I J T A
© Serials Publications
National Academy of Agricultural Science (NAAS)
Rating : 3. 03

Effect of Non-genetic Factors and Sire on Lactation Milk Yield in Holdeo

B.N. Thorat, B.M. Thombre and D.V. Bainwad*

Abstract: *India is mega cattle biodiversity in the country and an integral part of the agriculture. The data on milk production performance of 411 HF × Deoni crossbred having 1753 lactations were collected from records maintained at Cattle Cross Breeding Project, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra) over a period of 38 years (1977 to 2014). The leasts squares mean of lactation milk yield were estimated by considering effect of period of calving, season of calving, lactation order and age at first calving group and sire. The average lactation milk yield of Holdeo cows were 1387.94 ± 26.54 kg. In Holdeo cows the influence of period of calving, season of calving, lactation order and sire on lactation milk yield were significant (P < 0.01). However, the variation due to age at first calving group was non-significant. The variation in management, environmental effects as well as feeding practices coupled with population size during different periods might have affected lactation milk yield. The higher LMY in cows calved during winter season might be due to abundant availability of green fodder to milking cows, type of feed, environmental deviations and management, which varies greatly during different seasons.*

Keywords: *Holdeo, lactation milk yield, period, season, lactation order, age at first calving group, CCBP and sire.*

INTRODUCTION

In India miraculous achievement for becoming number one milk producing country in the world is the primary result of operation flood success, crossbreeding policies followed in India, hard work of farmers/Livestock owners and vast livestock population in India. The cattle biodiversity in India constitutes 39 well defined breeds of cattle, 13 breeds of buffaloes, 24 breeds of goat and 44 breeds of sheep (NBAGR, 2015).

India ranks first among the world's milk producing nations. Presently milk production of India is 146.31 MT during 2016 and per capita availability of milk is 322 gram per day and growth rate is 6.26% (NDDB, Statistics 2016). India has 190.9 million cattle, 108.7 million buffaloes, 135.2 million goats and 65.06 million sheep population (Livestock Census, 2012).

MATERIALS AND METHODS

Collection of Data

The observations pertaining to lactation milk yield for Holdeo (Holstein Friesian × Deoni) crossbred cattle were collected from history cum pedigree sheets and daily milk recording sheets over a period of 38 years (1977 to 2014) maintained at Cattle Cross Breeding Project, Vasantrao Naik Marathawada Krishi Vidyapeeth, Parbhani.

Standardization of Data

Records of abnormal case like lactation less than 100 days and milk yield less than 600 kg in lactation were not considered.

Classification of Data

The data collected on lactation milk yield were classified in suitable sub-class frequency and were

* Department of Animal Husbandry and Dairy Science, Vasantrao Naik Marathwada Krishi Vidyapeeth, College of Agriculture, Parbhani-431 402 *(corresponding author E-mail: badam.thorat2010@gmail.com)*

subjected for correction. The collected data of lactation milk yield were classified according to the period of calving, season of calving, lactation order and age at first calving group.

Period of Calving

Entire span of 38 years (1977 to 2014) were divided into 5 periods

Sr. No.	Years	Period
1.	< 1980-1986	P_1
2.	1987-1993	P_2
3.	1994-2000	P_3
4.	2001-2007	P_4
5.	2008-2014	P_5

Season of Calving

The year was divided into three seasons based on climatic conditions such as

Sr. No.	Month	Season	Code
1.	June-September	Rainy	S_1
2.	October-January	Winter	S_2
3.	February-May	Summer	S_3

Lactation Order

The lactation orders were considered up to 11th lactation orders and coded as

Sr. No.	Lactation orders	Code
1.	1st	L_1
2.	2nd	L_2
3.	3rd	L_3
4.	4th	L_4
5.	5th	L_5
6.	6th	L_6
7.	7th	L_7
8.	8th	L_8
9.	9th	L_9
10.	10th	L_{10}
11.	11th	L_{11}

Age at First Calving Group

The age at first calving were classified into following five groups

Sr. No.	AFC (days)	Code
1.	Up to 1250	A_1
2.	1251 to 1400	A_2
3.	1401 to 1550	A_3
4.	1551 to 1700	A_4
5.	Above 1700	A_5

STATISTICAL ANALYSIS

Least Squares Analysis

Analysis of data was carried out by using Least Squares analysis method for non-orthogonal data as described by Harvey (1990) and by using the Statistical Analysis System (SAS, 2002) software programme.

The following models were used :

Model I

The least squares means of lactation milk yield was estimated by considering effect of period of calving, season of calving, lactation order and age at first calving group. The model used for estimation was as under;

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

Where,

Y_{ijklm} = Observations on lactation milk yield of m^{th} animal belonging to i^{th} period of calving, j^{th} season of calving, k^{th} lactation order and l^{th} age at first calving group

μ = Population mean

P_i = Effect of i^{th} period of calving (i = 1, 2 – 5)

S_j = Effect of j^{th} season of calving (j =1, –3)

L_k = Effect of k^{th} lactation order (k = 1, 2 – 11)

A_l = Effect of l^{th} age at first calving group (l = 1 – 5)

e_{ijkl} = Random error associate with NID (0, $\sigma^2 e$)

Model II

The least squares means of lactation milk yield was estimated by considering effect of sire. The model used for estimation was as under;

$$Y_{ij} = \mu + S_i + e_{ij}$$

Where,

Y_{ij} = Observations on lactation milk yield of j^{th} individual belonging to the i^{th} sire

μ = Population mean

S_i = Effect of i^{th} sire (i = 1, 2, – 68)

e_{ij} = Random error associate with NID (0, $\sigma^2 e$)

Duncan's Multiple Range Test (DMRT)

Whenever the effects were significant the differences between means were tested for significance by Duncun's Multiple Range Test (DMRT) as modified by Kramer (1957) to make pair wise comparison between the Least Squares means (using the inverse coefficient matrix). If the values are greater than $\sigma^2 e$, ZP, n_2 then the difference is considered to be significant. The difference was considered if

$$X_i - X_j = SQRT\,[2/(C_{ii} + C_{jj} - 2C_{ij})] > \sigma^2 eZPn_2$$

Where,

$X_i - X_j$ = Difference between the two least squares mean

Cii = Corresponding i^{th} diagonal element of C matrix

Cjj = Corresponding j^{th} diagonal element of C matrix

Cij = Corresponding $(i, j)^{th}$ element

ZPn_2 = Standardized range value in Duncan's table of the chosen level of probability for the error degree of freedom

P = Number of means involved in the comparison

$\sigma^2 e$ = Root means squares for error

RESULT AND DISCUSSION

Lactation Milk Yield

The least squares mean of LMY and analysis of variance showing effects of period of calving, season of calving, lactation order and age at first calving group on lactation milk yield in Holdeo cows were presented in Table 1 and 2, respectively. The overall least squares mean for lactation milk yield of Holdeo was 1387.94 ± 26.54 kg. These results were in accordance with Rao *et al.* (1984) reported in Ongole cattle, Singh and Dave (1989) in Friesian × Tharparkar, Hadge *et al.* (2012) in Jersey × Sahiwal, Kumar *et al.* (2014) in Holstein Friesian × Indigenous, Bhutkar *et al.* (2015) and Pawar (2015) reported in Holstein Friesian × Deoni crossbred.

Table 1
Least squares means for lactation milk yield (kg) as affected by non-genetic factors in Holdeo

Source of variation	*Code*	*N*	*LMY (kg) Mean ± S.E*
Overall mean	μ	1753	1387.94 ± 26.54
Period of calving	P_1	516	1413.67^b ± 33.18
	P_2	605	1354.77^c ± 29.00
	P_3	341	1317.21^c ± 31.18
	P_4	153	1301.38^c ± 40.20
	P_5	138	1552.64^a ± 40.18
Season of calving	S_1	509	1338.29^b ± 29.71
	S_2	699	1430.97^a ± 29.23
	S_3	545	1394.55^b ± 30.31
Lactation order	L_1	411	1314.94^b ± 21.01
	L_2	341	1371.21^{ab} ± 22.68
	L_3	258	1447.82^{ab} ± 25.39
	L_4	213	1470.89^a ± 27.79
	L_5	177	1455.64^{ab} ± 30.35
	L_6	147	1496.74^a ± 33.01
	L_7	103	1413.03^{ab} ± 39.45
	L_8	59	1377.41^{ab} ± 51.56
	L_9	30	1440.76^{ab} ± 71.53
	L_{10}	11	1194.65^c ± 117.86
	L_{11}	3	1284.18^c ± 224.99
AFC groups	A_1	443	1408.53 ± 30.77
	A_2	176	1386.01 ± 38.51
	A_3	537	1411.23 ± 29.72
	A_4	436	1417.99 ± 30.69
	A_5	161	1315.92 ± 40.13

Means with similar superscripts are not differ significantly

1. Effect of period of calving

In Holdeo cows the influence of period of calving on lactation milk yield was significant ($P < 0.01$). Similar results were reported by Sharma *et al.* (1982), Reddy and Basu (1985), Mudgal *et al.* (1990), Jadhav *et al.* (1991), Lakshmi *et al.* (2009) and Komatwar *et al.* (2010) reported in Holstein Friesian × Sahiwal, Rao *et al.* (1984) in Ongole, Tharparkar and Malvi cattle, Kaul *et al.* (1985) in Holstein Friesian × Hariana and Brown Swiss × Hariana crossbred, Mandakmale and Kale (1990) and Patond (2013) in Gir triple cross cows, Dalal *et al.* (1991) in halfbred cattle, Dhangar and Patel (1991) in Jersey × Kankrej

Table 2
Analysis of variance for LMY in Holdeo

Source of variation	*df*	*SS*	*MSS*	*F value*
Period of calving	4	7141594.24	1785398.56	11.84**
Season of calving	2	2428472.71	1214236.35	8.05**
Lactation order	10	7309752.50	730975.25	4.84**
AFC groups	4	1348250.03	337062.50	2.23
Error	1732	261131005.55	150768.47	
Total	1752	279359075.04	159451.52	

** = $P < 0.01$

cattle, Singh and Tomar (1991) in Karan Fries cows, Thombre (1991), Thombre (1996), Ghatcharle (2003), Zewdu *et al.* (2013) and Ambhore (2015) in Holstein Friesian × Deoni, Shelke *et al.* (1992) in Red Kandhari, Dalal *et al.* (1993) and Kaushik *et al.* (1994) in Hariana cattle, Singh (1995) in Holstein Friesian × Zebu cattle, Bhoite (1996) in JG halfbred, FJG, JFG, BFG triple crosses and their interbreds, Nagadwali *et al.* (1996) in Sahiwal cattle, Nagare and Patel (1997) in Gir crosses, Patil (1997) in Jersey cattle, Tekerli *et al.* (2000), Ahamad *et al.* (2003) and Patel *et al.* (2010) in Holstein Friesian, Thakur and Singh (2001) in Jersey × Red Sindhi, Thombre *et al.* (2002), Salunkhe (2007) and Mruttu (2013) in Deoni cows, Vinoo *et al.* (2005) in Ongole, Dhaware *et al.* (2008) in Khillar, Khan and Kachwaha (2008) in Rathi, Sonawane (2008) in Red Sindhi, Nanavati and Singh (2009) in Nimari cattle, Badari *et al.* (2010) in Bhutana cattle, Chavan (2010) in HF × Gir and their interbreds, Mhasade (2010) in HF × Gir, Bajetha and Singh (2011) in crossbred cattle, Garudkar (2011) and Jadhav (2011) in Phule Triveni cows, Hadge *et al.* (2012) in Jersey × Sahiwal and Tambe (2016) in HF × Gir halfbred.

The DMRT revealed that the lactation milk yield (kg) of cows calved during period P_5 (1552.64 ± 40.18) was significantly higher than cows calved in P_1 (1413.67 ± 33.18), P_2 (1354.77 ± 29.00), P_3 (1317.21 ± 31.18) and P_4 (1301.38 ± 40.20). Similarly, difference in LMY among the cows calved during P_2, P_3 and P_4 was at par with each other.

2. *Effect of season of calving*

In Holdeo cows the effect of season of calving on lactation milk yield was significant ($P < 0.01$). These results were in accordance with Biswas *et al.* (1982)

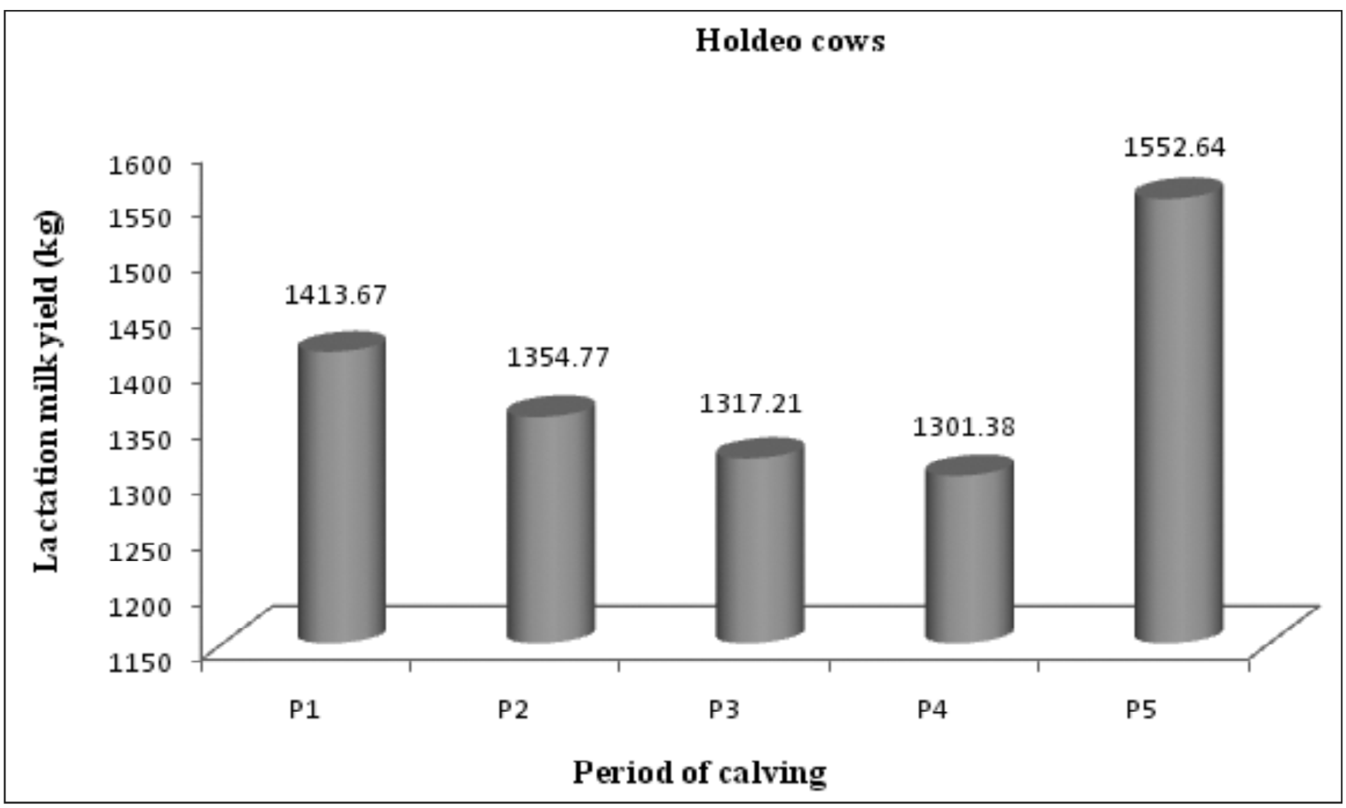

Figure 1: Effect of period of calving on lactation milk yield in Holdeo

noticed in Holstein Friesian × Hariana halfbred, Deshpande and Bonde (1982) in Friesian × Sahiwal crossbred, Bhutia and Pandey (1988) in various crossbred cows, Yeoitkar and Deshpande (1990) in rural crossbred, Dhangar and Patel (1992) in Jersey × Kankrej cows, Gandhi *et al.* (1995), Gaur and Raheja (1996) and Bajawa *et al.* (2004) in Sahiwal, Arora *et al.* (1996), Lakshmi *et al.* (2009) and Komatwar *et al.* (2010) in Holstein Friesian × Sahiwal, Tekerli *et al.* (2000), Ahamad *et al.* (2003) and Patel *et al.* (2010) in Holstein Friesian cows, Thakur and Singh (2001) in Jersey × Red Sindhi, Nanavati and Singh (2004) in Gir cattle, Dubey and Singh (2005) in Holstein Friesian × Sahiwal, Red Dane × Sahiwal and Holstein Friesian × Sahiwal × Rathi crossbred, Thakur and Singh (2005) in Jersey crossbred cows, Dhaware *et al.* (2008) in Khillar, Khan and Kachawa (2008) in Rathi, Badari *et al.* (2010) in Bhutan cattle, Garudkar (2011) and Jadhav (2011) in Phule Triveni cows, Hussain *et al.* (2012) in Jersey × Local and Holstein Friesian × Local, Zewdu *et al.* (2013) in Holstein Friesian × Deoni crossbred cows and Tambe (2016) in HF × Gir halfbred.

The mean LMY (kg) was significantly higher in Holdeo cows calved during S_2 (1430.97 ± 29.23) than S_3 (1394.55 ± 30.31) and S_1 (1338.29 ± 29.71). Difference in LMY among the cows calved during S_1 and S_3 was at par with each other.

3. *Effect of lactation order*

The variation due to lactation order in LMY of Holdeo cows was significant ($P < 0.01$). These results were supported with the findings of Deshmukh (1993) observed in Jersey × Sahiwal, Bhoite (1996) in FG, IFG, JG, FJG, IFJG, JFG and BFG, Bhuktare (1998) and Komatwar *et al.* (2010) in Holstein Friesian × Sahiwal, Gaur (2001) in Friswal cattle, Khade (2001) in Holstein Friesian × Gir, Holstein Friesian × Gir interse, 50% Holstein Friesian + 25% Jersey + 25% Gir crossbreds and their interbreds, Thakur and Singh (2001) in Jersey × Red Sindhi, Bhadoria *et al.* (2004) in Gir cows, Nagawade (2005) in Phule Triveni triple crossbred, Sonawane (2008) in Red Sindhi cows, Patond (2009) in Jersey cattle, Chavan (2010) and Tambe (2016) in HF × Gir halfbred, Mhasade (2010) in FG crossbred, Talape (2010) in Jersey crossbred, Jadhav (2011) and Garudkar (2011) in Phule Triveni cows, Patond (2013) in Gir triple cross cows and Zewdu *et al.* (2013) in Holstein Friesian × Deoni crossbred cows.

The mean LMY (kg) of Holdeo cows during L_6 lactation (1496.74 ± 33.01), L_4 (1470.89 ± 27.79), L_5 (1455.64 ± 30.35), L_3 (1447.82 ± 25.39), L_9 (1440.76 ± 71.53), L_7 (1413.03 ± 39.45), L_8 (1377.41 ± 51.56) and L_2 (1371.21 ± 22.68) were at par with each other and significantly higher than L_1 (1314.94 ± 21.01), L_{11} (1284.18 ± 224.99) and L_{10} (1194.65 ± 117.86). Results

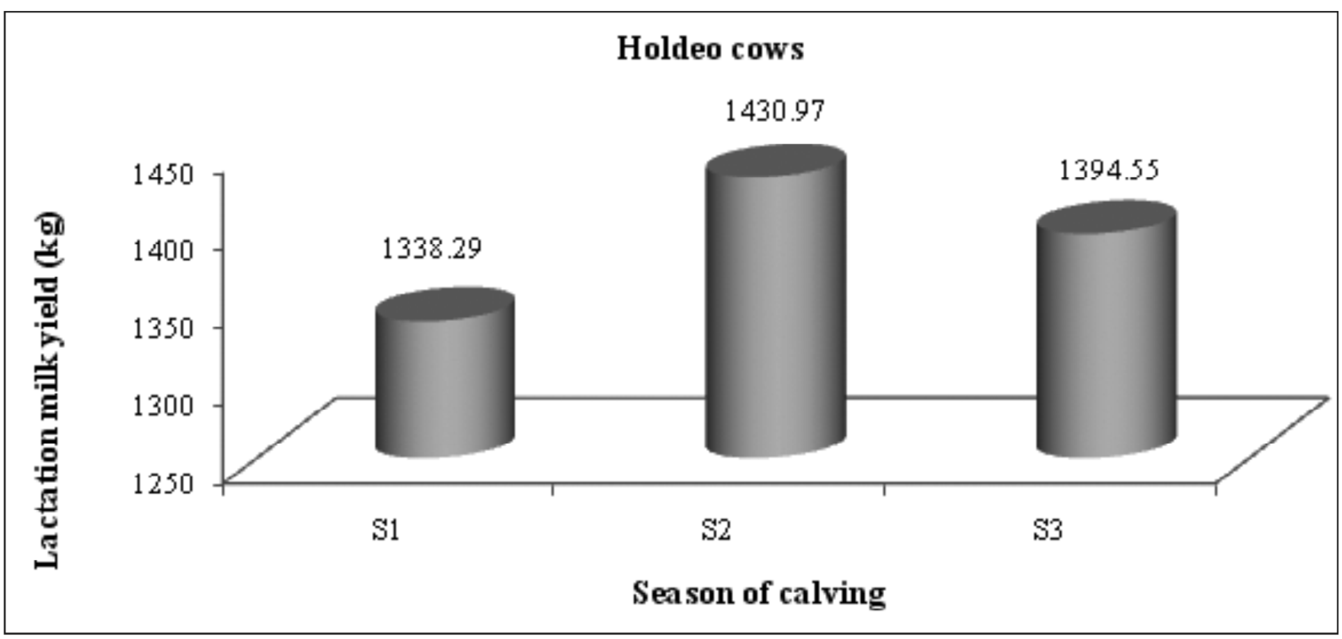

Figure 2: Effect of season of calving on lactation milk yield in Holdeo

revealed that lactation milk yield of cows increased gradually with the advancement of lactation order and reached peak during L_6 lactation and declined their after.

4. *Effect of age at first calving group*

The analysis of variance revealed non-significant effect of age at first calving group on LMY in Holdeo cows. Similar results were reported by Agasti *et al.* (1988) reported in Jersey × Hariana, Thombre (1991), Gatchearle *et al*. (2009) and Pawar (2015) in Holstein Friesian × Deoni, Natrajan (1989) in Tharparkar, Umrikar *et al.* (1990) in Gir cattle, Bareh *et al.* (1993) in Jersey and Friesian cattle, Mandakmale *et al*. (2002) and Shinde *et al.* (2005) in Phule Triveni cows, Dubey and Singh (2005) in Sahiwal crossbred, Vinoo *et al*. (2005) in Ongole, Mhasade (2010) in FG crossbred cows, Elemam and Nekhalia (2012) in Holstein Friesian × Local cattle and Jagdale (2015) in Deoni cattle.

5. *Effect of sire*

The analysis of variance indicating effect of sire on lactation milk yield and means of LMY were presented in Table 3 and 4, respectively. In Holdeo cows the effect of sires on lactation milk yield were significant ($P < 0.01$). Similar significant influence of sire on LMY was obtained by Hadge *et al*. (2009) noticed in Jersey × Sahiwal crossbred cows, Patond (2013) in Gir triple cross cows and Tambe (2016) in HF × Gir halfbred. The LMY was highest in cows of B_9 sire (1871.81 ± 168.98 kg) and lowest in cows of B_{52} sire (800.91 ± 377.86 kg). The better production performance of progenies of B_9 sire might be due to its superior genetic potentiality.

CONCLUSIONS

The highly significant effect of period of calving on lactation milk yield indicated the response of animals to varied environmental conditions including feeding, management and changing population dynamics due to selection pressure and culling. The higher LMY in cows calved during winter season might be due to abundant availability of green fodder to milking cows, type of feed, environmental deviations and management, which varies greatly during different seasons. The significant effect of lactation order on lactation milk yield attributed due to physiological maturity and development of body, milk secretary tissues and

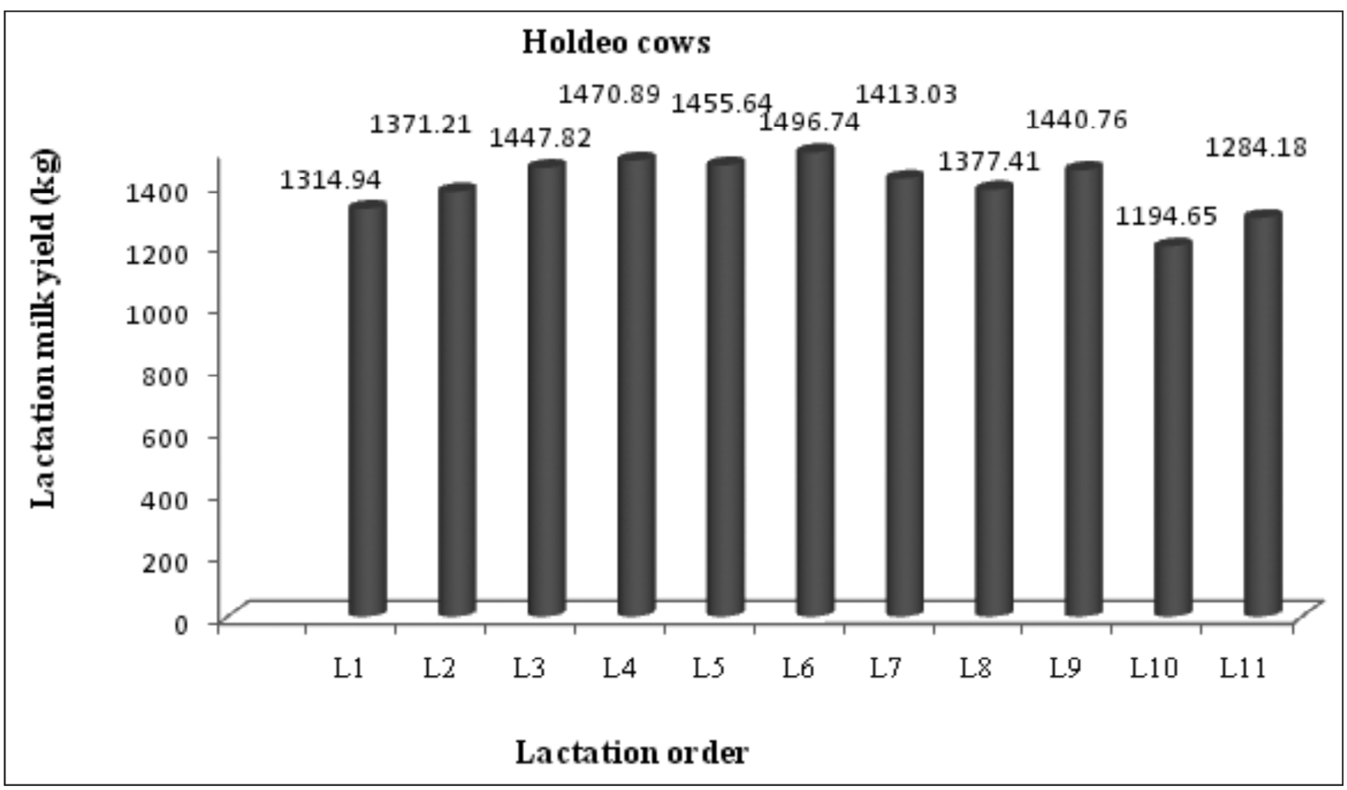

Figure 3: Effect of lactation order on lactation milk yield in Holdeo

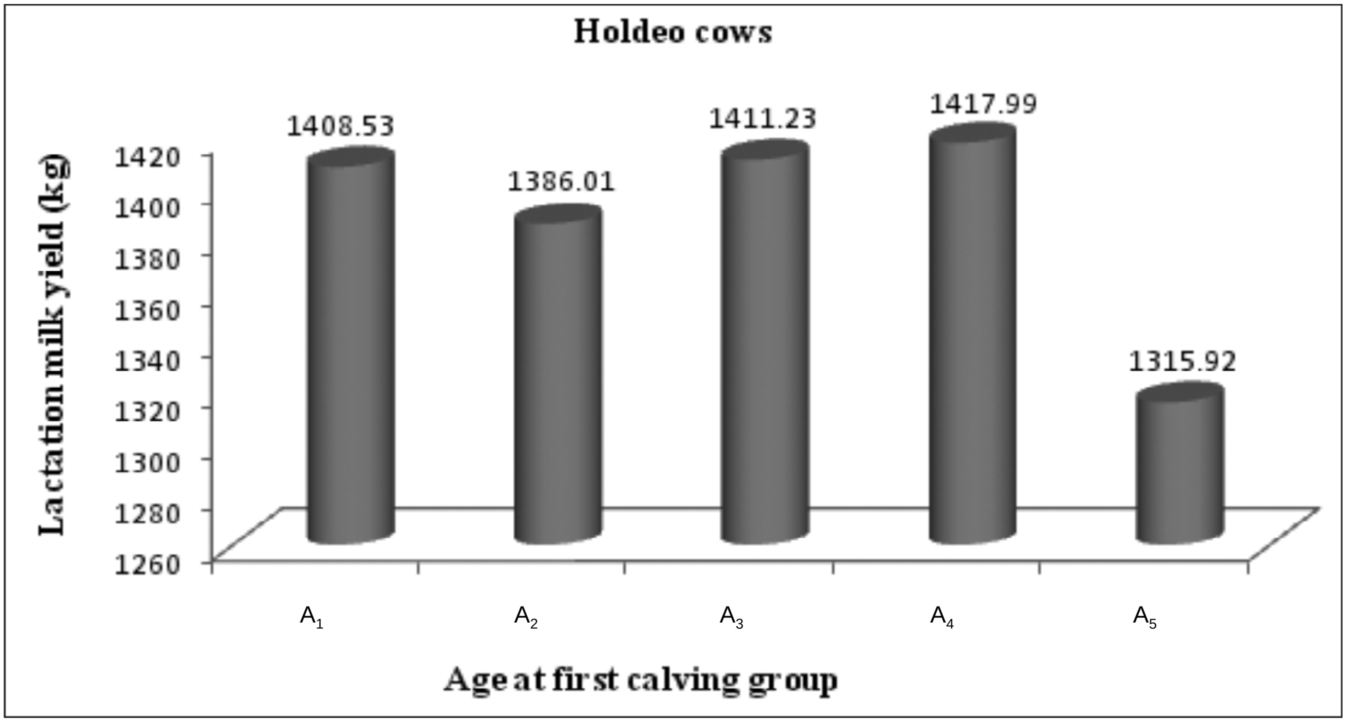

Figure 4: Effect of age at first calving groups on lactation milk yield in Holdeo

Table 3
Lactation milk yield in Holdeo as affected by sire

Sire code	*N*	*LMY (kg) Mean ± S.E*	*Rank*	*Sire code*	*N*	*LMY (kg) Mean ± S.E*	*Rank*
μ	1753	1332.09 ± 20.50		B_{35}	15	1411.78 ± 97.56	28
B_1	165	1389.30 ± 29.41	31	B_{36}	23	1458.33 ± 78.79	19
B_2	163	1405.32 ± 29.59	29	B_{37}	5	1242.04 ± 168.98	50
B_3	124	1366.21 ± 33.93	34	B_{38}	54	1344.38 ± 51.42	39
B_4	135	1464.61 ± 32.52	16	B_{39}	5	1355.57 ± 168.98	37
B_5	16	1465.39 ± 94.46	15	B_{40}	9	1526.94 ± 125.95	10
B_6	8	1842.44 ± 133.59	2	B_{41}	7	1249.54 ± 142.81	48
B_7	26	1388.24 ± 74.10	32	B_{42}	13	1404.08 ± 104.80	30
B_8	6	1484.87 ± 154.26	12	B_{43}	11	1315.28 ± 113.92	43
B_9	5	1871.81 ± 168.98	1	B_{44}	8	1712.89 ± 133.59	3
B_{10}	11	1522.26 ± 113.92	11	B_{45}	9	1478.83 ± 125.95	14
B_{11}	9	1247.53 ± 125.95	49	B_{46}	2	1288.90 ± 267.18	45
B_{12}	32	1420.04 ± 66.79	27	B_{47}	6	1707.91 ± 154.26	4
B_{13}	59	1464.20 ± 49.19	18	B_{48}	4	1455.70 ± 188.93	20
B_{14}	23	1464.51 ± 78.79	17	B_{49}	2	955.43 ± 267.18	62
B_{15}	21	1621.59 ± 82.45	7	B_{50}	4	944.43 ± 188.93	63
B_{16}	115	1362.89 ± 35.23	36	B_{51}	3	1196.03 ± 218.15	54
B_{17}	50	1433.20 ± 53.43	25	B_{52}	1	800.91 ± 377.86	68
B_{18}	66	1338.95 ± 46.51	41	B_{53}	6	988.17 ± 154.26	60
B_{19}	11	1225.05 ± 113.92	52	B_{54}	4	974.95 ± 188.93	61

Cont. table 3

Sire code	N	LMY (kg) Mean ± S.E	Rank	Sire code	N	LMY (kg) Mean ± S.E	Rank
B_{20}	54	1436.92 ± 51.42	24	B_{55}	3	848.60 ± 218.15	65
B_{21}	133	1365.19 ± 32.76	35	B_{56}	3	851.21 ± 218.15	64
B_{22}	18	1483.39 ± 89.06	13	B_{57}	1	828.24 ± 377.86	67
B_{23}	3	1567.35 ± 218.15	9	B_{58}	3	1318.46 ± 218.15	42
B_{24}	82	1254.99 ± 41.72	47	B_{59}	2	1148.89 ± 267.18	56
B_{25}	9	1387.01 ± 125.95	33	B_{60}	3	1026.75 ± 218.15	59
B_{26}	2	1668.41 ± 267.18	5	B_{61}	1	1342.70 ± 377.86	40
B_{27}	7	1072.67 ± 142.81	57	B_{62}	5	1352.96 ± 168.98	38
B_{28}	67	1442.81 ± 46.16	22	B_{63}	8	1180.36 ± 133.59	55
B_{29}	9	1447.23 ± 125.95	21	B_{64}	1	837.38 ± 377.86	66
B_{30}	12	1431.29 ± 109.07	26	B_{65}	11	1234.60 ± 113.92	51
B_{31}	43	1261.72 ± 57.62	46	B_{66}	6	1646.99 ± 154.26	6
B_{32}	10	1199.79 ± 119.49	53	B_{67}	8	1305.98 ± 133.59	44
B_{33}	6	1578.08 ± 154.26	8	B_{68}	2	1033.62 ± 267.18	58
B_{34}	5	1438.07 ± 168.98	23				

Table 4
Least squares analysis of variance of LMY as affected by sire in Holdeo

Source of variation	df	SS	MSS	F value
Sire	67	20548015.03	306686.79	2.148**
Error	1685	240582997.92	142779.22	
Total	1752	261131012.95	149047.38	

** = $P < 0.01$

mammary glands with advancing age of the cows. Age at first calving group does not showed significant influence on the production level of animals. Therefore, it is recommended to breed animals as early as possible so as to increase productive life of cows suitably. The better production performance of progenies may be due to its superior genetic potentiality.

Reference

Agasti, M. K., Choudhary, G. and Dhar, N. (1988), Genetic Studies on Some of the Traits of Milk Production in the Jersey × ariana Crossbred Cows. *Indian J. Anim. Health.* 27 (6): 67-71.

Ahamad, N. M., Sayed, M. M., Farood, M. S., Shah, S.I and Gill, R.A. (2003), Lactation Yield, Length and Persistency of Lactation in Holstein Cows under the Subtropical Enviornment of North West Frontier Provience. *Journal Anim. Vet. Adv.* 2(10): 548-553.

Ambhore, A.K. (2015), Studies on Persistency of Milk Yield in Holdeo (Holstein Friesian × Deoni) Straightbreds. M. Sc. (Agri.) *Thesis* Submitted to VNMKV, Parbhani (MS).

Arora, C.L., Singhal, R.A., Garg, R.C. and Subramanian, N.B. (1996), Age at First Calving in Frieswal Cows and Its Influence on First Lactation Milk Traits. *Indian J. Anim. Sci.* 66(10): 1067-1069.

Badari, T.M., Atta, M., Ibrahim, M.T. and Gulbartalla, K.A. (2010), Factors affecting Some Reproductive Indices of Bhutana Cows at Atbara Research Station. *Sudan Acad. Sci. J.* 3(2): 83-102.

Bajawa, I.R., Khan, M.S., Khan, M.A. and Gondal, K.Z. (2004), Environmental Factors Affecting Milk Yield and Lactation Length in Sahiwal Cattle. *Pakistan Vet. J.* 24 (1): 23-28.

Bajetha, G. and Singh, C.V. (2011), Estimates of Genetic and Phenotypic Parameters of First Lactation and Lifetime Performance Traits in Crossbred Cattle. *Indian J. Dairy. Sci.* 64(6): 494-500.

Bareh, E., Bardoli, T., Das, D. and Goswami, R.N. (1993), Factors Affecting First Lactation Milk Yield in Jersey and Holstein Friesian Cows in Meghalaya. *Indian J. Dairy. Sci.* 46(12): 61-63.

Bhadoria, H.B.S., Khan, F.H., Tomar, S.S. and Yadav, M.C. (2004), Genetic Study on Some of the Production Traits in Gir Cows. *Indian J. Dairy Sci.* 74(10): 1075-1078.

Bhoite, U.Y. (1996), Comparative Performance of Economic Traits of Halfbred, Triple Crosses of Gir and their Interbred Cows. Ph. D. *Thesis* Submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri.

Bhuktare, J.M. (1998), Factors Affecting Productive Performance in Holstein Friesian × Sahiwal Crossbred Cows. M.V.Sc. *Thesis* Submitted to Marathwada Agricultural University, Parbhani.

Bhutia, S.T. and Pandey, R.S. (1988), Genetic and Non-genetic Factors Affecting Milk Production and Lactation Length of Crossbred Cows. *Asian J. Dairy Res.* 7(1): 1-6.

Bhutkar, S.S., Thombare, B.M. and Bainwad, D.V. (2015), Production Traits in Holstein Friesian × Deoni Crossbred Cows. *Bioinfolet* 12 (1): 265-271.

Biswas, J.C., Saxena, M.M., Kumar, M and Kaushik, S.N. (1982), Factors Affecting Milk Yield in Friesian-Hariyana Halfbreds. *Indian J. Anim. Sci.* 52(3): 123-128.

Chavan, D. B. 2010. Reproductive and Productive Performance of Friesian × Gir Halfbred and Their Interbreds. M.Sc. (Agri.) *Thesis* Submitted to MPKV, Rahuri.

Dalal, D.S., Arora, K.C. and Rathi, S.S. (1991), Evaluation of Performance Traits in Halfbred Cattle. *Indian J. Dairy. Sci.* 44(7): 401-405.

Dalal, D.S., Arora, K.C. and Rathi, S.S. (1993), Effect of Period, Season, Parity and Age at First Calving on Performance Traits in Friesian × Hariana Halfbred Cows. *Indian J. Anim. Sci.* 61(9): 994-995.

Deshmukh, D.P. (1993), Genetic Studies on Reproduction and Production Efficiency Traits in Jersey × Sahiwal Crossbred Cows. M.V.Sc. *Thesis* Submitted to Marathwada Agricultural University, Parbhani.

Deshpande, K.S. and Bonde, H.S. (1982), Note on First Lactation Milk Yield in Friesian × Sahiwal Crossbreds. *Indian J. Anim. Sci.* 53(3): 303-306.

Dhangar, M.R. and Patel, J.M. (1992), Influence of Non-genetic Factors on First Lactation Milk Yield and First Service Period in Jersey × Kankrej Crossbred Cows. *Indian J. Anim. Mgmt.* 8(4): 225-229.

Dhanger, M.R and Patel, J.M. (1991), Factors Affecting First Lactation Milk Yield in Interse Mated Jersey × Kankrej Cows. *Indian J. Anim. Prod. Mgmt.* 7(3): 151-154.

Dhaware, S.A., Deshpande. K.S., Thombre, B.M., Deshmukh, D.S and Chauhan D.S. (2008), Evaluation of Some Economic Traits in Khillar Cattle. *Indian J. Anim. Res.* 42(1): 60-62.

Dubey, P.P. and Singh, C.V. (2005), Estimates of Genetic and Phenotypic Parameters Considering First Lactation and Lifetime Performance Traits in Sahiwal and Crossbreed Cattle. *Indian J. Anim. Sci.* 75(2): 1289-1294.

Elemam M.B. and Nekheila, A.M.A. (2012), Some Productive Traits of Crossbred Dairy Cows in the Farm of University of Khartoum, Sudan. *Emir. J. Food Agri.* 24(2): 155-158.

Gandhi, R. S., Gurani, M. and Singh, A. 1995. Influence of Non-genetic Factors on Some of the Economic Traits of Sahiwal Cattle. *Indian J. Dairy. Sci.* 48 (10): 605-606.

Garudkar S.R. (2011), Peak Yield and Its Relationship with Persistency and Lactation Milk Production in Phule Triveni Synthetic Cows. M.Sc. (Agri.) *Thesis* Submitted to M.P.K.V., Rahuri.

Gatchearle, P.L., Mitkari, K.R., Mule, R.S., Baswade, S.V. and Adangale, S.B. (2009), Effect of Age at First Calving on Lactation Milk Yield and Lactation Length. *Indian J. Anim. Res.* 43(3): 228-229.

Gaur, G.K. (2001), Environmental Factors Affecting Various Performance Traits of Frieswal Cattle. *Indian J. Dairy Sci.* 54(4): 209-213.

Gaur, G.K. and Raheja, K.L. (1996), Best Linear Unbiased Estimates of Different Enviornmental Effects for Production and Reproduction Traits in Sahiwal. *Indian J. Anim. Sci.* 66(6): 603-606.

Ghatcharle, P.L. (2003), Effect of Season of Calving on Production Traits in Interse Progeny of Holstein Friesian × Deoni. M.Sc. (Agri.) *Thesis* Submitted to MAU, Parbhani.

Hadge, M.R., Kuralkar, S.V., Ali, S.Z. and Kharkar, K.P. (2009), Performance of Sahiwal and Its Jersey Crosses for Reproductive Traits in Different Lactations. *Ind. J. Anim. Res.* 43(1): 75-76.

Hadge, M.R., Kuralkar, S.V., Ali, S.Z., Kharkar, K.P. and Sawaimul, A.D. (2012), Genetic Studies on Production Traits of Sahiwal and Sahiwal × Jersey Crossbred Cows. *Indian J. Anim. Res.* 46(1): 92-94.

Harvey, W.R. (1990), Least Squares Analysis of Data with Unequal Subclass Numbers. ARS, U.S. Department of Agriculture, Washington. D.C.

Hussain J., Roychoudhury R., Das G.C., Mili D.C. and Goswami R.N. (2012), Reproductive Performance of Dairy Cows under Field Condition of Assam State. *Indian J. Anim. Res.* 46(2): 180-183.

Jadhav, K.L., Tripathi, V.N., Taneja, V.K. and Kale. M.M. (1991), Performance of Various Holstein Friesian × Sahiwal Grades for Lactation, Reproduction and Production Traits. *Indian J. Dairy Sci.* 44(4): 209-216.

Jadhav, P.D. (2011), Generation Wise Comparative Reproduction and Production Performance of HF × Gir and Phule Triveni Synthetic Cows. M.Sc. (Agri.) *Thesis* Submitted to M.P.K.V., Rahuri.

Jagdale, V.Y. (2015), Studies on First Lactation Traits in Deoni Cattle. M.Sc. (Agri.) *Thesis* Submitted to VNMKV, Parbhani (MS).

Kaul, G.L., Pandey, H.N. and Katpal, B.G. (1985), Studies on Age at First Calving and its Reletionship with Weight and First Lactational Milk Yield in Crossbreds. *Indian J. Dairy. Sci.* 38(4): 332-334.

Kaushik, S.N., Agrawal, S.C. and Garg, R.C. (1994), Lifetime Traits in Hariana Cattle. *Indian J. Anim. Sci.* 64(10): 1104-1107.

Khade P.B. (2001), Studies on Herd Structure of Holstein Friesian Crosses Inrelation with Production Performance at R.C.D.P. on Cattle Rahuri. M.Sc. (Agri.) *Thesis* Submitted to M.P.K.V., Rahuri.

Khan, H.M. and Kachwaha, R.N. (2008), Lifetime Performance of Rathi Cattle at Organised Farm. *Indian J. Anim. Res.* 42(3): 186-190.

Komatwar, S.J., Deshpande, A.D., Kulkarni, M.D., Kulkarni, A.P., Yadav, G.B., Ulemale, A.H. and Sisode, M.G. (2010), Study the Production Traits in Holstein Friesian × Sahiwal Crossbreds. *Indian J. Anim. Prod. Mgmt.* 26(4): 177-181.

Kramer, C.V. (1957), Extension of Multiple Range Test to Group Correlated Adjusted Mean. *Biometric.* 13: 13-20.

Kumar, N., Eshetie, A., Tesfaye, A. and Yizengaw, A. (2014), Productive Performance of Indigenous and Holstein Friesian Crossbred Dairy cows in Gondar, Ethiopia. *Vet. World.* 7(3): 177-181.

Lakshmi, B.S., Gupta, B.R., Sudhakar, K., Prakash, M.G. and Sharma, C.S. (2009), Genetic Analysis of Production Performance of Holstein Friesian × Sahiwal Cows. *Tamilnadu J. Vet. Anim. Sci.* 5(1): 143-148.

Livestock Census (2012), 19th Livestock Census-2012. www.dahd.nic.in

Mandakmale, S.D. and Kale, K.M. (1990), Factors Affecting Milk Production Performance of Gir Halfbreds and Their Second Generation Crosses with Exotic Dairy Breeds. *Indian J. Anim. Sci.* 60(6): 730-731.

Mandakmale, S.D., Bhoite, U.Y., Lawar, V.S. and Deokar D.K. (2002), Studies on Effect of Age and Weight at First Calving on Production Performance of Phule Triveni A Triple Crossbred Cow. *J. Maharashtra. Agric. Univ.* 27(1): 94-95.

Mhasade, B.S. (2010), Effect of Age and Weight at First Calving on Production Performance of HF × Gir Crossbreds. M.Sc. (Agri.) *Thesis* Submitted to M.P.K.V., Rahuri.

Mruttu, H.A. (2013), Studies on Performance of Deoni Cattle at MAU Dairy Farm, Parbhani. Ph. D. (Agri.) *Thesis* Submitted to Marathwada Agriculture University, Parbhani (MS).

Mudgal, K.C., Taylor, C.M. and Singh, A. (1990), Studies on Dry Period and Service Period in Crossbred Cattle. *Indian Vet. J.* 63(7): 561-565.

Nagadwali, S.B., Kothekar, M.D., Gore, A.K. and Deshmukh, S.N. (1996), Effect of Non- genetic Factors and Inbreeding on Reproduction and Production Traits in Sahiwal. *Indian Vet. J.* 73(2): 159-163.

Nagare, W.K. and Patel, A.M. (1997), The Comparative Performance of Gir Crossbreds under Maharashtra Conditions. *Indian J. Anim. Prod. Mgmt.* 13(2): 87-92.

Nagawade, P.P. (2005), A Study on Colostrums Yield and Its Relation with Milk Production Traits and Prediction of Part Lactation Yield in Phule Triveni Cattle. M.Sc. (Agri.) *Thesis* Submitted to M.P.K.V., Rahuri.

Nanavati, S. and Singh, A. (2004), Non-genetic Factors Affecting Production Traits in Gir Cattle. *Indian J. Dairy Sci.* 57(5): 342-346.

Nanavati, S. and Singh, A. (2009). Factors Affecting Reproduction and Production Traits in Nimari Cattle. *Indian J. Dairy. Sci.* 52(3): 207-210.

Natarajan, N. (1989), Production and Reproduction Performance in Tharparkar Cattle, Lead Papers and Abstracts. *National Seminar on Genetics Aplied Livestock Production*: B-1.

NBAGR, (2015), Registered Breeds of Livestock. www.nbagr.res.in

NDDB, Statistics. (2016), Livestock Population in India. www.nddb.statistics.com

Patel, A.C., Vataliya, P.H., Josh, R.S., Derashri, H.J., Patel, J.A. and Belsare, V.P. (2010), Genetic and Non-genetic Factors Affecting Reproduction Traits in Holstein Friesian Cow in Tropical Enviornment. *Indian J. Anim. Prod. Mgmt.* 26(3-4): 125-127.

Patil, S.V. (1997). Genetic Studies on Production and Reproduction Efficiency Traits in Jersey, Sahiwal and Jersey × Sahiwal Crossberd Cows. M.Sc. (AGB) *Thesis* Submitted to MAU, Parbhani.

Patond M.N., (2013), Modelling of Lactation Curve in Gir Triple Cross Cows. Ph. D. *Thesis* Submitted to MPKV, Rahuri, (MS).

Patond, M.N. (2009), Persistency of Milk Yield in Jersey Cattle. M.Sc. (Agri.) *Thesis* Submitted to M. P. K. V., Rahuri.

Pawar, P.S. (2015), Studies on First Lactation Tarits in Holdeo (Holstein Friesian × Deoni) Straightbred Cattle. M. Sc. (Agri.) *Thesis* Submitted to VNMKV, Parbhani (MS).

Rao, A.V., Rao, G.N and Kumar, M. (1984), First Lactation Performance of Zebu, Jersey × Zebu and Brown Swiss × Zebu Cows. *Indian J. Anim. Sci.* 54(10): 477-478.

Reddy, C.O. and Basu, S.B. (1985), Factors Affecting Profit Functions and Production and Reproduction Traits in Crossbred Cattle. *Indian J. Anim. Sci.* 55: 477-484.

Salunkhe, M.S. (2007), Study on Productive and Reproductive Performance of Deoni Cattle. M.Sc. (Agri.) *Thesis* Submitted to Marathwada Krishi Vidyapeeth, Parbhani (MS).

SAS, 2002. User's Guide: Statistics, (2002), Version 9.3. Cary, NC, USA: SAS Institute Inc.

Sharma, J.M., Dhingra, M.M. and Gurung, B.S. (1982), Note on the Genetic and Non-genetic Factors Affecting Some Production Traits in Crossbred of HF × Sahiwal Cows. *Indian J. Anim. Sci.* 52(1): 42-45.

Shelke, B.S., Sakhare, P.G. and Deshpande, K.S. (1992), Breeding Efficiency and Milk Producing Ability of Red Kandhari and Jersey × Red Kandhari Halfbred Cows. *Indian J. Anim. Sci.* 62(1): 79-80.

Shinde, S.B., Jagtap, D.Z. and Dhane, V.H. (2005), Studies on Lifetime Production Traits at Year Basis in Phule Triveni Crossbred Cattle. *J. Maharashtra. Agric. Univ.* 30(1): 78-81.

Singh, M.R. and Tomar, S.S. (1991), Factors Affecting the Service Period and Its Association with Other Traits in Karan Fries Cattle. *Indian J. Dairy Sci.* 44(1): 6-8.

Singh, N.P. and Dave, S.K. (1989), Performance of Tharparkar × Holstein Friesian Interse Crossbreds in Central India. *Indian J. Anim. Prod. Mgmt.* 5(1): 1-4.

Singh, S.R. (1995), Variation in Some Performance Traits in Friesian × Zebu Cows. *Indian J. Dairy. Sci.* 48(1): 27-30.

Sonawne, S.B. (2008), Colostrum Production Traits Its Association with Milk Production Traits and Prediction of Part Lactation Milk Yield in Red Sindhi Cows. M.Sc. (Agri.) *Thesis* Submitted to M.P.K.V., Rahuri.

Talape, S.K. (2010), Studies on Production Performance and Breeding Efficiency of Jersey Crossbreds Maintained at Panjarpole Ahmednagar. M.Sc. (Agri.) *Thesis* Submitted to M.P.K.V., Rahuri.

Tambe, D.R. (2016), Modelling of Lactation Curve in HF × Gir halfbred. Ph. D. *Thesis,* Submitted to MPKV, Rahuri, (MS).

Tekerli, M., Kucukkebabci, M., Skalin, N. H. and Kocak, S. (2000), Effect of Enviornmental Factors on Some Milk Production Traits, Persistency and Calving Interval of Holstein Friesian Cows. *Livestock Prod. Sci.* 68(2): 275-281.

Thakur, Y.P and Singh, B.P. (2001), Performance Evaluation of Jersey × Red Sindhi Crossbreds. *Indian Vet. J.* 78(1): 62-63.

Thakur. Y.P. and Singh B.P. (2005), Factors Affecting First Lactation Milk Yield Traits in Jersey Cows. *Indian J. Anim. Res.* 39(2): 115-118.

Thombre, B.M. (1991), Effect of Age at First Calving on Lactation Milk Yield, Lactation Period, Dry Period, Service Period, Inter Calving Period, Peak Yield and Days Required to Reach Peak Yield of Holstein Friesian × Deoni Straight Breds in First Lactation. M. Sc. (Agri.) *Thesis* Submitted to MAU, Parbhani.

Thombre, B.M. (1996), Study on Genetic Architecture of few Economic Characters in Holstein Friesian × Deoni Halfbred. Ph. D. *Thesis* Submitted to MAU, Parbhani.

Thombre, B.M., Mitkari, K.R. and Karanjkar, L.M. (2002), Studies on Age at First Calving and Milk Yield in Deoni and Holstein Friesian × Deoni Halfbreds. *Indian J. Anim. Res.* 36(2): 141-143.

Umrikar, V.D., Natarjan, N., Thangaraju, P. and Rahumathulla, P.S. (1990), Factors Influencing Traits of Gir and Jersey × Gir Crossbred Cattle. *Cherion.* 19(3): 131-138.

Vinoo, R., Rao, N., Gupta, B.R. and Rao, B. (2005), Study on Productive and Reproductive Traits of Ongole Cattle. *Indian J. Anim. Sci.* 75(4): 438-441.

Yeotikar, S.S. and Deshapande, K.S. (1990), Factors Affecting Lactation Milk Yield in Village Crossbred. *Indian J. Anim. Sci.* 60(11): 1390-1391.

Zewdu, W., Thombre, B.M. and Bainwad, D.V. (2013), Effect of Non-genetic Factors on Milk Production of Holstein Friesian × Deoni Crossbred Cows. *International J. Livestock. Prod.* 4(7): 106-112.