Full Length Article

NON-GENETIC FACTORS AFFECTING MILK PRODUCTION PERFORMANCE OF JERSEY CROSSBRED CATTLE UNDER FARMERS' PRODUCTION SYSTEM IN TAMIL NADU

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ABSTRACT

Test day milk yield data of 81,653 Jersey crossbred cows reared under farmers' production system in Tamil Nadu state, over a period of 24 years (1999-2022) were utilised to determine the effects of non-genetic factors viz. agroclimatic zone, period of calving, season of calving and parity on lactation traits. The production traits considered were 305-day milk yield (305DMY), total lactation milk yield (TMY), 180-day milk yield (180DMY), peak yield (PY), days to attain PY and lactation length (LL), the least-squares means of which were 2458.82 ± 7.02 kg, 2470.77 ± 7.04 kg, 1657 ± 4.71 kg, 10.69 ± 0.03 kg, 73.22 ± 0.56 days and 298.09 ± 0.17 days respectively. The agroclimatic zone had significant (P<0.01) influence on all the lactation traits studied with Western zone having the highest mean (2763.08 kg) for 305DMY followed by North Western zone and Cauvery Delta zone while North Eastern zone had the least (2066.85 kg) milk yield. Both period and season of calving significantly (P<0.01) affected all the traits. The estimated means of 305DMY, TMY and 180DMY of 2960.99 kg, 2987.38 kg and 1934.75 kg respectively in period P2 (2004-2007) were significantly higher compared to other periods while period P1 (1999-2003) had the least milk production. Cows that gave birth in Northeast monsoon and Summer seasons produced more milk comparatively. Parity also had highly significant (P<0.01) influence on all the traits studied with cows above third lactation producing higher milk yield. The influence of non-genetic factors found on milk production of cows, revealed in this study will be useful in planning future breeding and management interventions for improving the milk production of the Jersey crossbred cattle under farmers' production system in Tamil Nadu.

Key words: Jersey crossbred cattle, Lactation length, Milk yield, Non-genetic factors, Peak yield

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INTRODUCTION

Tamil Nadu ranks eleventh among the states in India with an estimated annual milk production of 10.07 million tonnes in the year 2021-22. A very high proportion of this milk production was contributed by crossbreds (including a small proportion of exotic cattle) which constituted 81.15% of the state's cattle population of 95.19 lakh (Report, 2019). Jersey crossbred cattle is the predominant crossbred cattle reared by the farmers of the state, as it is well adapted to the prevailing weather conditions and production environment. Moreover, the state breeding policy advocates Jersey as the breed of choice for crossing with non-descripts in the plains and Holstein Friesian in hilly and high altitude, and high rainfall regions for improving milk production. Evaluation of the non-genetic factors affecting the milk production performance of Jersey crossbred cattle reared by farmers in Tamil Nadu is essential to formulate breeding and selection strategies. Although many studies have been carried out on Jersey crossbred cattle (Tagger *et al.*, 2014; Vinothraj, 2015; Ratwan *et al.*, 2016; Verma *et al.*, 2018; Vijayakumar *et al.*, 2021), most of them were based on organised or institutional farm conditions and a detailed study based on the farmers' production system is lacking. Therefore, the present investigation has been undertaken to determine the non-genetic factors affecting the milk production performance of Jersey crossbred cattle reared under farmers' production system, across different agro-climatic zones (except hilly and high altitude and high rainfall zones) of Tamil Nadu.

MATERIALS AND METHODS

Data on milk production in the form of monthly test day milk yield records from field performance recording programme of Tamil Nadu Co-operative Milk Producers' Federation from five agroclimatic zones of Tamil Nadu were used in the study. The data comprised of records of 81,653 Jersey crossbred cows, calved over a period of 24 years from 1999 to 2022. The population of Jersey crossbred cows studied had varied levels of Jersey inheritance (generally around 50%).

All animals were reared under a semi-intensive system of rearing under farmers' production system. Concentrate feed, either in the form of compounded feed or individual ingredients were fed at the rate of one kg for maintenance and 400 g for every kg of milk production. The cows were fed with 20-30 kg green fodder and 5-7 kg dry fodder. Additionally, the animals were allowed for grazing for two to four hours depending on the climatic conditions. Milking was done twice a day and calves at foot are allowed to suckle briefly to initiate lactation and were weaned between two and three months of age. Animals were vaccinated periodically against Foot-and-Mouth, Haemorrhagic septicaemia and Black Quarter diseases. Morning and evening milk yield was recorded on the test-day basis by trained enumerators on monthly intervals after 5th day of calving till the end of lactation. The traits studied were 305-day milk yield (305DMY), total lactation milk yield (TMY), 180-day milk yield (180DMY), peak yield (PY), days to attain PY and lactation length (LL). The cumulative milk yield (kg) for the first 180 days of lactation was taken as 180DMY. The cumulative milk yield (kg) for the first 305 days of lactation or less was considered as 305DMY and the total of milk production (kg) from the date of calving to the date of drying up is taken as TMY. The 180DMY, 305DMY and TMY were computed by the Test Interval method (Sargent *et al.*, 1968) as given below as recommended by International Committee for Animal Recording from test-day records.

$$MY = I_0 * M_1 + I_1 * \frac{M_1 + M_2}{2} + I_2 * \frac{M_2 + M_3}{2} + I_{n-1} * \frac{M_{n-1} + M_n}{2} + I_n * M_n$$

where,

M_1, M_2, M_n are the weights in kilograms of the milk yielded in the 24 hours of the recording day; I_1, I_2, I_{n-1} are the intervals in days, between recording dates. I_0 is the interval in days, between the date of calving and the first recording, n is the number of test-day records. The outliers beyond three standard deviations from the mean for each trait were not included in the analyses.

Agroclimatic zones, period, season and parity of calving were the fixed non-genetic effects considered for all the traits. Five agroclimatic zones considered were (1) North Eastern, (2) North Western, (3) Western, (4) Cauvery Delta and (5) Southern zones (Report, 2023). The entire duration of the study was grouped into six periods (4 years per period) and each year was classified into four seasons (Report, 2023) *viz.* Winter (January to February), Summer (March to May), Southwest monsoon (June to September) and Northeast monsoon (October to December). In addition, for the effect of parity, first five parities were considered separately and parities six and above were grouped together as sixth.

Statistical analysis

Univariate analysis was done by fitting a general linear model using IBM SPSS Statistics package (SPSS, 2017) to study the effect of various non-genetic factors. The model used for analysis was

$$Y_{ijklm} = \mu + C_i + P_j + S_k + N_l + e_{ijklm},$$

where, Y_{ijklm} = the mth observation in ith agroclimatic zone, jth period, kth season and lth parity, μ= overall mean when equal subclass frequencies exist, C_i = effect of ith agroclimatic zone (i = 1 to 5), P_j = effect of jth period (j = 1 to 6), S_k = effect of kth season (j = 1 to 4), N_l = effect of lth parity (l =1 to 6) and e_{ijklm} = random errors NID (0, σ^2_e). The pair-wise comparison for least-squares means within subclasses were done by Duncan's multiple range test.

RESULTS AND DISCUSSION

The overall least-squares means for 305DMY, TMY and 180DMY were 2458.82 ± 7.02, 2470.77 ± 7.04 and 1657 ± 4.71 kg respectively (Table 1). Most of the previous studies on crossbreds with Jersey inheritance in farm conditions have reported lower mean values for 305DMY and TMY (Taggar *et al.*, 2014; Vinothraj, 2015; Khunte *et al.*, 2016; Ratwan *et al.*, 2016; Hunde *et al.*, 2022) but Girimal *et al.* (2000) observed a higher value for Jersey x Sahiwal crossbred cattle. Comparable mean values were reported for crossbred cows by Lakshmi *et al.* (2009) (300-day milk yield) and Kumar *et al.* (2009) under field conditions in progeny testing programme, while higher value was reported by Valsalan *et al.* (2022) in field conditions in Kerala and Kaur *et al.* (2023) in farm conditions in Uttarakhand. Higher values than the present study were reported by Singh and Gurnani (2004), Singh *et al.* (2006) and Dash *et al.* (2014) for crossbred cattle with Holstein Friesian (HF) inheritance. The least squares mean observed for 180DMY in present study was higher than that reported for Jersey x Sindhi crossbreds in Tamil Nadu by Subramanian and Ulaganathan (1990) and Vinothraj (2015).

The pooled least squares mean PY, days to attain PY and LL was 10.69 ± 0.03 kg, 73.22 ± 0.56 days and 298.09 ± 0.17 days respectively (Table 2). The PY observed in this study is in close confirmity with those reported by Kumar *et al.* (2009) for crossbred cattle and, Kumar *et al.* (2016) for Jersey crossbred cows. Meanwhile, lower values were reported by Gupta and Prasad (2008), Vinothraj (2015) for Jersey x Red Sindhi cows, Khunte *et al.* (2016) for crossbred and graded cows under field conditions and Desai *et al.* (2017) for crossbred cattle (Dangi × Red Sindhi × Jersey). However, higher values were estimated by Tagger *et al.* (2014) and Ratwan *et al.* (2016) in Jersey crossbred cattle and Lakshmi *et al.* (2009) and Kumar *et al.* (2014) for crossbred HF cattle. The days to attain PY found in this study was on the higher side than those reported by Subramanian and Ulaganathan (1990), Gupta and Prasad (2008), Vinothraj (2015) and Desai *et al.* (2017). The reports of these authors were from farm-based studies wherein PY could exactly be ascertained and the present study was based on test day milk yield from the field condition, the highest test day yield was considered as PY. The overall least-squares mean of LL observed in this study is in close agreement with that of Varaprasad *et al.* (2013) (300.16 days), Wondifraw *et al.* (2013) (296.80 days), Al-Samarai *et al.* (2015) (298.26 days) and Hagan *et al.* (2022) (296.3 days) for Jersey x Red Sindhi, Deoni x HF cattle, Holstein cattle and Friesian x Sanga crossbreds respectively. Comparatively lower values were reported by Das *et al.* (2003) for Sahiwal x Friesian cows while values on the higher side were reported by several authors (Singh and Gurnani, 2004; Singh *et al.,* 2006; Lakshmi *et al.,* 2009; Mandal *et al.*, 2013; Tagger *et al.,* 2014; Vinothraj, 2015; Verma *et al.,* 2018; Vijayakumar *et al.,* 2021). It was observed that the performance of Jersey crossbred cattle was comparable and even better than those reported from sub-tropical / sub-temperate regions of India, implying that Jersey crossbred cattle have adapted to the milk production practices under farmers' production system in the state of Tamil Nadu.

In the present study, all the non-genetic factors had significantly (P<0.01) affected the lactation traits studied. The significant (P<0.01) effect of agroclimatic zone observed on all the production traits studied indicating that the varied environmental conditions affect the performance of the Jersey crossbred cattle. Western zone had the highest means for 305DMY, TMY, 180DMY and PY (2763.08 ± 6.59, 2594.80 ± 6.66, 1733.44 ± 4.45 and 11.08 ± 0.03 kg respectively) followed by North Western zone, Southern zone and Cauvery Delta zone while North Eastern zone had the lowest yield (2066.85 ± 6.68, 2075.41 ± 6.71, 1411.08 ± 4.49 and 9.42 ± 0.03 kg respectively) for these traits (Fig. 1-4). Moreover, the cows in North Eastern zone reached PY earlier (in 54.88 days) while the Western zone took longer duration (93.81 days) to reach PY (Fig. 5). Animals in Southern zone had highest LL (302.17 days) followed by North Western and cows in the North Eastern zone had the lowest LL of 293.32 days (Fig. 6). The milk yield in this study was higher than the estimates reported for Jersey crossbred cattle by Vinothraj (2015) for North Eastern zone and by Vijayakumar *et al.* (2021) (TMY) for Cauvery Delta zone. It could be inferred that Western and North Western zones were more conducive for milk production than other agroclimatic zones due to their favourable climatic and other environmental factors for expression of milk yield in Jersey crossbred cattle. Significant effect of location was reported by Kumar *et al.* (2009) for crossbred cattle under field conditions in Punjab.

The period of calving had highly significant (P<0.01) effect on all the traits studied. The highest estimates for milk yield traits *viz.*, 305DMY, TMY, 180DMY and PY of 2960.99 ± 13.14, 2987.38 ± 13.22, 1934.75 ± 8.79 and 12.04 ± 0.03 kg respectively were found for P2 (2004-2007), followed by P4 (2012-2015) while P1 (1999-2003) (2041.90 ± 27.95, 2048.90 ± 28.01, 1332.74 ± 18.75 and 8.66 ± 0.12 kg respectively) had the lowest values (Fig. 1-4). Moreover, a decreasing trend was noticed from P4 (2012-2015) to P6 (2020-2022) for all milk yield traits. Number of days to reach PY increased from 69.13 for the cows calved in P1 to 80.71 for the cows calved in P3 there after decreased to 73.36 days for P6 (Fig. 5). Period P2 with 302.48 ± 0.31 days had the longest LL closely followed by P4 (299.57 ± 0.27 days) and P3 (299.57 ± 0.14 days) but P5 and P6 (295.34 ± 0.14 and 295.17 ± 0.16 days) had shorter LL (Fig. 6). Similar significant effect of period of calving on 305DMY was reported by Kumar *et al.* (2009), Vinothraj (2015), Ratwan *et al.* (2016) and Kaur *et al.* (2023) while non-significant effect was reported by Singh *et al.* (2015). While TMY was significantly affected by period of calving in the studies by Kumar *et al.* (2009), Kumar *et al.* (2016), Ratwan *et al.* (2016) and Vijayakumar *et al.* (2021), non-significant effect was reported by Vinothraj (2015) and Verma *et al.* (2018). Similar decreasing trend for 305DMY was reported for Jersey crossbred by Ratwan *et al.* (2016) in West Bengal and Tagger *et al.* (2014) in Himachal Pradesh. The period of calving had no significant effect for 180DMY in an earlier study by Vinothraj (2015). Significant effect was reported by Kumar *et al.* (2009), Kumar *et al.* (2016) and Ratwan *et al.* (2016) for PY while Singh *et al.* (2015), Vinothraj (2015) and Kaur *et al.* (2023) reported no significant effect. Contrary to the findings of this study, Singh *et al.* (2015) and Vinothraj (2015) found non-significant effect of period of calving on days required to reach PY. Highly significant (P<0.01) effect of period of calving found for LL in this study corroborated with the findings of Vinothraj (2015), Ratwan *et al.* (2016), Vijayakumar *et al.* (2021) and Kaur *et al.* (2023) while non-significant effect was reported by Verma *et al.* (2018). The significant influence of period of calving might be attributed to the use of different sets of sires and different managemental and environmental conditions such as temperature, humidity, etc.

Season of calving had highly significant (P<0.01) influence on all the traits studied. Cows calved in Summer had the highest 305DMY, TMY, 180DMY and PY (2500.44 ± 7.61, 2513.15 ± 7.64, 1684.59 ± 5.11 and 10.80 ± 0.03 kg respectively) while cows calved in Northeast monsoon had the lowest yield (2432.99 ± 7.90, 2445.73 ± 7.93, 1624.77 ± 5.31 and 10.55 ± 0.03 kg respectively) (Fig. 1-4). Cows calved in Summer and Winter seasons attained PY in 77 days and differed significantly (P<0.01) from those cows calved in monsoons (Fig. 5). Highest LL was found for Summer (300.98 ± 0.18 days) followed by Northeast and Southwest monsoon seasons, and Winter had the lowest LL (295.39 ± 0.20 days) (Fig. 6). Significant effect of season was reported for 305DMY by Kumar *et al.* (2009), Singh *et al.* (2015), Ratwan *et al.* (2016) and Kaur *et al.* (2023); for TMY by Kumar *et al.* (2016) and Ratwan *et al.* (2016); for PY by Kumar *et al.* (2009), Singh *et al.* (2015), Kumar *et al.* (2016) and Ratwan *et al.* (2016). However, non-significant effect was observed for TMY by Vinothraj (2015), Verma *et al.* (2018) and Vijayakumar *et al.* (2021). Similarly, significant effect of season was reported for days to attain PY by Singh *et al.* (2015) in Punjab and Kaur *et al.* (2023) in Uttarakhand while non-significant effect was observed by Vinothraj (2015) in Tamil Nadu. Contrary to the observation in this study, non-significant effect of season of calving was reported by Vinothraj (2015), Kumar *et al.* (2016), Verma *et al.* (2018) and Vijayakumar *et al.* (2021) for LL. Cows calved in Summer produced higher milk yield and had longer LL because of increased availability of green fodder in the ensuing monsoon seasons while cows calved in Northeast monsoon have to tide over the driest Summer during their peak production resulting in comparatively lower milk production.

The significant (P<0.01) influence of parity was observed in all the traits studied. Cows in the fourth parity had the highest means for milk yield traits *viz.*. 305DMY, TMY, 180DMY and PY (2558.90 ± 8.93, 2570.67 ± 8.96, 1735.58 ± 6.00 and 11.18 ± 0.04 kg respectively) followed by fifth and sixth parity while lowest yield (2299.87 ± 7.10, 2311.90 ± 7.13, 1547.57 ± 4.77 and 10.00 ± 0.03 kg respectively) observed in the first parity (Fig. 1-4). Moreover, a pattern of increasing milk yield from first to fourth parities was noticed for all these traits which decreased beyond fourth parity. Days to attain PY ranged between 69.77 ± 0.62 for third parity cows to 77.12 ± 1.06 for those cows calved for more than five times (Fig. 6). The LL ranged between 297.48 ± 0.18 days (lowest) for second parity and 298.37 ± 0.17 days (highest) for primiparous cows (Fig. 5). There was no notable variation in days to PY and LL in different parities. Cows in third and fourth parities reached peak yield earlier than cows in other parities. The significant effect of parity on milk yield traits observed in the present study corroborated with the findings of Vinothraj (2015) and Ratwan *et al.* (2016). Conversely Vijayakumar *et al.* (2021) found no significant effect of parity on TMY. Primiparous cows had generally lower production than pluriparous cows and animals in fourth and fifth parities produced more milk

Table 1. Least-squares means (±SE) of milk yield (kg) traits of Jersey crossbred cows under farmers' production system

Traits	305DMY		TMY		180DMY	
	n	Mean ± SE	n	Mean ± SE	n	Mean ± SE
Overall mean (µ)	89218	2458.82 ± 7.02	89218	2470.77 ± 7.04	89194	1657.33 ± 4.71
Agroclimatic zone		**		**		**
North Eastern	35076	2066.85 ± 6.68^{e}	35080	2075.41 ± 6.71^{d}	35078	1411.08 ± 4.49^{e}
North Western	20468	2578.20 ± 6.63^{b}	20467	2594.80 ± 6.66^{b}	20486	1733.44 ± 4.45^{b}
Western	29180	2763.08 ± 6.59^{a}	29181	2774.19 ± 6.61^{a}	29138	1883.87 ± 4.42^{a}
Cauvery Delta	3684	2377.91 ± 11.02^{d}	3681	2383.70 ± 11.06^{c}	3688	1588.14 ± 7.40^{c}
Southern	810	2508.09 ± 20.83^{c}	809	2525.76 ± 20.93^{a}	804	1670.14 ± 14.05^{d}
Period of calving		**		**		**
P1 (1999 to 2003)	433	2041.90 ± 27.95^{e}	435	2048.90 ± 28.01^{e}	435	1332.74 ± 18.75^{f}
P2 (2004 to 2007)	2052	2960.99 ± 13.14^{a}	2046	2987.38 ± 13.22^{a}	2074	1934.75 ± 8.79^{a}
P3 (2008 to 2011)	3012	2540.78 ± 11.11^{b}	3013	2558.13 ± 11.15^{b}	3009	1694.48 ± 7.47^{c}
P4 (2012 to 2015)	27331	2599.32 ± 5.68^{b}	27333	2606.81 ± 5.71^{b}	27303	1791.87 ± 3.83^{b}
P5 (2016 to 2019)	35038	2440.93 ± 5.96^{c}	35041	2446.44 ± 5.99^{c}	35025	1688.38 ± 4.01^{d}
P6 (2020-2022)	21352	2169.03 ± 6.57^{d}	21350	2176.97 ± 6.60^{d}	21348	1501.77 ± 4.42^{e}
Season of calving		**		**		**
Winter	15027	2458.34 ± 8.17^{d}	15025	2469.12 ± 8.20^{d}	15037	1656.29 ± 5.49^{c}
Summer	25856	2500.44 ± 7.61^{a}	25857	2513.15 ± 7.64^{a}	25839	1684.59 ± 5.11^{a}
Southwest Monsoon	28656	2443.53 ± 7.54^{c}	28656	2455.08 ± 7.56^{c}	28630	1663.69 ± 5.07^{a}
Northeast Monsoon	19679	2432.99 ± 7.90^{b}	19680	2445.73 ± 7.93^{b}	19688	1624.77 ± 5.31^{b}
Parity		**		**		**
First	41201	2299.87 ± 7.10^{f}	41201	2311.90 ± 7.13^{f}	41188	1547.57 ± 4.77^{e}
Second	19193	2408.41 ± 7.53^{e}	19192	2419.83 ± 7.56^{e}	19174	1633.13 ± 5.06^{d}
Third	14141	2498.01 ± 7.87^{d}	14142	2510.18 ± 7.90^{d}	14147	1699.11 ± 5.29^{c}
Fourth	8179	2558.90 ± 8.93^{a}	8178	2570.67 ± 8.96^{a}	8182	1735.58 ± 6.00^{a}
Fifth	4075	2518.27 ± 11.09^{b}	4075	2530.40 ± 11.14^{b}	4074	1686.69 ± 7.46^{b}
Sixth and above	2429	2469.48 ± 13.37^{c}	2430	2481.66 ± 13.42^{c}	2429	1641.92 ± 8.99^{c}

**$P<0.01$; Means with at least one common superscript within sub-classes do not differ significantly; n – number of observations

Table 2. Least-squares mean (±SE) of peak yield (kg), days to peak yield (days) and lactation length (days) of Jersey crossbred cows under farmers' production system

Effect	Peak yield		Days to Peak yield		Lactation Length	
	n	Mean ± SE	n	Mean ± SE	n	Mean ± SE
Overall mean (μ)	89130	10.69 ± 0.03	88966	73.22 ± 0.56	86832	298.09 ± 0.17
Zone		**		**		**
North Eastern	35051	9.42 ± 0.03[e]	34835	54.88 ± 0.53[e]	34024	293.32 ± 0.16[e]
North Western	20485	11.08 ± 0.03[c]	20381	81.57 ± 0.53[b]	19983	301.99 ± 0.16[b]
Western	29080	12.04 ± 0.03[a]	29264	93.81 ± 0.52[a]	28391	298.04 ± 0.16[c]
Cauvery Delta	3698	10.25 ± 0.05[d]	3667	71.46 ± 0.87[c]	3630	294.94 ± 0.27[d]
Southern	816	10.67 ± 0.09[b]	819	64.41 ± 1.64[d]	804	302.17 ± 0.50[a]
Period of calving		**		**		**
P1 (1999 to 2003)	435	8.66 ± 0.12[f]	430	69.13 ± 2.22[d]	436	296.49 ± 0.67[d]
P2 (2004 to 2007)	2081	12.18 ± 0.06[a]	2070	70.61 ± 1.04[b]	2074	302.48 ± 0.31[a]
P3 (2008 to 2011)	3037	10.93 ± 0.05[c]	3029	80.71 ± 0.88[a]	2980	299.48 ± 0.27[b]
P4 (2012 to 2015)	27311	11.55 ± 0.02[b]	27281	74.60 ± 0.45[c]	26965	299.57 ± 0.14[c]
P5 (2016 to 2019)	35010	10.94 ± 0.03[d]	34998	70.93 ± 0.47[c]	34572	295.34 ± 0.14[e]
P6 (2020-2022)	21256	9.90 ± 0.03[e]	21158	73.36 ± 0.52[b]	19805	295.17 ± 0.16[e]
Season of calving		**		**		**
Winter	15032	10.64 ± 0.03[c]	14940	76.34 ± 0.65[a]	14347	295.39 ± 0.20[d]
Summer	25834	10.80 ± 0.03[b]	25777	77.61 ± 0.60[a]	24780	300.98 ± 0.18[a]
Southwest Monsoon	28596	10.78 ± 0.03[a]	28649	69.86 ± 0.60[b]	28154	297.83 ± 0.18[c]
Northeast Monsoon	19668	10.55 ± 0.03[b]	19600	69.09 ± 0.63[b]	19551	298.16 ± 0.19[b]
Parity		**		**		**
First	41141	10.00 ± 0.03[e]	40929	76.90 ± 0.56[b]	39899	298.37 ± 0.17[d]
Second	19155	10.55 ± 0.03[d]	19134	70.83 ± 0.60[c]	18638	297.48 ± 0.18[d]
Third	14143	10.94 ± 0.03[c]	14173	69.77 ± 0.62[c]	13838	297.92 ± 0.19[c]
Fourth	8188	11.18 ± 0.04[a]	8231	70.12 ± 0.71[b]	8057	298.16 ± 0.22[b]
Fifth	4077	10.88 ± 0.05[b]	4085	74.61 ± 0.88[a]	4012	298.36 ± 0.27[a]
Sixth and above	2426	10.61 ± 0.06[c]	2414	77.12 ± 1.06[a]	2388	298.26 ± 0.32[ab]

**P<0.01; Means with at least one common superscript within sub-classes do not differ significantly; n – number of observations when compared to earlier and late parities, as expected due to physiological reasons.

CONCLUSION

The performance of Jersey crossbred cows observed under farmers' production system in the study were generally better than those reported for Jersey crossbred cattle from sub-tropical and sub-temperate regions of India. Milk production performance of Jersey crossbred cattle was significantly ($P<0.01$) affected by non-genetic factors such as agroclimatic zones, period and season of calving and parity of the cows. The study revealed that the crossbreds performed better in Western and North Western zones, which might be attributed to the better management and favourable climatic conditions in these zones as compared to other agroclimatic zones. Cows calved in Summer had the highest milk yield while the cows calved in Northeast monsoon had lowest milk production. Milk yield traits improved over the parities till fourth and declined thereafter. Information on the significant effects of non-genetic factors observed through this study may be useful in planning and making future breeding and management decisions for improving the milk production potential of the Jersey crossbred cattle under farmers' production system in Tamil Nadu.

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