} (88)	2146.59±74.15^{b} (88)	6.75±0.16^{d} (88)	5.22±0.18^{b} (78)	98.48±9.62 (78)	415.22±10.97 (78)	11.07±0.25^{c} (88)	74.49±4.28^{ab} (88)
2016-2020	323 .74±8.79b (83)	1785.70±64.88bcd (83)	1900.28±75.71ab (83)	5.82±0.16bc (83)	4.58±0.19b (66)	110.90+10.26 (66)	436.26±11.70 (66)	10.02±0.26bc (83)	85.44±4.37b (83)
Parity	**	**	*	**	**	NS	**	**	NS
1	364.08±8.78^{c} (85)	1610.00±64.8 ^{la} (85)	1862.81+75.63^{ab} (85)	5.06±0.16^{a} (85)	3.94±0.17^{a} (82)	120.44±9.36 (82)	480.03±10.68^{b} (82)	8.36±0.26^{a} (82)	77.48±4.50 (80)
2	297.05±9.23^{ab} (76)	1594.16±68.12^{a} (76)	1686.20±79.49^{a} (76)	5.57±0.17^{ab} (76)	4.04±0.18^{ab} (72)	118.74±9.90 (72)	419.71±11.29^{a} (72)	9.41±0.27^{ab} (76)	69.43±4.66 (74)
3	305.68±9.81^{ab} (67)	1829.27±72.36^{abc} (67)	1907.62±84.44^{ab} (67)	6.07±0.18^{bc} (67)	4.70±0.21^{abc} (55)	112.74±11.30 (55)	415.44±12.88^{a} (55)	10.42±0.29^{bcd} (67)	60.19±4.91 (66)
4	282.10±11.64^{a} (47)	1763.21±85.85^{ab} (47)	1819.52±10.18^{ab} (47)	6.28±0.21^{bc} (47)	4.77±0.24^{bc} (41)	104.12±13.05 (41)	390.63±14.88^{a} (41)	10.37±0.34^{bc} (47)	57.86±5.79 (47)
5	310.12±12.71^{ab} (40)	2038.87±93.73^{c} (40)	2125.66±10.38^{b} (40)	6.75±0.23^{c} (40)	5.14±0.25^{c} (40)	113.61±13.28 (40)	422.82±15.15^{a} (40)	11.53±0.37^{d} (40)	72.66±6.41 (39)
6	301.64±13.62^{ab} (36)	1961.93±10.44^{bc} (36)	2056.19±17.21^{b} (36)	6.76±0.25^{c} (36)	5.07±0.30^{c} (29)	116.21±15.98 (29)	422.50±18.23^{a} (29)	11.41±0.40^{cd} (36)	71.90±6.78 (36)
7 and above	331.15±9.70^{bc} (71)	1823.93±71.58^{abc} (71)	1949.64±83.54^{ab} (71)	6.00±0.18^{bc} (71)	4.67±0.22^{bc} (51)	113.76±11.87 (51)	437.94±13 .54^{a} (51)	10.52±0.28^{bcd} (71)	67.36±4.84 (71)

*Significant (P<0.05) ** Significant (P<0.01).

several workers also reported effect of period of calving in Tharparkar cattle on 305 days LY and TLY (Natarajan, 1989); peak yield and MY/LL (Patel *et al*., 2000); ML/LL (Bhattacharya *et al.,* 2002); peak yield and days to attain peak yield traits (Khadda *et al.,* 2011). The reproductive performance traits like dry period and calving interval in Tharparkar cattle were not significantly influenced by the period of calving, however, a little improvement was observed after 2nd period particularly in dry period. Similarly, non-significant effect of the period of calving on calving interval in Tharparkar cattle was also reported by Patel *et al.* (2000) and Choudhary *et al.* (2019). Contrary to this, Kishore *et al.* (2016) reported significant effect of the period of calving on calving interval in Tharparkar cattle.

Effect of parity

The effect of parity was observed significant on milk production traits, lactation length, calving interval of Tharparkar cattle (Table 1). The lactation yield was observed higher in first parity due to longer lactation length, but thereafter the milk yield was increased from second to fifth parity in 305 days and total lactation period. The MY/LL showed clear cut increasing trend of about 33.4% from first to fifth parity. The gradual increase in milk yield of Tharparkar cattle from first to fifth parity could be due to increasing in physiological maturity. Chand (2011) and Kishore (2012) also found significant effect of parity on lactation yield in Tharparkar cattle. Similar to lactation yield the peak yield also increased significantly up to 5th parity in the present study. Similarly, significant effect of parity was found on peak yield by Patel *et al.* (2000) but on the contrary Khadda *et al.* (2011) found non-significant effect on peak yield in Tharparkar cattle. The interval between two calvings was significantly affected by parity in the present study. The calving interval was reduced continuously from 1st lactation to 4th lactation and thereafter, it remained almost constant or increased up to 7th and above parities. Similar types of reducing the trend of calving interval over the parity has been reported by Kishore *et al.* (2016) and Choudhary *et al.* (2019) in Tharparkar cattle. The improving reproductive efficiency over the parity may be attributed to the physiological stability and adoption of selective animals in herd. Hence the Tharparkar cattle can economically reared up to 5th lactation with increase milk production performance and reproductive efficiency.

CONCLUSION

The results of the present findings showed that the milk production and reproduction performance of Tharparkar cattle in CAZRI herd was quite comparable with those of well-established farms of Tharparkar cattle in India. Selection of high yielding animals and improving management condition in herd might be a probable reason for the improvement in lactation yield, lactation length and peak yield over the period. It is also revealed from the parity effect on production and reproduction traits that to make the dairy farm profitable the rigid culling of animals should be followed after 5th lactation onwards. The season of calving did not affect most of the economic traits in this breed, indicating the adaptability characters against the extreme climatic condition of the arid zone. Thus, it may be concluded that Tharparkar is a most climate resilient breed among indigenous breeds of the Indian continent, which can be incorporated in cattle breeding plans for up-gradation of non-descript cattle.

Conflict of interest

All authors declare that they have no conflict of interest.

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