academicJournals

Vol. 4(7), pp. 106-112, September, 2013
DOI: 10.5897/IJLP2013.0173
ISSN 2141-2448 ©2013 Academic Journals
http://www.academicjournals.org/IJLP

International Journal of Livestock Production

Full Length Research Paper

Effect of non-genetic factors on milk production of Holstein Friesian × Deoni crossbred cows

Zewdu Wondifraw*, B. M. Thombre and D. V. Bainwad

Department of Animal Husbandry and Dairy Science, College of Agriculture, Marathwada Agricultural University (MAU), Parbhani- 431402 (M.S) India.

Accepted 9 September, 2013

This research was conducted to evaluate the effect of non-genetic factors on milk production of Holstein Friesian × Deoni crossbred cows. Data representing 256 HF × Deoni crossbred cows from cattle crossbreeding project with 1485 total records of lactation over a 30 years period were analyzed to determine the effects of period of calving, season of calving, age at first calving and parity on milk production. The overall least squares mean of lactation milk yield, 305 days milk yield, lactation length, and milk yield per day of lactation length were 1661.35±15.17, 1707.25±13.25, 296.80±2.29 and 5.65±0.04 kg, respectively. All sources of variation were significant except season of calving for 305 days milk yield and lactation length; age at first calving for 305 days milk yield and milk yield per day of lactation length. Milk production was depressed for cows calving in summer. First lactation cows had lowest milk production, and highest production occurred in 5th parity. It was therefore, concluded that, HF × Deoni crossbred cows were affected by non-genetic factors.

Key words: Crossbred cows, productive traits, period and season of calving, parity.

INTRODUCTION

Dairy sector is economically and socially very important in India due to the multi-functionality of dairy animals performing output, input, asset and socio-cultural functions. Dairying accounts for more than two-thirds of the livestock output in India. The sector in the country has emerged as an important source of livelihood for a vast majority of the rural population. According to the 2007 Livestock Census, there are 166 million indigenous cattle, 33 million crossbred cattle and 105 million buffaloes in India. The decade wise trend in livestock population (1997 to 2007) shows a distinct shift in composition of dairy animal stock in favour of buffaloes and crossbred cattle, as their numbers increased by 5.91 and 6.05 million, respectively, while that of indigenous cattle declined by 1.8 million (GOI, 2007). Milk productivity in the country remains one of the lowest as compared to many leading countries of the world. In India, average milk productivity of crossbred cows, indigenous cows and buffaloes is about 6.44, 1.97 and 4.3 kg/day, respectively (GOI, 2007). India has always been 100% self-sufficient in milk, with total imports/exports of about 0.3 million tonnes per annum; it may thus be considered as almost unconnected with the world dairy market (FAO, 2010). The economic survey 2011 analyzed the dairy situation in India, considering that the requirement of milk in 2021 to 2022 is expected to be 180 million tonnes as against the current level of milk production of 127.3 million tonnes (MOA, 2012).

*Corresponding author. E-mail: zewduwondifraw@gmail.com. Tel: +251910172313 Fax: +215587711764.

In India, there are about 37 breeds of cattle. Two important breeds of cattle that is, Deoni and Red Kandhari have gifted to Marathwada region. In spite of the presence of large and diverse cattle genetic resources, the productivity of cows remains low in the country, for various reasons, such as inadequate nutrition, poor genetic potential, inadequate animal health services, the harsh climatic conditions and other management related problems.

The indigenous cattle breeds are low producers; they mature late and have a delayed conception coupled with long calving intervals. The productivity of dairy animals could be increased by crossbreeding the low yielding nondescript cows with high yielding suitable exotic breeds. This systematic cross breeding of temperate dairy breeds, principally undertaken to combine high milk yield and early sexual maturity of European dairy breeds with hardiness, disease resistance and adaptability of indigenous cattle.

Thus, crossbreeding of local non-descript cattle with exotic breeds of high genetic potential is considered to be a rapid and effective method of improvement. Marathwada Agricultural University has taken a project for improvement of Deoni cattle breed by cross breeding local Deoni cows with Holstein Friesian. The present study was, therefore, planned to assess the effects of non-genetic factors on the performance of milk production in HF × Deoni crossbred cows kept at Cattle Cross Breeding Project (CCBP).

MATERIALS AND METHODS

Study area

This study was conducted at Cattle Cross Breeding Project of Marathwada Agricultural University, Parbhani India. The university is located at an altitude of 407 m a.s.l. It is situated at a distance of 500 km from Mumbai (the capital city of Maharashtra State). The Cattle Cross Breeding Project (CCBP) is situated between 17° 35' N and 20° 40' N latitude and between 70° 40' E and 78° 15' E longitude. The mean daily maximum temperature varies from 29.1°C in December to 42.5°C in May. The mean daily minimum temperature varies from 6.9°C in December to 25.4°C in May. The relative humidity ranges from 11 to 90%. Normally the summer becomes hot and general dryness persists throughout the year except during south-west monsoon. The region is essentially a subtropical one and it comes under assured rainfall zone with an average rainfall of 900 mm spread in about 70 rainy days mostly received from June to September.

Management of animals

The management of animals at Cattle Cross Breeding Project (CCBP) becomes identical with variation due to reason beyond control. The daily routine management activity for lactating animals starts at 8 a.m. After calving, the calves remain with their dams for about 5 to 7 h. The calves then weighed, tagged and bucket milk fed twice a day until weaning. The dams remain in barn for the first five days during which they are provided with green fodder, concentrate meal, and transfer to the milking herd afterwards. Cows are hand-milked twice a day, early in the morning (6:00 to 7:00 am) and late in the afternoon (5:00 to 6:00 pm) after feeding concentrate mixture regularly. The cows are allowed for grazing in fallow land from 9.00 a.m. to 5.00 p.m. on a regular basis. However, in summer season (March to June) the cows are allowed for grazing from 9.00 a.m to 12.00 a.m. after that the animals are tied and stall-fed with required quantities of dry and green fodder under the shade. All the calves are separated from their dam at birth and weaned at around 3 months of age. The milk recording starts after 4th day from calving. All animals are routinely checked for any incident of health problem and treatments given if any abnormality existed. Additionally, animals regularly vaccinated against major diseases such as FMD, Black Leg and Haemorrhagic Septicaemia. The milking cows are washed and groomed regularly. They are always fed individually. The project used teaser bull for regular heat detection. Upon heat detection, cows mated naturally to a bull. From conception up to 7 months of pregnancy, cows are grazed on natural pasture after which they are kept indoors and offered roughage and concentrated feed.

Sources and nature of data

Data representing 256 HF × Deoni crossbred cows from CCBP with 1485 total records of lactation over a 30-yr period (1981 to 2010) were collected and organized to study the effects of period of calving, season of calving, age at first calving and parity on milk production. The complete year was divided into 4 seasons and 6 periods having 5 years each. Six levels of age at first calving (AFC) were coded as A_1 for ≤ 1000 days to A_6 for ≥ 1601 days with a class interval of 150 days. The parties farther divided for L_1, L_2, L_3, L_4, L_5, L_6, L_7, L_8, L_9 and L_{10}. The four seasons namely winter (December to February), summer (March to May), monsoon (June to September) and post monsoon (October to November) were coded as S_1, S_2, S_3 and S_4. Each cow having at least three offspring's was considered in this study.

Statistical analysis

Data were analyzed by linear models (SAS, 2002). When the analysis of variance indicated the existence of significant within class, Duncan's Multiple Range Test (DMRT) were employed to test and locate means that are significantly differed from the rest.
The following statistical model was employed to analyse the data.

$$Y_{ijklm} = \mu + Ti + S_j + A_k + P_l + e_{ijklm}$$

where, Y_{ijklm} – is the LMY, 305 day MY, LL, MY/DLL record of a cow calved during i^{th} period, in j^{th} season, at k^{th} age of first calving, on l^{th} parity. µ - is the population mean common to all the observations.
Ti– is the effect of i^{th} time-period of calving (where i = 1, 2, 3, 4, 5 and 6). S_j – is the effect of j^{th} season of calving (where j = 1, 2, 3 and 4). A_k – is the effect of k^{th} AFC (where k = 1, 2, 3, 4, 5 and 6) groups; P_l – is the effect of l^{th} parity (where l = 1, 2……………10). e_{ijklm} – Random error associated with the measurement, which is assumed to be normally, identically and independently distributed with a zero mean and common error variance i.e., IND ($0.\sigma^2 e$).

RESULTS AND DISCUSSION

Lactation milk yield

Performance of dairy animal is judged from the milk it produces during a specified period of lactation. Variation

Table 1. Least square means and standard errors for lactation milk yield (LMY), and adjusted milk yield at 305 days in Kg (305 dMY) on period and season of calving, AFC and parity.

Source	Code	LMY (Kg)	305 day MY (Kg)
Overall Mean	μ	1661.35±15.17	1707.25±13.25
Period of calving	P_1	1903.56±30.89^{d}	1824.59±26.96^{e}
	P_2	1764.46±21.02^{c}	1761.92±18.35^{d}
	P_3	1602.36±22.61^{b}	1685.82±19.74^{c}
	P_4	1481.74±35.91^{a}	1612.43±31.35^{b}
	P_5	1511.15±42.47^{ab}	1516.22±37.08^{a}
	P_6	1704.84±41.01^{c}	1837.31±37.80^{e}
Season of calving	S_1	1692.37±22.21^{b}	1720.35±19.39^{a}
	S_2	1627.81±21.23^{a}	1671.49±20.53^{a}
	S_3	1642.72±23.52^{ab}	1715.97±18.53^{a}
	S_4	1682.51±24.56^{ab}	1721.05±21.44^{a}
Age at first calving	A_1	1642.73±33.20^{ab}	1714.16±28.98^{a}
	A_2	1636.04±30.98^{ab}	1737.86±27.05^{a}
	A_3	1684.55±27.37^{ab}	1680.20±23.89^{a}
	A_4	1609.99±27.06^{a}	1672.45±23.62^{a}
	A_5	1717.10±26.83^{b}	1718.28±23.42^{a}
	A_6	1677.68±28.11^{ab}	1721.71±24.54^{a}
Parity	L_1	1586.95±26.78^{ab}	1592.59±23.38^{a}
	L_2	1625.84±26.28^{ab}	1621.27±22.94^{ab}
	L_3	1706.10±27.62^{ed}	1744.24±24.11^{cd}
	L_4	1772.93±29.03^{d}	1798.82±25.34^{de}
	L_5	1793.77±30.24^{e}	1801.51±26.40^{e}
	L_6	1760.49±32.12^{de}	1762.86±28.04^{de}
	L_7	1667.83±37.30^{bce}	1726.36±32.56^{bcde}
	L_8	1613.19±44.83^{abc}	1640.13±39.13^{abc}
	L_9	1654.88±56.60^{bcde}	1719.72±52.03^{bcde}
	L_{10}	1431.51±83.11^{a}	1660.81±72.55^{abc}

Means connected with different superscripts in a column differ significantly.

observed in lactation milk yield from lactation to lactation in the same animal. The main reason of variation attributed to the physiology of lactation is the given set of genes and their reaction with non-genetic factors. The lactation performance of dairy cattle is usually measured by determining total milk yield per lactation or per year, average daily milk yield, lactation length, persistency of milk production and milk composition.

The least squares means and ANOVA of lactation milk yield as affected by season, period of calving, AFC and parity are presented in Tables 1 and 2, respectively. The overall LSM of LMY of HF × Deoni crossbred cows was recorded as 1661.35±15.17 kg. Similar results were reported by Thombre (1996). In contrast, higher lactation milk yield were reported by Thakur and Singh (2001) and Komatular et al. (2010).

The effect of period of calving on lactation milk yield

The lactation milk yield was affected by period of calving ($P < 0.01$). The variation in LMY observed in different periods indicates the level of management as well as environmental effects. Similar observations were reported by Thombre (1996) and Komatular et al. (2010). However, Gadmade (1999) reported non-significant effect of period of calving on LMY.

The effect of season of calving on lactation milk yield

The LMY was significantly ($P < 0.05$) affected by season of calving. Maximum production occurred during winter season. Milk production was depressed for cows calving

Table 2. Analysis of variance of means for LMY and 305-d MY on period, season, AFC and parity.

Sources	DF	LMY		305-d MY	
		MSS('000)	F value calculated	MSS('000)	F value calculated
Period	5	2857.00	20.36**	1998.00	18.69**
Season	3	369.50	2.63*	71.81	0.67^{NS}
AFC	5	333.60	2.38*	179.50	1.68^{NS}
Parity	9	1043.00	7.43**	1098.00	10.27**
Error	1462	140.30		106.90	
Total	1484				

*P<0.05, ** P<0.01; NS= Non-significant.

in summer. Similar findings were reported by Gaur (2007) and Mishra and Joshi (2009). However, Nagare and Patel (1997) and Auradkar (1999) reported non-significant effect of season of calving on LMY. This variation could be due to the type of feed, environmental deviations and management, which varies greatly during different seasons.

The effect of age at first calving on lactation milk yield

The lactation milk yield was significantly (P < 0.05) influenced by AFC. The highest LMY was observed from the cows that had AFC group A_5 followed by cows that had AFC group A_3 and the lowest of all from those cows, which had AFC group A_4.

The effect of parity on lactation milk yield

The lactation milk yield was significantly (P < 0.01) affected by parity. First lactation cows had lowest milk production, and highest production occurred in 5^{th} parity. The present finding is in agreement with reports of Thakur and Singh (2001) and Komatular et al. (2010). In contrast, Gadmade (1999) have reported non-significant effect of parity on LMY.

The analysis of variance of means for LMY has verified that the effect of period of calving and parity were significant (P<0.01) while; the effect of season of calving and AFC were substantial (P<0.05) on LMY.

305-days milk yield

The least squares means and ANOVA of 305-days milk yield as affected by season, period of calving, AFC and parity are given in Tables 1 and 2, respectively. The overall least square mean of 305 days milk yield of HF × Deoni crossbred cows was observed as 1707.25±13.25 kg. The statistical analysis revealed that observed differences of 305 days MY due to period of calving and party effect were significant (P < 0.01) while, the variations due to season of calving and AFC on 305-days milk yield were non-significant.

The analysis of variance of means for 305 days milk yield has verified that the effect of period of calving and parity were significant (P < 0.01) whereas, the effect of season of calving and AFC were non-significant on 305-days milk yield.

Lactation length

Lactation length is an important production trait as it influences the total milk yield. In most modern dairy farms, a lactation length of 305 days commonly accepted as a standard. This standard allows for calving every 12 months with a 60-day dry period. The 12-month interval has considered "Ideal" for many years. If a cow milked longer than 305 days, her yield for the first 305 days taken as the lactation yield. Some cows are not milked for a full 305 days because they go dry or the lactation terminated for any of several reasons. These short records projected to a 305 days equivalent.

The least squares means and ANOVA of lactation length as affected by season and period of calving, AFC and parity are given in Tables 3 and 4, respectively. The overall mean of LL of HF × Deoni crossbred cows were recorded as 296.80±2.29 days. This result was in close agreement with the finding reported by Patil (1996, 1997) and Auradkar (1999) reported higher estimates than the present finding.

The effect of period of calving on lactation length

The lactation length was significantly (P < 0.01) affected by period of calving. Cows calved in P_4 and P_6 had comparatively low lactation length perhaps due to the reason of better feeding management that led to early conception of these cows resulting on time of subsequent calving. Similar results were reported by Chavan (2001) and Komatular et al. (2010). However, Gadmade (1999) and Auradkar (1999) reported non-significant effect of

Table 3. Least square means and standard errors for Lactation Length (LL) and Milk Yield Per Day of Lactation Length (MY/DLL) on period, season, AFC and parity.

Source	Code	LL (Days)	MY/DLL (Kg)
Overall mean	µ	296.80±2.29	5.65±0.04
Period	P_1	318.20±4.66^{d}	6.12±0.12^{e}
	P_2	305.44±3.17^{c}	5.85±0.06^{d}
	P_3	289.90±3.41^{ab}	5.57±0.06^{c}
	P_4	280.28±5.42^{a}	5.31±0.10^{b}
	P_5	303.98±6.41^{bcd}	4.98±0.12^{a}
	P_6	283.01±6.19^{a}	6.08±0.09^{de}
Season	S_1	300.04±3.36^{a}	5.57±0.06^{a}
	S_2	297.03±3.55^{a}	5.11±0.07^{b}
	S_3	291.98±3.21^{a}	5.64±0.06^{a}
	S_4	298.17±3.71^{a}	5.70±0.07^{a}
Age at first calving	A_1	292.29±5.01^{ab}	5.66±0.09^{a}
	A_2	287.13±4.68^{a}	5.74±0.09^{a}
	A_3	305.79±4.13^{c}	5.57±0.08^{a}
	A_4	293.61±4.09^{a}	5.52±0.08^{a}
	A_5	304.79±4.05^{bc}	5.72±0.08^{a}
	A_6	297.20±4.25^{abc}	5.59±0.08^{a}
Parity	L_1	303.92±4.04^{a}	5.25±0.08^{a}
	L_2	305.86±3.97^{a}	5.38±0.07^{ab}
	L_3	298.33±4.17^{a}	5.75±0.08^{cd}
	L_4	300.61±4.38^{a}	5.97±0.08^{e}
	L_5	303.69±4.58^{a}	5.99±0.09^{e}
	L_6	304.59±4.85^{a}	5.87±0.09^{de}
	L_7	294.66±5.63^{a}	5.73±0.11^{cde}
	L_8	299.99±6.77^{a}	5.43±0.13^{abc}
	L_9	293.50±9.00^{a}	5.73±0.17^{bcde}
	L_{10}	292.89±12.55^{a}	5.39±0.24^{abcd}

Means connected with different superscripts in a column differ significantly.

period of calving on lactation length.

The effect of season of calving on lactation length

The lactation length was not significantly affected by season of calving. Similar results were reported by Gadmade (1999) and Chavan (2001). However, Auradkar (1999) and Komatular et al. (2010) reported significant effect of season on lactation length.

The effect of age at first calving on lactation length

The lactation length was significantly (P<0.01) affected by AFC. The maximum LL was observed from the cows that had AFC group A_3 followed by cows, which had AFC group A_5 and the lowest of from those cows that had AFC group A_2.

The effect of parity on lactation length

The lactation length was not significantly affected by parity. The present finding was in agreement with reports of Gadmade (1999) and Chavan (2001). But, Auradkar (1999) and Komatular et al. (2010) reported significant effect of parity on lactation length.

The analysis of variance of means for LL has verified that the effect of period of calving and AFC were significant (P<0.01) whereas, the variation due to season of calving and parity on lactation length were non-significant.

Milk yield per day of lactation length (MY/DLL)

It is a very important production efficiency trait, which is a combination of milk yield and lactation length. Cows with high milk yield per day of lactation length (MY/DLL) are economic producers and have more lactation milk yield. In the estimates of MY/DLL, milk yield on average basis of the lactation length were calculated without taking into account the initial low production, peak yield and the declining in production in the last phase of the lactation.

The least squares means and ANOVA of milk yield per day of lactation length as affected by season and period of calving, AFC and parity are given in Table 3 and 4, respectively. The overall LSM of milk yield per day of lactation length in HF × Deoni crossbred cows was recorded as 5.65±0.04 kg. This result was in close agreement with the findings reported by Patil (1997). However, higher yield were reported by Buktare (1998) and Auradkar (1999). This might be because of difference in genotype of crossbred cows and management situations.

The effect of period of calving on milk yield per day of lactation length

The milk yield per day of lactation length was significantly (P<0.01) affected by period of calving. Similar results were reported by Buktare (1998) and Auradkar (1999). However, Yazdani et al. (1996) and Gadmade (1999) reported non-significant effect of period of calving on MY/DLL. The variation in MY/DLL in different periods indicates the level of management as well as environmental effects.

The effect of season of calving on milk yield per day of lactation length

The effect of season of calving was significant (P<0.05)

Table 4. Analysis of variance of means for LL and MY/DLL on period, season, AFC and parity.

Sources	DF	LL		MY/DLL	
		MSS	F value calculated	MSS	F value calculated
Period	5	23020.00	7.20**	20.40	18.01**
Season	3	4806.00	1.50^{NS}	3.16	2.79*
AFC	5	10360.00	3.24**	1.71	1.51^{NS}
Parity	9	5068.00	1.58**	12.11	10.69**
Error	1462	3199.00		1.13	
Total	1484				

*P<0.05, ** P<0.01 and NS= Non-significant.

on milk yield per day of lactation length. The milk yield per day of lactation length was depressed for cows calving in summer. Cows that calve in summer were apparently more sensitive to heat stress in early lactation when production and energy requirements were highest. Similar results were reported by Buktare (1998) and Changunda et al. (2009). On the other hand, non-significant effect of season on MY/DLL were reported by Yazdani et al. (1996) and Auradkar (1999).

The effect of age at first calving on milk yield per day of lactation length

The highest milk yield per day of lactation length was observed from the cows that had AFC group A_2 followed by from cows which had AFC group A_5 and the lowest of from those cows which had AFC group A_4. DMRT indicated that, observed differences of milk yield per day of lactation length due to AFC effect were non-significant.

The effect of parity on milk yield per day of lactation length

The milk yield per day of lactation length was significantly (P<0.01) affected by parity. First lactation cows had lowest milk production, and highest production occurred in 5^{th} parity. The present result was in agreement with reports of Buktare (1998) and Auradkar (1999). However, and Gadmade (1999) reported non-significant effect of parity on milk yield per day of lactation length.

Conclusions

This study indicates that the performance of HF × Deoni crossbred cows on lactation milk yield and milk yield per day of lactation length is comparably low which needs an improvement in overall management of the dairy cows. Moreover, these crossbred cows were susceptible for periodical and seasonal changes on their milk production performance in the entire study period where, it could be difficult for them to thrive and maintain their production potential. Therefore, additional production strategies like improving environmental factors and management of cows are needed to counteract the adverse effect of periodical and seasonal changes.

ACKNOWLEDGMENTS

The authors acknowledge with thanks Prof. D.S. Chauhan Senior Scientist, Cattle Cross Breeding Project, Dr. S. Khillare and all staff members of Cattle Cross Breeding Project (CCBP) for providing the required data of HF × Deoni crossbred cows from the record maintained at CCBP and their unreserved collaboration. Appreciation is also expressed to Dr. B.M. Thombre for his continuing guidance and valuable comment.

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