"GENETIC AND NON-GENETIC FACTORS INFLUENCING MILK PRODUCTION EFFICIENCY OF CATTLE IN AND AROUND MADHEPURA (BIHAR)"

THESIS

SUBMITTED TO THE

RAJENDRA AGRICULTURAL UNIVERSITY

(FACULTY OF VETERINARY AND ANIMAL SCIENCES)

PUSA (SAMASTIPUR) BIHAR

By

Dr. Pramod Prabhakar

Registration No. - M/ABG/10/2005-2006

In partial fulfilment of the requirements

FOR THE DEGREE OF

MASTER OF VETERINARY SCIENCE

(Animal Breeding & Genetics)

DEPARTMENT OF ANIMAL BREEDING & GENETICS

BIHAR VETERINARY COLLEGE

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FOR THE DEGREE OF

Master of Veterinary Science

(Animal Breeding & Genetics)

DEPARTMENT OF ANIMAL BREEDING & GENETICS
BIHAR VETERINARY COLLEGE
P A T N A – 800 014

2007

DEPARTMENT OF ANIMAL BREEDING & GENETICS
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Dr. Shashi Bhushan Verma
M.V.Sc. (I.V.R.I.), Ph. D (B.A.U.)
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CERTIFICATE – I

This is to certify that the thesis entitled "***Genetic and non-genetic factors influencing milk production efficiency of cattle in and around Madhepura (Bihar)***" submitted in partial fulfillment of the requirements for the Degree of **Master of Veterinary Science (Animal Breeding & Genetics)** of the faculty of post-graduate studies, Rajendra Agricultural University, PUSA, Samastipur, Bihar is the record of bonafide research work carried out by **Dr. Pramod Prabhakar, Registration No. M/ABG/10/2005-06,** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

It is further certified that the assistance and help received during the course of this investigation and preparation of the thesis have been fully acknowledged.

Endorsed

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(Shashi Bhushan Verma)
Major Advisor

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CERTIFICATE – II

We, the undersigned members of the Advisory Committee of **Dr. Pramod Prabhakar**, Registration No. **M/ABG/10/2005-2006**, a candidate for the Degree of Master of Veterinary Science with major in **Animal Breeding & Genetics** have gone through the manuscript of the thesis and agree that the thesis entitled "***Genetic And Non-Genetic Factors Influencing Milk Production Efficiency Of Cattle In And Around Madhepura (Bihar)***" may be submitted by **Dr. Pramod Prabhakar** in partial fulfilment of the requirements for the degree.

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CERTIFICATE – III

This is to certify that the thesis entitled "***Genetic and non-genetic factors influencing milk production efficiency of cattle in and around Madhepura (Bihar)***" submitted by **Dr. Pramod Prabhakar, Registration No. M/ABG/10/2005-06** in partial fulfillment of the requirements for the Degree of **Master of Veterinary Science (Animal Breeding & Genetics)** of the Faculty of Post-Graduate Studies, Rajendra Agricultural University, PUSA, Samastipur, Bihar was examined and approved on 11th/ October/ 2007.

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Dedicated

to my

beloved

Parents

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Place - BVC, Patna

Date - 25/05/07

Pramod Prabhakar

(Pramod Prabhakar)

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CHAPTER - 1

INTRODUCTION

INTRODUCTION

India is the largest milk producer country in the world producing about 90.7 million tonnes of milk per annum (India, 2007). The daily requirement of milk per head per day has been recommended to be 231 g (India, 2007). Since the population of the country has already crossed the mark of 100 crores in 2001, there has become a big gap between availability and requirements of milk. Thus, intensive efforts are being made to increase milk production through scientific breeding, balanced feeding, health care and better management of milch animals.

Animal husbandry and dairy farming are vital sectors of rural economy. These provide a significant proportion of self employment opportunities in these sectors. Landless milk producers and marginal and small farmers engage themselves in dairying for gainful employment or supplementing their income. The importance of dairying lies not only in production of milk but it brings about significant change in socio-economic structure of rural economy.

After truncation of the state in 2000, the remaining Bihar has become too much deficient in industries, minerals and forest resources as major portion of these sectors have gone to Jharkhand. The remaining Bihar is left over only with agriculture and animal husbandry for its economic resources. It is well known fact that every year north Bihar has to bear a great economic loss due to flood. Apart from these, there are poor irrigation facilities because of poor generation of electricity and lack of canal facilities. Thus, animal husbandry, in general and dairying in particular remains as the only tool for alleviation of poverty in the state.

Milk production in Bihar is mainly under the control of landless, small and marginal farmers constituting about 65% of the total production. A large number of Khatals have cropped up in and around district towns of the state where the dairy farmers are keeping Desi as well as crossbred cattle. These dairy units require best technological and managemental knowhow for which suitable strategies are to be formulated for maximizing milk production.

Madhepura is one of the historic towns of Mithilanchal which has its glorious background of Mithila culture. Madhepura is famous for well known B.N.M. University and the famous temple of Lord Shiva at Singheshwar which is situated only 5 kms away from the Madhepura town. As per 2003 census, there are more than 4 lacs 13 thousand indigenous cattle including the crossbreds in Madhepura district which shows the keen interest of the people of Madhepura in dairying. These cattle produce large quantity of milk which cater the need of the people of Madhepura. The growing population of Madhepura town mainly because of unidirectional flow of population from rural to urban area, has significantly increased the demand of milk and thus the town has become a very good market for milk and milk products. Resultantly a large number of dairy units (khatals) have cropped up and become operational in and around Madhepura.

Since the profitability is the main objective of any enterprise, there must be optimum level of milk production for maximizing the economic gain. The milk producing efficiency of cows is dependent upon various genetic and non-genetic factors. Although many studies have been conducted on milk production efficiency of cows in organized farms, yet the information on the cows maintained in unorganized dairy units (khatals) is scanty (Kalra 1995; Chandra and Agarwal, 2000; Shrivastava and Singh,

2000; Kumar, 2005 and Kumar 2006). Therefore, the present study has been planned with the following objectives :

1. To estimate the phenotypic parameters of some of the milk production efficiency measures of Desi, HF crossbred cows and Jersey crossbred cows maintained in unorganized farm in and around Madhepura (Bihar).
2. To study the nature and magnitude of variation in various measures of milk production efficiency under consideration due to genetic and non-genetic factors in and around Madhepura (Bihar).
3. To study the various constraints perceived by the dairy farmers in and around Madhepura in rearing high yielding cows.
4. To provide suggestions for suitable dairy practices for economic milk production to the dairy farmers in and around Madhepura (Bihar).

CHAPTER - 2

REVIEW OF LITERATURE

REVIEW OF LITERATURE

LACTATION MILK YIELD :

AVERAGE : The average lactation milk yield (kg) as reported by various authors are tabulated as below :

Table-1 : Average Lactation Yield of various genetic groups :

Genetic Group	Lactation / 300 days or less	Milk Yield (Kg)	Author
HFX Hariana Jersey x Hariana	300 days or less Do	2609.82 ± 20.92 Kg 2143.94 ± 17.15 Kg	Panda and Sadhu (1983)
Hariana HFX H Jersey x Hariana	305 days Do Do	1150.70 ± 44.65 Kg 2001.97 ± 54.55 Kg 1588.24 ± 50.78 Kg	Duc and Taneja (1984)
Hariana JX H	Lactation milk yield	1066.28 kg 2110.58 kg	Raj Kumar (1985)
Hariana Hariana x Holstein Friesian	305 days Do	693.2 ± 67.8 kg 1933.2 ± 42.1 kg	Parmar et al. (1986)
Friesian crossbreds ≥ 50% 50% ≤ 50%	Lactation milk yield	3556.2 ± 83.6 kg 3655.1 ± 125.6 kg 2288.8 ± 158.5 kg	Singh et al. (1986[a])
Friesian crossbreds	Do	3166.7 ± 74.4 kg	Singh et al. (1986[b])
Jersey x Kankrej (F_1)	Lactation milk yield	2681.11 ± 83.6 kg	Patel and Trivedi (1989)
½ Holstein Friesian x ½ Hariana ½ Jersey x ½ Hariana	Do Do	2647.3± 55.5 kg 1968.9 ± 68.2 kg	Chopra (1990)
½ Jersey ½ Friesian ¾ Jersey ¾ Friesian	Do Do Do Do	1971.03 ± 13.72 kg 2357.23 ± 16.00 kg 1951.17 ± 25.60 kg 2358.96 ± 23.64 kg	Hayatnagarkar et al. (1990)
Holstein Friesian x Sahiwal Tharparkar	Do Do	2494.70 ± 50.43 kg 1935.61±51.31 kg	Jadhav et al. (1991) Vij. et al. (1992)
Hariana	Do	1426.53 ± 18.11 kg	Yadav and Rathi (1992)
Sahiwal	Do	1695.88 ± 20.55 kg	Yadav et al. (1992)
Sahiwal Jersey x Sahiwal Red Dane x Sahiwal	Do Do Do	1508.32 ± 77.8 kg 2581.08 ± 77.8 kg 2769.30 ± 77.8 kg	Singh et al. (1993)

Friesian x Hariana	Do	2432 ± 33.6 kg	Raheja (1997)
Hariana	300 days	1132.0 ± 19.5 kg	Pundir and Raheja (1997)
Friesian crossbreds	Lactation milk yield	2716.03 ± 7.89 kg	Shrivastava et al. (1998)
½ Jersey x ½ Hariana > ½ Jersey x < ½ Hariana	300 day or 1st Lactation Do	1258.3 ± 46.31 kg 1256.8 ± 67.9 kg	Thakur et al. (1999)
Jersey crossbreds HF crossbreds	Lactation milk yield	2355.42 ± 56.29 kg 3021.73 ± 40.53 kg	Singh et al. (2000)
Jersey crossbreds	300 day	1652.2 ± 129.4 kg 2044.55 ± 55.5 kg	Thakur et al. (1999)
Jersey crossbreds	Lactation milk yield	1899.81 ± 47.6 lit.	Rao et al. (2000)
Hariana	300 day or less	1081.0 ± 14.21 kg	Dalal et al. (2002)
Tharparkar Tharparkar x HF (F_1) (F_2)	Lactation milk yield Do Do	1525.06 ± 58.75 kg 2753.16 ± 67.15 kg 1747.99 ± 169.65 kg	Bhattacharya et al. (1999)
½ Jersey x ½ Sahiwal	Do	2662.67 ± 132.9 kg	Kumar and Kumar (2003)
HF Cross	Lactation yield (kg)	3299.89 ± 79.02 kg	Shiv Prasad (2003)
HF Cross	Do	2264.45 ± 42.49 kg	Akhter et al. (2003)
Jersey cross	1st lactation milk yield	1614.0 ± 32.38 kg	Varade et al. (2004)
Desi HFX JX	Lactation milk yield Do Do	1005.19 ± 43.83 2800.2 ± 34.32 2169.30 ± 40.25	Kumar (2005)
HF > 50% HF 50% HF < 50% Hariana Pure	Lactation yield	1703.83 ± 89.42 2233.81 ± 64.36 1204.51 ± 106.92 837.99 ± 132.61	Sharan (2005)
Desi HFX JX	Lactation yield	1030.15±39.40 2705.13±32.99 2137.48±36.31	Kumar (2006)

GENETIC AND NON-GENETIC FACTORS AFFECTING LACTATION YIELD :

EFFECT OF GENETIC GROUP :

Panda and Sadhu (1983) observed significant ($P<0.01$) effect of genetic group on lactation yield and reported the overall lactation yield to be highest in Hariana x HF followed by Desi Bengal x HF, Hariana x Jersey and Desi Bengal x Jersey.

Raj Kumar (1985) found nearly double higher milk yield in Jersey x Hariana (F_1) than Hariana cows.

Singh et al. (1986b) studied the effect of genetic and non-genetic factors in Friesian crossbred cows maintained in small dairy units belonging to private sectors in and around Ranchi and reported significant effect of genetic grades of cows on the lactation yield.

Hayatnagarkar et al. (1990) Reported highly significant ($P<0.01$) effect of genetic group on lactation yield in rural crossbred cows. They found that the lactation milk yield was highest in ¾ Friesian followed by ½ Friesian, ½ Jersey and ¾ Jersey inheritance.

Jadhav et al. (1991) Observed significant ($P<0.01$) effect of genetic group on 300-day lactation yield and reported that ½ grades had the highest performance for 300-day milk yield followed by 7/8 and 5/8 grades.

Singh et al. (1993) found significant ($P<0.01$) effect of genetic group on 1st lactation milk yield in Sahiwal, Jersey x Sahiwal and Red Dane x Sahiwal and reported the highest 1st lactation milk yield to be in Red Dane x Sahiwal followed by Jersey x Sahiwal and Sahiwal.

Thakur et al. (1999) Observed significant ($P<0.01$) effect of genetic group on 1st lactation 300 days or less milk yield in nine genetic groups of Jersey x Zebu crossbreds.

Bhattacharya et al. (2002) Studied the dairy performance of Tharpakar and Holstein Friesian and their crosses and reported that the lactation milk yields of F_1 crossbreds of Holstein Friesian were better than Indian born Holstein Friesian and also F_2 crossbreds of HF x Tharpakar.

Priya Raj (2002) Observed that genetic group had significant ($P<0.01$) effect on lactation milk yield under farmers' managemental

condition in and around Patna and reported that HF crossbreds had significantly (P<0.01) higher lactation milk yield than Jersey crossbreds.

Akhter et al (2003) compared the performance of two and three bred cross progenies of three exotic breeds viz. Holstein Friesian (F), Jersey (J), Red Dane (RD) with three Zebu breeds viz. Sahiwal (S), Hariana (H) and Red Sindhi (RS) and observed significant effect of genetic group on 1st lactation milk yield. They reported that the highest & lowest milk yields in 1st lactation were produced by 5/8 F x 3/8 S and J (FxS) crossbreds respectively.

Bhadauria and Katapatal (2003) reported significant (P<0.01) effect of genetic grades of Friesian and Sahiwal crosses on 300 days milk yield of 1st lactation. They observed that 300 days milk yield significantly (P<0.01) increased from 3/8th Friesian level upto 5/8th level but beyond that there was a gradual decline in the milk production.

Kumar[1] (2004) studied the effect of genetic group on lactation yield in Hariana and its crosses with HF and Jersey in hot humid climate of North-Bihar. He reported that ½ HF ½ H genetic group produced highest milk followed by ½ J ½ H genetic group.

Kumar[2] (2004) reported that ½ HF ½ H genetic group had highest lactation yield among the six genetic groups of cows and had more than double 300 days or less milk yield than Hariana and HF 62.5% groups. The ½ J ½ H group yielded 2nd highest lactation milk yield which was significantly (P<0.01) higher than Hariana pure, HF50%, HF62.5% and HF 75% genetic groups.

Kumar (2005) Studied the effect of genetic group on lactation milk yield in Desi, HFX and JX cows under farmers' managemental condition in and around Patna (Bihar). He reported that HF crossbreds had significantly (P<0.01) 1795.01 kg and 630.9 kg more milk yield that Desi and Jersey

crossbred cows respectively. He further reported that HFX and JX had nearly 3 times lactation yields than Desi cows.

Sharan (2005) studied the effect of genetic group on lactation yield in cattle and reported significant ($P<0.01$) effect of genetic group on it. The ½ HF ½ H group yielded highest quantity of milk which was significantly ($P<0.01$) higher by 529.983 and 1029.294 kg than HF>50% and HF<50% genetic groups respectively. He further reported that Hariana yielded lowest quantity of milk and ½ HF ½ H genetic group had more than double lactation yield than Hariana.

Kumar (2006) Studied the effect of genetic group on lactation yield in cattle in and around Biharsharif of Nalanda district (Bihar). He observed highly significant ($P<0.01$) effect of genetic group on it. He further reported that HFX had the highest lactation yield followed by JX and Desi cows. He found that both HFX and JX had more than double LMY than Desi cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Singh et al. (1986^{b}) observed significant ($P<0.01$) effect of location of herd on lactation milk yield in Friesian crossbred cows of private sector in and around Ranchi.

Hayatnagarkar et al. (1990) studied the effect of location of herd on total milk yield and reported significant ($P<0.01$) effect of location of herd on total milk yield in the crossbreds consisting of ½ J (Jersey) ½ non-descript (ND), ½ Friesian (F) ½ ND, ¾ J ¼ ND and ¾ F ¼ ND.

Jadhav et al. (1991) observed that farm had significant ($P<0.01$) effect on 1^{st} lactation 300 days milk yield in various Holstein x Sahiwal grades.

Priya Raj (2002) reported non-significant effect of zones on lactation milk yield of crossbred cows under farmers' managemental condition.

Bhadauria and Katpatal (2003) observed that farm had no significant influence on 1st lactation 300 days milk yield in Friesian x Sahiwal crosses.

Kumar[1] (2004) reported that location of herd in and around Darbhanga did not influence the lactation milk yield of cattle significantly.

Kumar (2005) observed that location of herd had significant ($P<0.05$) effect on lactation milk yield in cattle in and around Patna under farmers' managemental condition.

Kumar (2006) studied genetic and non-genetic factors affecting efficiency of milk production of cattle in and around 15 Kms of Biharsharif of Nalanda district (Bihar) and reported significant ($P<0.05$) effect of location of herd (Zones) on lactation milk yield (LMY).

HERD SIZE :

Shrivastava et al. (1998) observed that herd size had significant ($P<0.05$) effect on lactation yield in Friesian crossbred cows of un-organized herd.

Priya Raj (2002) observed that herd size did not influence lactation milk yield significantly in crossbred cows under farmers' managemental condition in and around Patna.

Kumar[1] (2004) observed significant ($P<0.05$) effect of herd size on lactation milk yield in cattle in and around Darbhanga (Bihar). He reported that animals maintained in the herd size of 11-14 had the highest average lactation milk yield followed by those in the herd sizes of 7-10, 3-6 and 15 & more cows.

Kumar (2005) reported significant ($P<0.05$) effect of herd size on lactation milk yield in cattle maintained in private dairy units located in and around Patna. He observed that the dairy units maintaining 7 & above cows had significantly ($P<0.05$) 95.56 kg more lactation yield than those maintaining 3-6 cows.

Kumar (2006) reported significant ($P<0.01$) effect of herd size on lactation milk yield in Desi, HFX and JX cows in and around Biharsharif of Nalanda district (Bihar). He observed that the herd size of 7-8 and 9 & above had significantly ($P<0.05$) higher LMY than those having the sizes of 3-4 and 5-6.

HERD CONSTITUTION :

Kumar[1] (2004) observed that herd constitution had no significant influence on the lactation milk yield in cattle and buffalo in and around Darbhanga (Bihar). However, he reported the average lactation milk yield to be the highest in the milch animals maintained in the Khatals having only cows and to be the lowest in the animals maintained in the units having only buffaloes.

Kumar (2005) reported that herd constitution did not influence the lactation yield significantly under farmers' managemental condition in and around Patna. However, the average lactation milk yield was found to be the highest in the dairy units which maintained Desi along with HFX followed by Desi and Jersey crossbred cows.

Kumar (2006) reported that herd constitution played significant ($P<0.05$) role on LMY. He observed the highest LMY to be in the combination of Desi and HFX cows maintained in the private dairy units situated in around Biharsharif of Nalanda district (Bihar)

SEASON OF CALVING :

Jadhav et al. (1991) found that season of calving had no significant influence on lactation milk yield in six grades of Holstein x Sahiwal cows.

Yadav and Rathi (1992) reported that season of calving had no significant effect on 1st three lactations of Hariana breeds extending over a period of twelve years between 1975-1986.

Singh et al. (1993) observed that season of calving had no significant influence on 1st lactation milk yield in Sahiwal and its crosses with Jersey and Red Dane. However, they reported that the highest lactation milk was yielded during June-August followed by March-May, December-February and September-November.

Raheja (1997) observed non-significant influence of season of calving on first lactation milk yield in half breds of Hariana and Sahiwal with Holstein Friesian.

Shettar and Govindaiah (1999) observed that season of calving had significant ($P<0.05$) effect on 305 days and total lactation milk yields in crossbred cows.

Thakur et al. (1999) reported non-significant effect of season calving on 1st lactation 300 days or less milk yield in nine genetic groups of Jersey x Zebu crossbreds.

Singh et al. (2000) reported that season of calving did not influence the lactation milk yield significantly in crosses of Holstein Friesian, Brown Swiss and Jersey with Hariana.

Priya Raj (2002) reported that season of calving had no significant influence on lactation milk yield in crossbred cows under farmers' managemental condition in and around Patna (Bihar).

Shiv Prasad (2003) reported non-significant effect of season of calving on lactation milk yield in 7/8 Holstein Friesian cows. However, he observed the yield to be the highest during summer followed by winter and rainy seasons.

Akhter et al. (2003) observed that season had significant ($P<0.05$) effect on 1st lactation milk yield in two and three breed cross progenies of three exotic breeds viz. Holstein Friesian, Jersey and Red Dane with Zebu breeds constituting twelve genetic groups.

Bhadauria and Katpatal (2003) found that season of calving did not influence the 300 days milk yield of 1st lactation in Friesian x Sahiwal crosses.

Kumar[1] (2004) observed that season of calving had significant ($P<0.01$) effect on lactation milk yield in cattle and buffalo under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar[2] (2004) observed that season of calving had no significant influence on 300 days or less milk yield in six genetic grades of Hariana and its crosses with Holstein Friesian and Jersey.

Kumar (2005) reported that season of calving had significant ($P<0.01$) influence on lactation milk yield in cattle maintained in privates dairy units located in and around Patna. He observed the lactation yield to be the highest in the cows calved during rainy season followed by summer and winter. However, the lactation yield of cows calved during summer and rainy seasons did not differ significantly.

Sharan (2005) reported significant ($P<0.01$) effect of season of calving on lactation yield in Hariana and its crosses with Holstein Friesian. He observed that the highest milk yield was produced by winter calvers which was significantly ($P<0.05$) higher by 332.92 kg than rainy calvers.

However, the lactation yields of winter and summer calvers did not differ significantly.

Kumar (2006) observed that season of calving had significant ($P<0.01$) effect on LMY in Desi, HFX and JX cows maintained in the private dairy units situated in and around Biharsharif of Nalanda district (Bihar). He observed the highest LMY to be in the cows calved during rainy season. He found that the average LMY of cows calved during rainy season was significantly ($P<0.05$) higher by 137.82 kg and 269.27 kg than winter and summer seasons of calving respectively. Besides, the cows calved during winter season had significantly ($P<0.05$) 131.45 kg more LMY than those calved during summer.

LACTATION ORDER :

Raj Kumar (1985) observed significant ($P<0.01$) effect of sequence of lactation on milk yield on Hariana and its crosses with HF. He reported gradual increase in milk yield upto the 3rd lactation after which it tended to decline.

Priya Raj (2002) reported significant ($P<0.01$) effect of sequence of lactation on lactation milk yield in crossbred cows under farmers' managemental condition in Patna (Bihar). She observed the highest lactation milk yield to be in 3rd lactation after which it tended to decline.

Shiv Prasad (2003) observed that the lactation milk yield significantly ($P<0.01$) increased with the increase of sequence of lactaton in 7/8 Holstein Friesian cows and reported the highest milk yield to be in 3rd lactation.

Kulkarni et al. (2003) reported that sequence of lactation had significant ($P<0.05$) effect on total lactation milk yield in crosses of Jersey, Holstein Friesian and Gir in varying inheritance and their interse. They

observed that the lactation yield increased with the increase of sequence of lactation which attained its maximum in 3rd lactation.

Kumar[2] (2004) reported non-significant effect of parity of lactation on lactation milk yield in Hariana and its crosses with HF and Jersey.

Kumar (2005) found significant (P<0.01) effect of sequence of lactation on lactation milk yield in Desi, HFX and JX cows under farmers' managemental condition in and around Patna. He reported that although the lactation yield increased gradually from 1st to 4th parity of lactation, yet it did not differ significantly upto 4th lactation after which there was significant decline.

Sharan (2005) observed that parity of lactation did not influence lactation milk yield significantly in Hariana and its crosses with Holstein Friesian.

Kumar (2006) studied the effect of lactation order on lactation milk yield in Desi, HFX and JX cows maintained in the private dairy units situated in and around Biharsharif of Nalanda district (Bihar) and reported that parity of lactation did not influence LMY significantly.

FARMING SYSTEM :

Kumar[1] (2004) studied the effect of system of farming on lactation milk yield in cattle and buffalo in and around Darbhanga (Bihar) and observed that there was non-significant effect of farming system on the lactation milk yield. However, he reported that the animals maintained in the units involving dairying alone had higher average lactation milk yield than those maintained in the dairy units integrated with agriculture farming.

Kumar (2005) observed significant (P<0.01) influence of farming system on lactation milk yield in Desi, HFX and Jersey crossbred cows under farmers' managemental condition in and around Patna (Bihar). He

observed that the cows maintained in the dairy units integrated with agriculture farming yielded significantly (P<0.01) 224.15 kg more milk than those maintained in the units involving dairying alone.

Kumar (2006) reported that the cows maintained in the units integrated with agriculture farming yielded significantly (P<0.05) 128.26 kg more LMY than those which were maintained in the units involving dairying alone in the private dairy units situated in and 15 kms. around Biharsharif of Nalanda district (Bihar).

LACTATION LENGTH :

AVERAGE : Lactation length plays very important role in monitoring the economy of the farm. The mean lactation length (days) of cows of different genetic groups as reported by various authors are depicted as follow :

Table -2 Average Lactation Length (days) of various genetic groups :

Genetic Group	Lactation length (days)	Author
Hariana Hariana x HF (F_1)	385.3±16.3 432.7±10.4	Parmar et al. (1986)
HF ≥ 50% 50% ≤ 50%	310.2±1.6 305.3±2.4 292.8±3.0	Singh et al. (1986[a])
HF crossbred	30208±1.4	Singh et al. (1986[b])
½ HF ½ Hariana ½ Jersey ½ Hariana	344.4±5.3 328.3±6.5	Chopra (1990)
HFX Sahiwal	295.70±3.93	Jadhav et al. (1991)
Hariana	268.28±1.91	Yadav and Rathi (1992)
Sahiwal	280.40±2.38	Yadav et al. (1992)
Sahiwal Sahiwal x Jersey Sahiwal x Red Dane	286.38±7.31 306.08±7.31 303.04±7.31	Singh et al. (1993)
Jersey crossbreds	309.87±3.56	Deshmukh et al. (1995)
HF crossbreds	324.70±6.4	Singh (1995)
Hariana	336.00±4.3	Pundir and Raheja (1997)
Friesian crossbreds	298.73±0.48	Shrivastava et al. (1998)
½ JX ½ H > ½ JX < ½ H	314.70±9.9 356.10±14.5	Thakur et al. (1999)

Sahiwal	269.45±2.41	Sethi et al. (2000)
Tharparkar Tharparkar x HF (F_1) (F_2)	279.00±9.99 312.20±6.49 247.87±18.58	Bhattacharya et al. (2002)
½ Jersey x ½ Sahiwal	312.32±14.32	Kumar and Kumar (2003)
HF cross	307.57±0.58	Akhter et al. (2003)
Desi HFX JX	293.29±1.71 334.64±1.99 333.43±2.02	Kumar[1] (2004)
Hariana HF < 50% HF 50% HF 625% HF 75 J 50%	325.38±13.96 390.74±18.30 334.85±18.39 341.47±31.36 406.98±18.17 462.69±15.44	Kumar[2] (2004)
Desi HFX JX	360.70±4.38 349.01±3.43 358.44±40.3	Kumar (2005)
HF > 50% HF 50% HF < 50% Hariana Pure	400.69±15.32 423.41±11.03 391.88±18.34 328.5±22.72	Sharan (2005)
Desi HFX JX	352.18±5.20 331.78±4.35 342.77±4.79	Kumar (2006)

EFFECT OF GENETIC GROUP :

Thakur et al. (1999) observed significant (P<0.01) effect of genetic group on 1st lactation length among Jersey x Zebu crossbreds.

Priya Raj (2002) reported that the Jersey crossbreds had significantly (P<0.01) longer lactation length than HF crossbreds under farmers' managemental codition in and around Patna.

Akhter et al. (2003) reported the longest and shortest 1st lactation periods in ½ HF ½ Sahiwal and >75% exotic inheritance genetic groups respectively among two and three breed crosses involving HF, Jersey, Red Dane, Sahiwal, Hariana and Red Sindhi breeds.

Kumar[1] (2004) reported that HF crossbreds had the longest average lactation length followed by Jersey crossbreds and Desi cows under farmers' managemental condition.

Kumar[2] (2004) observed the significant ($P<0.05$) effect of genetic group on lactation length and reported the longest and shortest lactation lengths (days) to be in ½ J ½ H and Hariana pure genetic groups respectively.

Sharan (2005) reported significant ($P<0.01$) effect of genetic group on lactation length. He observed the longest and shortest lactation lengths (days) to be in HF > 50% and Hariana pure groups respectively. However, the average lactation lengths of HF > 50%, HF 50% and HF < 50% genetic groups did not differ significantly.

Kumar (2006) reported that Desi cows maintained in the private dairy units at farmers' door located in and around Biharsharif of Nalanda district (Bihar) had significantly ($P<0.05$) 20.40 days and 9.41 days longer LL than HFX and JX respectively. He further observed that although the average LL (days) of HFX and JX did not differ significantly, yet JX cows had 1.99 days longer LL than HFX cows.

Kumar et al. (2007) reported that genetic group did not influence lactation length significantly, in Desi, HFX and JX cows under farmers' managemental condition in and around Patna.

EFFECT OF NON-GENETIC FACTORS :

DIFFERENT ZONES IN AND AROUND MADHEPURA :

Jadhav et al. (1991) reported significant ($P<0.01$) effect of farm on lactation length in different grades of Holstein Friesian with Sahiwal.

Priya Raj (2002) observed non-significant effect of zone on lactation length in different crossbred cows under farmers' managemental condition in and around Patna.

Kumar[1] (2004) observed that the zones had no significant effect on lactation length in different genetic groups of cattle under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar (2006) studied the effect of different zones on milk production efficiency traits in Desi, HFX and JX cows under farmers' managemental condition in and around 15 kms of Biharsharif of Nalanda district (Bihar) and reported that different zones did not influence the lactation length (days) significantly.

Kumar et al. (2007) observed that different zones in and around Patna under farmers' managemental condition had no significant effect on the lactation length of Desi, HFX and Jersey crossbred cows.

HERD SIZE :

Priya Raj (2002) studied the effect of size of the herd on lactation length of crossbred cows under farmers' managemental condition in and around Patna and observed non-significant effect of herd size on the lactation length.

Kumar[1] (2004) observed that the effect of herd size on lactation length in different genetic groups of cattle and buffalo in and around Darbhanga (Bihar) had no significant effect.

Kumar (2006) reported that the cows maintained in the herd sizes of 7-8 and 9 & above had significantly ($P<0.05$) 22.24 days and 19.83 days longer LL than the herd having the size of 5-6 respectively. He further observed that the average LL (days) of herd sizes 7-8 and 9 & above did not differ significantly suggesting longer LL in a herd size of 7 and above.

Kumar et al. (2007) reported that the size of the herd did not influence significantly the lactation length in Desi, HFX and Jersey crossbred cows under farmers' managemental condition in and around Patna.

HERD CONSTITUTION :

Kumar[1] (2004) observed that the herd constitution did not influence significantly the lactation length in different genetic groups of cattle and buffalo in and around Darbhanga (Bihar).

Kumar (2006) studied the effect of herd constitution on lactation length (days) in Desi, HFX and JX cows under farmers' managemental condition in and around 15 kms of Biharsharif of Nalanda district (Bihar) and observed that herd constitution did not play significant role on lactation length.

Kumar et al. (2007) reported significant ($P<0.05$) effect of herd constitution on lactation length. The highest (362.69 days) and the lowest (345.85 days) lactation lengths were observed to be in private dairy units maintaining Jersey along with HFX and Desi along with Jersey crossbred cows respectively.

SEASON OF CALVING :

Jadhav et al. (1991) reported significant ($P<0.05$) effect of season of calvig on lactation length in different genetic grades of Holstein Friesian and Sahiwal. They found that summer and spring calvers had significantly ($P<0.05$) longer lactation lengths than those calved during other seasons.

Yadav et al. (1992) reported that the season of calving did not influence significantly the lactation length in Sahiwal cows.

Yadav and Rathi (1992) could not find significant effect of season of calving on lactation length in Hariana.

Singh et al. (1993) observed that season of calving did not influence significantly the 1st lactation length in Sahiwal and its crosses with Jersey and Red Dane.

Shettar and Govindaiah (1999) observed that season of calving did not influence the lactation length in different genetic groups of cows involving crosses of Holstein Friesian, Jersey and Red Dane with Red Sindhi, Hallikar and Amritmahal.

Thakur et al. (1999) observed non-significant influence of different seasons of calving on 1st lactation length in nine genetic groups of Jersey x Zebu crossbreds.

Singh et al. (2000) found non-significant influence of season of calving on half-breds and three-fourth bred cows involving Friesian, Brown-Swiss, Jersey and Hariana breeds.

Priya Raj (2002) observed that the season of calving had significant ($P<0.01$) effect on lactation length of HFX and Jersey cross-bred cows under farmers' managemental condition in and around Patna. She observed that the cows calved during Novemebr-February had the longest lactation length followed by July-August and March-June.

Akhter et al. (2003) reported non-significant influence of season of calving on 1st lactation length in crossbred cows involving three exotic and three Zebu breeds.

Kumar[1] (2004) reported non-significant effect of season of calving on lactation length in different genetic groups of cattle and graded buffalo under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar[2] (2004) reported that season of calving had no significant influence on lactation length in Hariana and its crosses with HF and Jersey.

Sharan (2005) found non-significant effect of season of calving on lactation length in Hariana and its crosses with Holstein Friesian.

Kumar (2006) reported that season of calving played significant ($P<0.01$) role on lactation length in Desi, HFX and JX cows maintained in

private dairy units under farmers' managemental condition. He observed that rainy calvers had the longest lactation length (days) followed by summer and winter calvers. He furhter found that rainy and summer calvers had significantly ($P<0.05$) 26.64 days and 23.11 days longer LL than winter calvers respectively.

Kumar et al. (2007) observed significant ($P<0.01$) effect of season of calving on lactation length in Desi, HFX and Jersey crossbred cows. They reported that summar calvers had longer lactation length than winter and rainy calvers.

LACTATION ORDER :

Yadav and Rathi (1992) observed significant ($P<0.05$) effect of sequence of lactation on lactation length in Hariana cows.

Yadav et al. (1992) reported that 1st lactation had significantly ($P<0.05$) longer lactation length than 3rd in Sahiwal cows.

Singh and Nagarcenkar (1997) reported significant ($P<0.05$) effect of parity of lactaton on lactation length in Sahiwal cows.

Sethi et al. (2000) observed that parity of lactation had significant ($P<0.05$) effect on pooled lactation period in Sahiwal cows.

Singh et al. (2000) studied the effect of sequence of lactation on lactation length in seven genetic groups of crossbreds involving Holstein Friesian, Brown Swiss, Jersey and Hariana and reported that the parity of lactation significantly ($P<0.01$) influenced the lactation length.

Priya Raj (2002) observed significant ($P<0.01$) effect of sequence of lactation on lactation length in the crossbred cows under farmers' managemental condition in and around Patna. She reported the longest and shortest duration of lactation lengths to be in 2nd and 5th parity of lactations.

Kumar[1] (2004) reported that sequence of lactation had significant ($P<0.01$) effect on lactation length in different genetic groups of cattle and buffalo.

Kumar[2] (2004) observed that the parity of lactation did not influence significantly the lactation length in Hariana and its crosses with HF and Jersey.

Sharan (2005) studied the effect of genetic and non-genetic factors on lactation length in Hariana and its crosses with HF and observed that parity of lactation had no significant effect on lactation length.

Kumar (2006) reported significant ($P<0.05$) effect of sequence of lactation on LL (days) in Desi, HFX and JX cows under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He observed that the LL (days) significantly ($P<0.05$) increased by 12.04 days in 2^{nd} lactation from 1^{st}, after which it declined in 3^{rd} & 4^{th} lactations and then again increased showing irregular trend.

Kumar et al. (2007) reported that sequence of lactation did not play significant role on lactation length in Desi, HFX and Jersey crossbred cows under farmers' managemental condition in and around Patna.

FARMING SYSTEM :

Kumar[1] (2004) reported that farming system had non-significant effect on lactation length in various genetic groups of cattle and buffalo under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar (2006) observed significant ($P<0.01$) effect of farming system on LL (days). He reported that the cows maintained in the private dairy units integrated with agriculture had significantly ($P<0.01$) 15.55 days longer LL than those maintained in the dairying alone.

Kumar et al. (2007) reported significant (P<0.01) effect of farming system on lactation length in Desi, HFX and JX cows maintained under farmers' managemental condition in and around Patna. They observed that the cows maintained in the dairy units integrated with agriculture farming had significantly (P<0.01) 16.45 days longer lactation length than those maintaining dairying alone.

PEAK YIELD :

AVERAGE : The average peak yield of cows under various genetic groups as reported by different authors are tabulated as below :

Table-3 : Average peak yield (kg) of various genetic groups

Genetic Group	Peak yield (kg)	Author
Hariana ½ HF + ½ Hariana ½ Jersey + ½ Hariana	5.95 ± 0.13 14.39 ± 0.27 12.02 ± 0.44	Raheja (1982)
Hariana ½ HF + ½ Hariana ½ Jersey + ½ Hariana	5.95 14.39 12.04	Raheja and Balaine (1982)
HF ≥ 50% 50% ≤ 50%	14.4 ± 0.03 16 ± 0.3 13.6 ± 0.5	Singh et al. (1986[b])
HFX Sahiwal	11.89 ± 0.20	Jadhav et al. (1991)
Hariana	8.11 ± 0.08	Yadav and Rathi (1992)
Sahiwal	9.22 ± 0.18	Yadav et al. (1992)
Sahiwal Sahiwal x Jersey Sahiwal x Red Dane	8.65 ± 0.38 13.27 ± 0.38 14.92 ± 0.38	Sigh et al. (1993)
HF cross	13.3 ± 0.3	Singh (1995)
Friesian crossbreds	13.52 ± 0.04	Shrivastava et al. (1998)
Friesian crossbreds	8.51	Tomar et al. (1998)
7/8 HF	16.19 ± 0.34	Shiv Prasad (2003)
FH BH JH	10.40 ± 0.17 8.87 ± 0.24 8.82 ± 0.25	Singh et al. (2004)
Hariana Pure HF < 50% HF 50% HF 62.5% HF 75% J 50%	5.36 ± 0.22 6.37 ± 0.19 11.02 ± 0.52 5.32 ± 0.46 8.89 ± 0.52 8.56 ± 0.22	Kumar[2] (2004)
Desi HFX JX	4.21 ± 0.30 12.19 ± 0.23 7.96 ± 0.27	Kumar (2005)
Desi HFX JX	4.49 ± 0.25 11.86 ± 0.21 8.24 ± 0.23	Kumar (2006)

EFFECT OF GENETIC GROUP :

Jadhav et al. (1991) conducted an experiment to study the effect of genetic group on peak yield in six Holstein x Sahiwal grades and observed that the half grades had the highest performance for peak yield in 1st lactation followed by 7/8 and 5/8 grades.

Nayak and Raheja (1996) reported that grades of Hariana and its crosses with exotic dairy breeds influenced peak yield significantly.

Dutt and Bhusan (2001) reported that genetic grade had significant ($P<0.05$) effect on peak yield in half breds of HF, BS and Jersey with Hariana. However, they reported that three breed grades had no significant effect on peak yield.

Priya Raj (2002) reported that the average peak yield of Friesian crossbred cows was significantly ($P<0.01$) higher than those of Jersey crossbreds under farmers' managemental condition in and around Patna.

Kumar[2] (2004) reported the highest peak yield to be in HF 50% followed by HF 75%, Jersey 50% and HF<50% groups in the genetic groups involving Hariana, HFX and JX Cows.

Singh et al. (2004) studied the effect of genetic groups viz. ½ HF ½ H, ½ BS ½ H and ½ J ½ H on peak yield in 1st three lactations. They reported the peak yield to be significantly ($P<0.05$) higher in ½ HF ½ H group in all the lactations. However, they could not find significant difference between the average peak yields of ½ BS ½ H and ½ J ½ H genetic groups.

Kumar (2005) studied the effect of genetic groups on peak yield under farmers' managemental condition in and around Patna. He reported significant effect ($P<0.05$) of genotypes on peak yield. He observed the

highest peak yield (12.19kg) to be in HF crossbreds followed by Jersey crossbred and Desi cows.

Kumar (2006) reported significant (P<0.01) effect of genetic group on peak yield in cows maintained in un-organised farm of private dairy units located in and around Biharsharif of Nalanda district (Bihar). He observed that HFX had significantly (P<0.05) 7.73 kg and 6.32 kg higher peak yields than Desi and JX cows. Besides JX had also significantly (P<0.05) 7.35 kg higher PY then Desi cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD:

Jadhav et al. (1991) reported significant (P<0.01) effect of farm on peak yield in 1st lactation of various Holstein x Sahiwal grades.

Priya Raj (2002) observed that the different zones had no significant effect on peak milk yield in HF and Jersey crossbred cows maintained under farmers' managemental condition in and around Patna.

Kumar[1] (2004) reported that the cows maintained in different zones under farmers' managemental condition in and around Darbhanga (Bihar) did not influence peak yield significantly.

Kumar (2005) reported non-significant effect of location of herd on peak yield in Desi, HFX and Jersey crossbred cows under farmers' managemental condition in and round Patna.

Kumar (2006) observed significant (P<0.01) effect of location of herd on peak yield in Desi, HFX and JX Cows under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

HERD SIZE :

Priya Raj (2002) studied the effect of size of herd on average peak milk yield in HFX and JX cows maintained in the Khatals in and around Patna. She observed that herd size had no significant effect on peak yield.

Kumar[1] (2004) reported that the size of the herd had no significant effect on peak milk yield in different genetic groups of cattle and buffalo under farmers' managemental condition in and around Dharbhanga (Bihar).

Kumar (2005) could not find significant effect of herd size on peak milk yield in Desi, HFX and JX cows under farmers' managemental condition in and around Patna (Bihar).

Kumar (2006) observed significant ($P<0.01$) effect of herd size on peak yield in Desi, HFX and JX cows maintained in private dairy units in and around Biharsharif of Nalanda district (Bihar). He observed that the cows maintained in herd size of 9 & above had significantly ($P<0.05$) 1.12 kg and 0.80 kg higher PY than those maintained in the herd sizes of 3-4 and 5-6. However, he found that mean PY of the herd size of 9 & above did not differ significantly with those of 7-8.

HERD CONSTITUTION :

Kumar[1] (2004) observed that herd constitution had no significant effect on peak milk yield in cattle and buffalo maintained under farmers' managemental condition in and around Dharbhanga (Bihar).

Kumar (2005) reported non-significant effect of herd constitution on peak milk yield in Desi, HFX and JX cows maintained in private dairy units under farmers' managemental condition in and around Patna (Bihar).

Kumar (2006) could not find significant effect of herd constitution on peak yield in Desi, HFX and JX cows maintained under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

SEASON OF CALVING :

Jhadhav et al. (1991) reported significant ($P<0.01$) effect of season of calving on 1st lactation period of Holstein x Sahiwal grades. They observed the highest and lowest peak milk yields to be during winter and rainy seasons of calving respectively.

Singh et al. (1993) observed non-significant effect of season of calving on the 1st lactation peak milk yield in Sahiwal and its crossbreds with Jersey and Red Dane.

Singh et al. (2000) reported that season of calving had no significant effect on peak milk yield in seven genetic groups involving HF, BS and Jersey crosses with Hariana cows.

Dutt & Bhusan (2001) reported that season of calving had no significant effect on peak milk yield among half breeds but it was the significant source of variation in three breed grades involving HF, BS and Jersey with Hariana.

Priya Raj (2002) reported that HFX and JX cows calved during December - February had the highest peak milk yield followed by those calved during July-October and March-June under farmers' managemental condition in and around Patna (Bihar).

Kumar[2] (2004) observed that season of calving had no significant effect on peak milk yield in Hariana its crosses with HF and Jersey.

Kumar (2006) could not find significant effect of herd constitution on peak yield in Desi, HFX and JX cows maintained under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

SEASON OF CALVING :

Jhadhav et al. (1991) reported significant ($P<0.01$) effect of season of calving on 1st lactation period of Holstein x Sahiwal grades. They observed the highest and lowest peak milk yields to be during winter and rainy seasons of calving respectively.

Singh et al. (1993) observed non-significant effect of season of calving on the 1st lactation peak milk yield in Sahiwal and its crossbreds with Jersey and Red Dane.

Singh et al. (2000) reported that season of calving had no significant effect on peak milk yield in seven genetic groups involving HF, BS and Jersey crosses with Hariana cows.

Dutt & Bhusan (2001) reported that season of calving had no significant effect on peak milk yield among half breeds but it was the significant source of variation in three breed grades involving HF, BS and Jersey with Hariana.

Priya Raj (2002) reported that HFX and JX cows calved during December - February had the highest peak milk yield followed by those calved during July-October and March-June under farmers' managemental condition in and around Patna (Bihar).

Kumar[2] (2004) observed that season of calving had no significant effect on peak milk yield in Hariana its crosses with HF and Jersey.

Singh et al. (2004) reported significant ($P<0.05$) effect of season of calving on peak milk yield in 2nd & 3rd lactations involving crosses of Hariana with Friesian, Brown swiss and Jersey.

Kumar (2005) reported that season of calving had no significant effect on peak milk yield in Desi, HFX and JX cows in private dairy units maintained under farmers' managemental condition in and around Patna (Bihar).

Kumar (2006) observed significant ($P<0.05$) effect of season of calving on peak yield in Desi, HFX and JX cows under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He observed that cows calved during rainy season had significantly ($P<0.05$) 0.57 kg and 0.73 kg higher peak yields than those calved during winter and summer.

LACTATION ORDER :

Yadav et al. (1992) observed that sequence of lactation had no significant effect on peak milk yield in sahiwal cows.

Yadav and Rathi (1992) reported that the sequence of lactation significantly ($P<0.01$) affected the peak milk yield in Hariana cows in 1st three lactation records.

Bhattacharya et al. (1999) reported that sequence of lactation order had no significant effect on peak milk yield in Hariana cows.

Singh et al. (2000) reported significant ($P<0.01$) influence of sequence of lactation on peak milk yield in crossbred cows involving HF, BS and Jersey with Hariana upto 3 lactations. They observed that the peak milk yield increased with the increase of lactation order and reached the highest (15.40kg) in 3rd lactation.

Priya Raj (2002) reported that lactation order significantly ($P<0.01$) influenced peak milk yield in HFX and JX cows maintained in the private dairy units under farmers' managemental condition. She observed that the peak milk yield increased with the increase of the sequence of lactation upto 3rd lactation after which it tended to decline gradually.

Kumar[2] (2004) reported non-significant effect of lactation order on peak milk yield in different genetic groups of Hariana and its crosses with HF and Jersey.

Kumar (2005) observed non-significant effect of sequence of lactation on peak mil yield in Desi, HFX and JX cows maintained in the private dairy units under farmers' managemental condition in and around Patna (Bihar).

Kumar (2006) observed that sequence of lactation did not influence peak yield significantly in Desi, HFX and JX cows maintained under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

FARMING SYSTEM :

Kumar[1] (2004) studied the effect of farming system on peak milk yield in cattle and buffalo maintained in the private dairy units under farmers' managemental condition in and around Darbhanga (Bihar). He reported that system of farming had no significant effect on peak milk yield.

Kumar (2005) reported that animal husbandry along with agriculture had significantly ($P<0.05$) higher peak milk yield than those practising animal husbandry alone in Desi, HFX and JX cows maintained under farmers' managemetnal condition in and around Patna (Bihar).

Kumar (2006) reported that the dairy units integrated with agriculture had significantly ($P<0.05$) 1.30 kg more peak yield than those maintaining dairying alone in Desi, HFX and JX cows maintained under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

DAYS TO ATTAIN PEAK MILK YIELD (DAPY) :

Table 4 : Average the mean days of DAPY as mentioned by various authors are tabulated below :-

Genetic group	Days to attain peak yield (days)	Author
HF x Hariana	54.25	Rathi (1975)
HF cross	41.6±1.60	Raheja (1982)
Hariana ½ HF + ½ Hariana ½ Jersey + ½ Hariana ½ BS + ½ Hariana ½ Red Dane + ½ Hariana	52.31 38.64 36.5 36.3 73.41	Raheja and Balaine (1982)
Sahiwal Sahiwal x Jersey Sahiwal x Red Dane	42.86 ± 1.70 38.65 ± 1.70 42.87 ± 1.70	Sigh et al. (1993)
Hariana	51.83 ± 2.48	Bhattachariya et al. (1999)
7/8 HF	34.00 ± 2.30	Shiv Prasad (2003)
FH BH JH	41.72± 3.87 40.96± 5.13 56.60± 5.47	Singh et al. (2004)
Hariana Pure HF < 50% HF 50% HF 62.5% HF 75% J 50%	39.72 ± 2.32 26.80± 1.40 30.35± 3.41 28.12± 1.41 33.80± 2.60 35.35± 1.78	Kumar[2] (2004)
Desi HFX JX	59.94 ± 0.86 46.39± 0.67 50.12± 0.79	Kumar (2005)
Desi HFX JX	55.70 ± 0.73 46.67 ± 0.61 49.38 ± 0.67	Kumar (2006)

DAYS TO ATTAIN PEAK MILK YIELD (DAPY) :

EFFECT OF GENETIC GROUP :

Singh et al. (1993) reported non-significant effect of genetic group on DAPY in Sahiwal and its crosses with Jersey and Red Dane.

Kumar[1] (2004) reported that genetic group had significant ($P<0.01$) effect on DAPY. He observed that Desi cows significantly ($P<0.01$) attained peak milk yield earlier than JX and HFX under farmers' managemetnal condition.

Kumar[2] (2004) reported that genetic group had significant ($P<0.01$) effect on DAPY in Hariana and its different grades with HF and Jersey. He observed the longest and shortest DAPY to be in HF<50% and Hariana pure breed respectively.

Singh et al. (2004) reported that genetic group had significant ($P<0.01$) effect on DAPY in 1st two lactations and observed that ½ J ½ H genetic group had significantly ($P<0.01$) longer DAPY than ½ HF ½ H and ½ BS ½ H.

Kumar (2005) studied the effect of genetic group on DAPY in Desi, HFX and Jersey cows maintained under farmers' managemental condition in and around Patna. He reported that HFX had significantly ($P<0.05$) shorter DAPY than Jersey cross breds and Desi cows. He further observed that Jersey crossbred had significantly ($P<0.05$) 9.82 days shorter DAPY than Desi.

Kumar (2006) observed that genetic group had significant ($P<0.01$) effect on DAPY in HFX, JX and Desi cows maintained under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He reported that HFX had significantly ($P<0.05$) 9.03 days and 2.71 days lower DAPY than Desi and JX cows respectively. He further

observed that JX cows had also significantly (P<0.05) 6.32 days lower DAPY than Desi cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Kumar[1] (2004) observed that different locations of herd had no significant effect on DAPY in private dairy units maintained under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar (2005) observed that location of herd influenced DAPY significantly (P<0.05) in Desi, HFX and JX cows in private dairy units maintained under farmers' managemental condition in and around Patna.

Kumar (2006) reported that location of herd had played significant (P<0.01) role on DAPY in Desi and crossbred cows maintained in private dairy units under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

HERD SIZE :

Kumar[1] (2004) studied the effect of size of herd on DAPY in cattle and buffalo under farmers' managemental condition in and around Darbhanga (Bihar). He reported that the herd size did not influence DAPY significantly.

Kumar (2005) observed that the size of the herd did not play significant role on DAPY in Desi, HFX and JX cows in private dairy units maintained under farmers' managemental condition in and around Patna (Bihar).

Kumar (2006) reported that the size of the herd had no significant effect on DAPY in Desi, HFX and JX cows maintained under farmers' managemental condition located in and around Biharsharif of Nalanda district (Bihar).

HERD CONSTITUTION :

Kumar[1] (2004) reported that the herd constitution had no significant effect on DAPY in Desi, HFX and JX cows under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar (2005) reported that herd constitution had significant ($P<0.05$) effect on DAPY, Desi, HFX and JX cows maintained in private dairy units under farmers' managemental condition in and around Patna (Bihar).

Kumar (2006) observed significant ($P<0.05$) effect of herd constitution on DAPY under farmers' managemental condition located in and around Biharsharif of Nalanda district (Bihar). He reported the lowest DAPY to be in HFX genetic group.

SEASON OF CALVING :

Singh et al. (1993) reported non-significant effect of season of calving on DAPY in Sahiwal and its crosses with Jersey and Red Dane.

Singh et al. (2004) studied the effect of season of calving on DAPY in ½ breds of Hariana with HF, Jersey and Brown Swiss. They reported that season of calving had significant ($P<0.05$) effect on DAPY which were observed to be lowest in summer calvers and highest in autumn calvers.

Kumar[1] (2004) observed significant ($P<0.05$) effect of season of calving on DAPY in Desi, HFX and JX cows maintained in private dairy units under farmers' managemental condition. He observed that the average DAPY of March-June calvers had significantly ($P<0.05$) higher DAPY than those calved during November- February.

Kumar[2] (2004) studied the effect of season of calving on DAPY in Hariana and its crosses with HF and Jersey. He reported the average DAPY to be the highest and the lowest during winter and summer seasons of calving respectively.

Kumar (2005) studied the effect of genetic and non-genetic factors on milk production efficiency traits in Desi, HFX and JX cows maintained under farmers' managemental condition in and around Patna (Bihar). He reported that rainy calvers had significantly ($P<0.05$) lower days to attain peak yield than winter and summer calvers.

Kumar (2006) reported significant ($P<0.05$) effect of season of calving on DAPY in Desi, HFX and JX genetic groups of cows maintained under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He observed the lowest DAPY to be in cows calved during rainy season followed by winter and summer calvers.

LACTATION ORDER :

Kumar[1] (2004) observed that the average DAPY increased significantly ($P<0.01$) from 1st to 3rd lactation orders after, which it tended to decline gradually in Desi HFX and JX cows maintained in the private dairy units under farmers' managemental condition.

Kumar[2] (2004) observed that lactation order had no significant influence on DAPY in Hariana and it crosses with HF and Jersey.

Kumar (2005) reported that sequence of lactation played significant ($P<0.05$) effect on DAPY in Desi, HFX and JX cows maintained under farmers' managemental condition. He reported that the DAPY had a tendency to decrease from 1st and 2nd lactations (pooled together) to 3rd

lactation where it was observed to be the minimum after which it tended to increase in subsequent lactations.

Kumar (2006) observed significant ($P<0.01$) effect of lactation order on DAPY in Desi, HFX and JX cows under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He observed that 3rd & 4th lactations had significantly ($P<0.05$) lower DAPY than 1st, 2nd and 5th & above lactations.

FARMING SYSTEM :

Kumar[1] (2004) observed that system of farming did not influence DAPY significantly in Desi, HFX and JX cows maintained in private dairy units under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar (2005) reported that system of farming had no significant role on DAPY in Desi, HFX and JX cows maintained in private dairy units under farmers' managemental condition in and around Patna.

Kumar (2006) reported that system of farming did not play significant role on average DAPY in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharshrif of Nalanda district (Bihar).

MILK YIELD PER DAY OF LACTATION LENGTH (MY/day LL):

AVERAGE :

The means of My/day LL (kg) as reported by various authors are tabulated as follow :

Table - 5: Average milk yield per day of lactation length (MY/day LL) of various genetic groups. :

Genetic Group	Milk yield (kg) per day of lactation length (day)	Author
HF crossbred	7.929±0.216	Singh et al. (1989)
½ J ½ HF ¾ J ¾ HF	6.05 ± 0.04 7.01 ± 0.04 5.94 ± 0.07 7.13 ± 0.06	Hayatnagarkar et al. (1990)
HFX Sahiwal	8.41 ± 0.13	Jadhav et al. (1991)
Hariana	5.29 ± 0.05	Yadav and Rathi (1992)
Sahiwal	6.02 ± 0.05	Yadav et al. (1992)
Tharpakar	6.54 ± 0.16	Vij et al. (1992)
Sahiwal Sahiwal x Jersey Sahiwal x Red Dane	5.78 ± 0.16 7.11 ± 0.16 9.15 ± 0.16	Singh et al. (1993)
Frisian crossbred	6.75	Tomar et al. (1998)
Frisian crossbred	9.09 ± 0.03	Shrivastava and Singh (2000)
FH BH JH FBH BFH FJH JFH	8.95 ± 0.15 8.43 ± 0.21 7.30 ± 0.20 8.43 ± 0.23 7.84 ± 0.27 8.28 ± 0.26 7.89 ± 0.27	Singh et al. (2000)
Tharpakar Tharpakar x HF (F_1) (F_2)	5.47 ± 0.12 8.71 ± 0.13 6.65 ± 0.39	Bhattacharya et al. (2002)
Hariana Pure HF < 50% HF 50% HF 62.5% HF 75% J 50%	2.75 ± 0.13 3.46 ± 0.17 6.05 ± 0.20 2.82 ± 0.24 4.84 ± 0.29 5.03 ± 0.14	Kumar[2] (2004)
Desi HFX JX	2.98 ± 0.19 8.05 ± 0.15 6.06 ± 0.17	Kumar (2005)
HF > 50% HF 50% HF < 50% Hariana Pure	4.37 ± 0.19 5.32 ± 0.14 4.18 ± 0.23 2.64 ± 0.28	Sharan (2005)
Desi HFX JX	3.78 ± 0.69 8.45 ± 0.58 6.66 ± 0.64	Kumar (2006)

MILK YIELD PER DAY OF LACTATION LENGTH (MY/day LL):

EFFECT OF GENETIC GROUP :

Hayatnagarkar et al. (1990) observed that ½ HF ½ Indian cows had significantly ($P<0.01$) higher MY / day LL than ½ J ½ Indian cows.

Jhadav et al. (1991) reported significant ($P<0.01$) effect of genetic group on MY / day LL and observed that the production traits increased upto ½ grades after which they tended to decline gradually.

Singh et al. (1993) observed significantly ($P<0.01$) higher 1st lactation MY / day LL in Red Dane x Sahiwal than Jersey x Sahiwal and Sahiwal pure.

Thakur et al. (1999) reported significant ($P<0.05$) effect of genetic groups involving Jersey and four indigenous breeds viz. Red Sindhi, Sahiwal, Tharparkar and Hariana on MY / day LL. They found the highest and lowest MY / day LL to be in ½ J ½ T and ½ J ½ H genetic groups respectively.

Shrivastava and Singh (2000) studied the effect of different grades of Friesian x Zebu on MY / day LL under farmers' managemental condition. They reported that the cows possessing 50% and more Friesian inheritance had significantly ($P<0.05$) higher MY / day LL than those having less than 50% inheritance of Friesian.

Singh et al. (2000) observed significant ($P<0.01$) effect of genetic group on MY / day LL in crossbred cows of HF, Jersey and BS with Hariana. They reported the highest and lowest average milk yield to be in HF and JX genetic groups respectively.

Bhattacharya et al. (2002) reported the highest MY / day LL to be in F_1 of HF x Tharparkar followed by Indian born HF, F_2 of Tharparkar and pure Tharparkar.

Priya Raj (2002) observed significantly (P<0.01) higher MY / day LL in HFX than JX in un-organised private dairy units in and around Patna.

Akhter et al. (2003) conducted an experiment to study the effect of genetic grades of crossbred cattle involving three exotic breeds viz. HF, Jersey and Red Dane, and three Indian Zebu breeds viz. Sahiwal, Tharparkar and Red Sindhi on average daily milk yield of 1st lactation period. They reported that the cows having 62.5% exotic inheritance from Friesian and Jersey and 37.5% from Sahiwal had significantly (P<0.05) higher 1st lactation milk yield per day of lactation period than their own half breds and all the three breed crosses. In addition to these, they also concluded that Friesian crosses were superior to all Jersey crossbreds.

Kumar[1] (2004) observed that HFX and Jersey crossbreds had significantly (P<0.05) more than double MY / day LL than Desi cows under farmers' managemental condition.

Kumar[2] (2004) studied the effect of different grades of HF and Jersey on MY / day LL. He reported that ½ HF ½ H had significantly (P<0.05) higher MY / day LL than all the genetic groups. He observed that ½ HF ½ H had more than double and ½ J ½ H had nearly double MY / day LL than Hariana pure.

Kumar (2005) studied the effect of genetic groups on MY / day LL in un-organised farm located in and around Patna. He reported that both HFX and JX cows had significantly (P<0.05) more than double MY / day LL than Desi cows. Besides, he also found that HFX had significantly (P<0.05) 1.99 kg more MY / day LL than JX cows.

Sharan (2005) studied the effect of genetic group on MY / day LL in Hariana and its crosses with HF. He observed the highest MY/day LL to be in ½ HF ½ H genetic group which was significantly (P<0.05) higher by

0.97 kg, 1.134 kg and 2.61 kg than HF > 50%, HF < 50% and Hariana pure genetic groups respectively.

Kumar (2006) reported significant (P<0.01) effect of genetic group on MY / day LL in Desi, HFX and JX cows under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He observed the highest MY / day LL to be in HFX cows which was significantly (P<0.05) higher by 4.67 kg and 1.79 kg than Desi and JX cows respectively. He further noted that JX cows had also significantly (P<0.05) 2.88 kg higher MY / day LL than Desi cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Shrivastava and Singh (2000) studied the effect of different zones on MY / day LL in and around Ranchi (Jharkhand) in un-organised herd of Friesian and Zebu crossbreds. They reported significant (P<0.05) effect of location of herd on it.

Priya Raj (2002) reported non-significant effect of zone on MY / day LL in crossbreds of HF and Jersey under farmers' managemental condition in and around Patna (Bihar).

Kumar[1] (2004) observed that zone had no significant role on MY / day LL in Desi, HFX and JX cow in and around Darbhanga (Bihar).

Kumar (2005) observed that location of herd had significant (P<0.05) effect on MY / day LL in Desi, HFX and JX cows in private dairy units under farmers' managemental condition in and around Patna (Bihar).

Kumar (2006) observed non-significant effect of zones on MY / day LL in Desi, HFX and JX cows maintained under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

HERD SIZE :

Shrivastava and Singh (2000) observed that the size of the herd upto five cows had significantly ($P<0.05$) higher MY / day LL than herd sizes of 6-8, 9-11 and 12 & above in Friesian and Zebu crossbreds under farmers' managemental condition in and around Ranchi (Jharkhand).

Priya Raj (2002) reported non-significant effect of herd size on MY / day LL in HFX and JX cows in private dairy units of un-organised farm located in and around Patna (Bihar).

Kumar[1] (2004) reported significant ($P<0.05$) effect of herd size on MY / day LL in Desi, HFX and JX crossbred cows under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar (2005) reported non-significant effect of herd size on MY / day LL in Desi, HFX and JX cows under farmers' managemental condition in and around Patna (Bihar).

Kumar (2006) studied the effect of herd size on MY / day LL in cows of different genetic groups under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar) and reported that the size of the herd did not influence MY / day LL significantly.

HERD CONSTITUTION :

Kumar[1] (2004) reported that the herd constitution did not play significant role on MY / day LL in different genetic groups of cows including buffalo of un-organised herd located in and around Darbhanga (Bihar).

Kumar (2005) observed non-significant effect of herd constitution on MY / day LL on Desi, HFX and JX cows in un-organised private dairy units located in around Patna (Bihar).

Kumar (2006) observed that herd constitution had no significant effect on MY / day LL in Desi, HFX and JX cows maintained in the private dairy units located in and around Biharsharif of Nalanda district (Bihar).

SEASON OF CALVING :

Yadav and Rathi (1992) reported that season of calving did not play significant role on MY / day LL in Hariana cows.

Yadav et al. (1992) observed that season of calving had no significant role on MY / day LL in Sahiwal cows.

Singh et al. (1993) reported non-significant effect of season of calving on MY / day LL of 1st lactation records in three genetic groups of cows viz. Sahiwal, Jersey x Sahiwal and Red Dane x Sahiwal.

Thakur et al. (1999) reported non-significant effect of season of calving on 1st lactation MY / day LL in Jersey and its crosses with four indigenous breeds viz. Red Sindhi, Sahiwal, Tharparkar and Hariana.

Shrivastava and Singh (2000) observed that season of calving had no significant role in MY / day LL in Friesian x Zebu crossbreds of un-organised farm located in and around Ranchi (Jharkhand).

Priya Raj (2002) observed that season of calving had no significant role on MY / day LL in HFX and JX cows maintained under farmers' managemental condition in and around Patna (Bihar).

Akhter et al. (2003) reported that season of calving had no significant effect on FL / DLP in crossbred cows involving three exotic breeds viz. HF, Jersey and RD and three Zebu breeds viz. Hariana, Red Sindhi and Sahiwal.

Kumar[1] (2004) reported significant ($P<0.01$) effect of season of calving on MY / day LL in Desi, HFX and JX cows maintained in un-organised dairy units located in and around Darbhanga (Bihar). He reported

crossbred cows in un-organised private dairy units located in and around Patna (Bihar).

Kumar[1] (2004) observed that MY / day LL increased significantly upto 4th sequences of lactation after which it tended to decline in different genetic groups of cows including buffalo under farmers' managemental conditions.

Kumar[2] (2004) observed non-significant effect of lactation order on MY / day LL in Hariana and its different grades with HF and Jersey inheritance.

Kumar (2005) observed significant ($P<0.05$) effect of sequence of lactation on MY / day LL in Desi, HFX and JX cows under farmers' managemental condition in and around Patna (Bihar). He, however, reported that the average MY / day LL from 1st to 4th lactation did not differ significantly after which it declined in 5th and 6th lactations.

Kumar (2006) studied the effect of sequence of lactation on MY / day LL in Desi, HFX and JX cows maintained in private dairy units located in and around Biharsharif of Nalanda district (Bihar) and observed that lactation order had no significant role on MY / day LL.

FARMING SYSTEM :

Kumar[1] (2004) reported that system of farming did not influence MY / day LL significantly in Desi and crossbred cows in un-organised private dairy units located in and around Darbhanga (Bihar).

Kumar (2005) reported that cows maintained in dairy units integrated with agriculture farming had significantly ($P<0.05$) higher MY / day LL than those units maintaining dairying alone in Desi and crossbred cows of HF and Jersey maintained in un-organised dairy units located in and around Patna (Bihar).

Kumar (2006) repotted that system of farming did not play significant role on MY / day LL in Desi, HFX and JX cows maintained under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

CALVING INTERVAL :

AVERAGE :

The followings are the average calving intervals (days) of different genetic groups as reported in literature :

Table-6 : Average Calving interval of various genetic groups :

Genetic Group	Calving Interval (days)	Author
Hariana	416.57±3.88	Yadav and Rathi (1992)
Sahiwal	486.75±6.43	Yadav et al. (1992)
Jersey Sahiwal Jersey x Sahiwal	422.41±28.50 447.07±21.19 451.70±7.76	Chaudhari et al. (1995)
Friesian crossbreds	384.48±1.40	Shrivastava et al. (1996)
Friesian crossbreds	403.72	Tomar et al. (1998)
FH BH JH FBH BFH FJH JFH	429.47±40.53 423.11±8.17 405.94±8.17 456.05±9.14 479.38±10.75 455.35±10.42 444.94±10.96	Singh et al. (2000)
½ JX ½ Sahiwal	440.34±15.92	Kumar et al. (2003)
5/8 F x 3/8 S ½ F x ½ S ½ R x ½ S 5/8 JX 3/8 S ½ F x ½ S ½ F x ½ H	386.62±2.59 378.7±2.59 380.64±2.59 396.87±2.59 390.87±2.59 380.2±2.59	Akhter et al. (2003)
HF crossbreds	382.37±0.93	Akhter et al. (2003)
Desi HFX JX	470.56±5.05 427.09±3.96 430.07±4.04	Kumar (2005)
HF > 50% HF 50% HF < 50% Hariana Pure	538.97±24.06 528.70±16.75 570.70±34.22	Sharan (2005)
Desi HFX JX	466.18±5.44 405.63±4.56 416.03±5.02	Kumar (2006)

EFFECT OF GENETIC GROUP :

Jadhav et al. (1991) observed significant (P<0.01) effect of various genetic grades of Holstein x Sahiwal inheritance on calving interval and the lowest and highest calving interval days were observed to be in ½ and 7/8 genetic grades respectively.

Singh et al. (2000) observed significant (P<0.01) effect of genetic group on calving interval in ½ (one exotic breed) and ¾ (two exotic breeds) inheritance involving HF, BS and Jersey crosses with Hariana cows. They reported the lowest (405.94±8.17 days) and the highest (479.38±10.75 days) days of CI to be in JH and BFH genetic groups respectively.

Priya Raj (2002) studied the effect of genetic group on calving interval in HFX and Jersey crossbred cows under farmers' managemental condition in and around Patna (Bihar). She reported that HF crossbred cows had significantly (P<0.01) lower calving interval days than the crossbred cows of Jersey.

Akhter et al. (2003) reported that various genetic grades of crossbred cows involving HF, Jersey and Red Dane with Sahiwal, Hariana and Red Sindhi had non-significant effect on 1st lactation calving interval. They observed the lowest and highest CI days to be in ½ F x ½ S and 75% exotic inheritance genetic groups respectively.

Kumar (2005) reported that both HFX and Jersey crossbred cows had significantly (P<0.05) lower calving interval by 43.37 days and 40.49 days than Desi cows respectively in private dairy units under farmers' managemental condition in and around Patna (Bihar). However, the mean days of calving interval of HFX and Jersey crossbred cows did not differ significantly.

Sharan (2005) reported significant (P<0.05) effect of genetic group on inter-calving period in crosses of HF with Hariana.

Kumar (2006) studied the effect of genetic group of cattle on calving interval under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He reported the lowest days of CI to be in HFX followed by JX and Desi cows. He further observed that HFX and JX cows had significantly (P<0.05) 60.55 days and 50.15 days lower average CI than Desi cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Jadhav et al. (1991) reported significant (P<0.01) effect of farm on calving interval in various HF and Sahiwal grades of 1st lactation.

Priya Raj (2002) reported non-significant effect of different zones on calving interval in crossbred cows of HF and Jersey maintained in the private dairy units under farmers' managemental condition in and around Patna (Bihar).

Kumar[1] (2004) reported that different zones had no significant effect on calving interval in Desi and crossbred cows under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar (2005) observed that location of herd had non-significant effect on the calving interval in Desi and crossbred cows of HF and Jersey under farmers' managemental condition in and around Patna (Bihar).

Kumar (2006) observed significant (P<0.05) role of location of herd on calving interval of cows of different genetic groups maintained in private dairy units in and around Biharsharif of Nalanda district (Biahr).

HERD SIZE :

Priya Raj (2002) observed that the size of herd had no significant effect on calving interval in crossbred cows under farmers' managemental condition in and around Patna (Bihar).

Kumar[1] (2004) reported that size of herd had no significant effect on calving interval in different genetic groups of cows and buffalo in and around Darbhanga (Bihar) under farmers' managemental condition.

Kumar (2005) reported non-significant effect of size of herd on CI in Desi and crossbred cows in private dairy units under farmers managemental condition in and around Patna (Bihar). However, he observed that the cows maintained in the herd size of 3-6 had lower CI than those maintained in the herd size of 7 & above.

Kumar (2006) studied the effect of herd size on CI in Desi, HFX and JX cows under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar) and reported that size of the herd significantly ($P<0.01$) influenced the CI.

HERD CONSTITUTION :

Kumar[1] (2004) reported non-significant effect of herd constitution on calving interval in Desi, crossbred cows and buffalo under farmers' managemental condition.

Kumar (2005) observed that the herd constitution had no significant role on CI in Desi and crossbred cows of HF and Jersey in the Khatals located in and around Patna (Bihar).

Kumar (2006) observed significant ($P<0.05$) effect of herd constitution on CI in cows of different genetic groups maintained under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

SEASON OF CALVING :

Jadhav et al. (1991) found that autumn, rainy and winter calvers had significnatly ($P<0.01$) lower days of calving interval than summer and spring calvers in 1st lactation of various Holstein x Sahiwal grades.

Yadav et al. (1992) reported that season of calving had no significant effect on CI in Sahiwal cows.

Yadav and Rathi (1992) reported non-significant effect of season of calving on CI (days) in Hariana cows.

Singh et al. (2000) observed that season of calving had no significant effect on CI in seven genetic groups of crossbred cows involving HS, BS and Jersey with Hariana.

Priya Raj (2002) reported non-significant influence of months of calving on CI (days) in crossbred cows of HF and Jersey under farmers' managemental condition in and around Patna (Bihar).

Akhter et al. (2003) reported significant ($P<0.05$) effect of season of calving on CI in two and three breed crosses involving three exotic breeds viz. HF, J and Red Dane with three Zebu breeds viz. Sahiwal, Hariana and Red Sindhi.

Kumar (2005) reported significant ($P<0.01$) effect of season of calving on CI in Desi, HFX and Jersey crossbred cows under farmers' managemental condition in and around Patna (Bihar). He further reported that winter calvers had lowest CI which was significantly ($P<0.05$) 75.35 days and 49.21 days lower than summer and rainy calvers respectively.

Besides, rainy calvers had also significantly (P<0.05) 26.14 days less CI than the cows calved during summer.

Kumar (2006) reported significant (P<0.01) effect of season of calving on CI in Desi, HFX and JX cows maintained in private dairy units located in and around Biharsharif of Nalanda district (Bihar). He further observed that winter calvers had the lowest days of CI which was significantly (P<0.05) lower by 26.93 and 37.42 days than summer and rainy calvers respectively.

LACTATION ORDER :

Yadav et al. (1992) opined significant (P<0.01) decrease in CI (days) with the advancement of lactation order in Sahiwal cows.

Yadav and Rathi (1992) reported significant (P<0.01) decrease in CI (days) with the increase of parity of lactation in Hariana cows.

Singh et al. (2000) observed significant (P<0.05) decrease in CI (days) with the increase of parity of lactation in crossbred cows involving HF, BS and Jersey with Hariana. They reported the longest (456.23±5.92) and the shortest (427.65±6.02) C.I. days to be in 1st and 3rd lactations respectively.

Priya Raj (2002) observed significant (P<0.05) effect of sequence of calving on CI (days) in crossbred cows in private dairy units under farmers' managemental condition in and around Patna (Bihar). However, she could not find any definite trend for the effect of parity of lactation on this trait.

Kumar[1] (2004) observed that sequence of lactation had significant (P<0.01) effect on CI (days) in Desi, crossbred cows and buffalo under

farmers' managemental condition in and around Darbhanga (Bihar). However, he also could not find any definite trend.

Kumar (2005) observed that parity of lactation had significant ($P<0.01$) effect on CI (days) in Desi, HFX and Jersey crossbred cows in private dairy units located in and around Patna (Bihar). However, he could not find any definite trend.

Sharan (2005) reported that parity of lactation had no significant effect on CI (days) in Hariana and its crosses.

Kumar (2006) observed significant ($P<0.01$) effect of lactation order on CI in Desi, HFX and JX cows maintained under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He observed the lowest days of CI to be in 3rd & 4th lactations pooled together.

FARMING SYSTEM :

Kumar[1] (2004) reported that farming system did not play significant role on CI (days) in Desi, HFX, JX and buffalo under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar (2005) observed that system of farming had significant ($P<0.01$) effect on CI (days). He reported that cows managed in the units involved in the dairying alone had significantly ($P<0.01$) 28.17 days less CI in comparison to those maintained in the units integrated with agriculture farming.

Kumar (2006) reported that the Desi, HFX and JX cows maintained under farmers' managemental condition had significantly ($P<0.05$) 26.05

days lower CI in the dairy units involved in dairying alone than those units integrated with agriculture farming.

MILK YIELD PER DAY OF CALVING INTERVAL (MY / day CI) :

The average milk yield per day of CI as mentioned by various authors is tabulated below :

Table-7 : Average Milk yield per day of calving interval of various genetic groups.

Genetic Group	Milk yield per day of calving interval (kg)	Author
HF ≥ 50% 50% ≤ 50%	8.9 ± 0.2 9.4 ± 0.3 5.7 ± 0.4	Singh et al. (1986[b])
HF crossbred	5.92 ± 0.42	Singh et al. (1989)
½ J ½ H ¾ J ¾ HF	4.60 ± 0.03 5.34 ± 0.04 4.53 ± 0.06 5.41 ± 0.05	Hayatnagarkar et al. (1990)
HFX Sahiwal	6.10 ± 0.12	Jadhav et al. (1991)
Hariana	3.49 ± 0.04	Yadav and Tathi (1992)
Sahiwal	3.60 ± 0.05	Yadav et al. (1992)
Tharparkar	4.90 ± 0.14	Vij et al. (1992)
Friesian crossbred	4.18	Tomar et al. (1998)
Friesian crossbred	7.11 ± 0.03	Shrivastava et al. (2000)
5/8 F x 3/8 S ½ F x ½ S ½ R x ½ S 5/8 JX 3/8 S ½ F x ½ S ½ F x ½ H	7.82 ± 0.08 6.86 ± 0.08 6.3 ± 0.08 6.52 ± 0.08 6.20 ± 0.08 6.29 ± 0.08	Akhter et al. (2003)
Desi HFX JX	2.34 ± 0.15 6.57 ± 0.12 5.04 ± 0.14	Kumar (2005)
HF > 50% HF 50% HF < 50% Hariana Pure	3.19 ± 0.19 3.67 ± 0.12 2.95 ± 0.28 1.65 ± 0.27	Sharan (2005)
Desi HFX JX	2.19 ± 0.09 6.63 ± 0.07 5.12 ± 0.08	Kumar (2006)

EFFECT OF GENETIC GROUP :

Jadhav et al. (1991) studied the effect of six grades of Holstein x Sahiwal crosses on MY / day CI in the cows maintained at military farms located at Ambala, Deharadun and Jalandhar and reported significant ($P<0.05$) effect of genetic group on MY / day CI. They observed the

days lower CI in the dairy units involved in dairying alone than those units integrated with agriculture farming.

MILK YIELD PER DAY OF CALVING INTERVAL (MY / day CI) :

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HFX Sahiwal	6.10 ± 0.12	Jadhav et al. (1991)
Hariana	3.49 ± 0.04	Yadav and Tathi (1992)
Sahiwal	3.60 ± 0.05	Yadav et al. (1992)
Tharparkar	4.90 ± 0.14	Vij et al. (1992)
Friesian crossbred	4.18	Tomar et al. (1998)
Friesian crossbred	7.11 ± 0.03	Shrivastava et al. (2000)
5/8 F x 3/8 S ½ F x ½ S ½ R x ½ S 5/8 JX 3/8 S ½ F x ½ S ½ F x ½ H	7.82 ± 0.08 6.86 ± 0.08 6.3 ± 0.08 6.52 ± 0.08 6.20 ± 0.08 6.29 ± 0.08	Akhter et al. (2003)
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EFFECT OF GENETIC GROUP :

Jadhav et al. (1991) studied the effect of six grades of Holstein x Sahiwal crosses on MY / day CI in the cows maintained at military farms located at Ambala, Deharadun and Jalandhar and reported significant ($P<0.05$) effect of genetic group on MY / day CI. They observed the

highest (6.87±0.18 kg) and lowest (4.89±0.16 kg) MY / day CI to be in ½ HF ½ S and ¼ HF ¾ S genetic grades respectively.

Shrivastava and Singh (2000) observed significant (P<0.05) effect of genetic group of cattle on MY / day CI in un-organized herd located in and around Ranchi (Jharkhand). They reported MY / day CI to be the highest (7.45 ± 0.05 kg) and the lowest (6.49 ± 0.07 kg) in ½ Friesian ½ Zebu and <50% Friesian inheritance genetic groups respectively.

Singh et al. (2000) observed significant (P<0.05) effect of genetic group on MY / day CI in 407 crossbred cows of HF, BS and Jersey with Hariana. They further reported the highest (7.17 ± 0.16 kg) and the lowest (5.88 ± 0.23 kg) MY / day CI to be in HF x H cows and J x H cows respectively.

Priya Raj (2002) reported significantly (P<0.01) higher MY / day CI in HF crossbred cows than Jersey crossbreds in private dairy units under farmers' managemental condition in and around Patna (Bihar).

Akhter et al. (2003) studied the effect of genetic group on 1st lactation MY / day CI in twelve genetic groups involving three exotic breeds viz. HF, J and RD with 3 Zebu breeds viz. Sahiwal (S), Hariana (H) and Red Sindhi (RS). They reported significant (P<0.05) effect of genetic group on MY / day CI.

Kumar[1] (2004) studied the effect of genetic group on MY / day CI in HFX, JX and Desi cows under farmers' managemental condition in and around Darbhanga (Bihar). He reported that HFX and JX had significantly (P<0.01) more than double MY / day CI than Desi cows. He further observed that HFX had higher MY / day CI than JX.

Kumar (2005) also found that HFX and JX cows with Hariana had significantly (P<0.01) more than double MY / day CI than Desi cows in private dairy units under farmers' managemental condition in and around Patna (Bihar). He observed the highest MY / day CI (6.57±0.12 kg) and the lowest 2.34±0.15 kg to be HFX and Desi cows respectively.

Sharan (2005) studied the effect of genetic group on MY / day CI in Hariana and its crosses with HF. He reported significant effect of genetic group on it. He further observed that HF 50% had significantly (P<0.01) higher MY / day CI than HF > 50%, HF < 50% and Hariana pure genetic groups.

Kumar (2006) studied the effect of genetic group on MY / day CI in Desi, HFX and JX cows under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He reported that HFX had the highest MY / day CI which was significantly (P<0.05) higher by 4.44 kg and 1.15 kg than Desi and JX cows respectively. He further noted that JX cows has also significantly (P<0.05) 2.93 kg higher MY / day CI than Desi cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Jadhav et al. (1991) observed significant (P<0.01) effect of farms on MY / day CI in six breeds of Holstein x Sahiwal on the basis of level of Holstein inheritance.

Shrivastava and Singh (2000) observed significant (P<0.05) effect of zones on MY / day CI in Friesian x Zebu crossbred cows in private dairy units under farmers' managemental condition in and around Ranchi (Jharkhand).

Priya Raj (2002) studied the effect of location of herd on MY / day CI in HFX and JX cows maintained in the Khatals located in and around Patna (Bihar). She reported its effect on MY / day CI to be non-significant.

Kumar[1] (2004) reported that different zones in and around Darbhanga (Bihar) had no significant effect on MY / day CI in Desi and crossbred cows and buffaloes.

Kumar (2005) observed significant ($P<0.01$) effect of location of herd on MY / day CI in Desi, HFX and JX cows in private dairy units under farmers' managemental condition in and around Patna (Bihar).

Kumar (2006) reported that location of herd had non-significant effect on MY / day CI in Desi, HFX and JX cows under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

HERD SIZE :

Shrivastava and Singh (2000) reported significant ($P<0.05$) decrease in MY / day CI with the increase of herd size in three different genetic grades of Friesian x Zebu cows of un-organised farm located in and around Ranchi (Jharkhand).

Priya Raj (2002) observed that the size of herd did not influence significantly the MY / day CI in HFX and JX cows maintained under farmers' managemental condition located in and around Patna (Bihar).

Kumar[1](2004) reported non-significant effect of herd size on MY / day CI in Desi and crossbred cows maintianed in private dairy units located in and around Darbhanga (Bihar).

Kumar (2005) observed that the herd size did not influence MY / day CI significantly in Desi, HFX and JX cows under farmers' managemental condition in and around Patna (Bihar).

Kumar (2006) reported significant (P<0.01) effect of herd size on MY / day CI in Desi, HFX and JX cows under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

HERD CONSTITUTION :

Kumar[1] (2004) reported that the herd constitution did not influence MY / day CI significantly in milch cows and buffalo under farmers' managemental condition in private dairy units located in and around Darbhanga (Bihar).

Kumar (2005) observed non-significant effect of herd constitution on MY / day CI in Desi and crossbred cows of HF and Jersey with Desi cows in private diary units located in and around Patna (Bihar).

Kumar (2006) studied the effect of herd size on MY / day CI in Desi and crossbred cows in private dairy units maintained under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He reported that the cows maintained in the herd size of 7 & above had significantly (P<0.05) higher MY / day CI than those maintained in the lower sizes.

SEASON OF CALVING :

Jadhav et al. (1991) observed that season of calving had significant (P<0.01) effect on MY / day CI in six genetic grades of HF x Sahiwal crossbreds. They further observed that winter and rainy calvers had significantly (P<0.01) higher MY / day CI than summer calvers.

Yadav et al. (1992) reported non-significant effect of season of calving on MY / day CI in Sahiwal cows. However, they observed the highest MY / day CI by winter calvers followed by summer and rainy calvers.

Yadav and Rathi (1992) observed non-significant effect of season of calving on MY / day CI in Hariana cows.

Shrivastava and Singh (2000) observed that season of calving had no significant influence on MY / day CI in HF x Zebu crossbred cows under farmers' managemental condition in private dairy units located in and around Ranchi (Jharkhand).

Singh et al. (2000) reported that season of calving had no significant effect on MY / day CI in crossbred cows involving HF, BS and Jersey with Hariana.

Priya Raj (2002) reported non-significant effect of season of calving on MY / day CI in HFX and JX cows under farmers' managemental condition in private dairy units located in and around Patna (Bihar).

Akhter et al. (2003) observed that season of calving had no significant effect on 1st lactation MY / day CI in twelve genetic groups of crossbred cows involving three exotic breeds viz. HF, J and RD with three Zebu breeds viz. Sahiwal, Hariana and Red Sindhi.

Kumar[1] (2004) observed significant ($P<0.01$) influence of season of calving on MY / day CI in Desi, crossbred cows and buffaloes under farmers' managemental condition in private dairy units located in and around Darbhanga (Bihar).

Kumar (2005) reported that season of calving had no significant effect on MY / day CI in Desi and crossbred cows maintained in the private dairy units located in and around Patna (Bihar).

Kumar (2006) observed that season of calving played significant ($P<0.05$) effect on MY / day CI in Desi, HFX and JX cows maintained in the private dairy units under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He observed that winter

calvers had significantly (P<0.05) 0.27 kg and 0.57 kg higher average MY / day CI than the rainy and summer calvers respectively. He further noted that rainy calvers had also 0.30 kg higher MY / day CI than summer calvers.

LACTATION ORDER :

Vij et al. (1992) observed the effect of order of lactation on MY / day CI to be significant (P<0.01) in Tharparkar cows. However, they could not find any definite trend for the effect of parity of lactation on it.

Yadav and Rathi (1992) observed the effect of parity of lactation on MY / day CI to be significant (P<0.05) in Hariana cows and reported that MY / day CI increased consistently upto 3rd lactation.

Yadav et al. (1992) reported that the milk yield per day of CI increased significantly (P<0.01) upto 3rd lactation in Sahiwal cows.

Shrivastava and Singh (2000) observed that parity of lactation had significant (P<0.05) effect on MY / day CI in three genetic grades of Holstein Friesian crosses with Zebu under farmers' managemental condition in private dairy units located in and around Ranchi (Jharkhand). They observed that the MY / day CI increased significantly (P<0.05) upto 3rd lactation.

Singh et al. (2000) observed significant (P<0.01) effect of sequence of lactation on MY / day CI in seven genetic groups of crossbred cows of HF, BS and J with Hariana. They reported that MY / day CI significantly (P<0.05) increased from 1st to 2nd lactation. However, the mean MY / day CI of 2nd and 3rd lactations did not differ significantly.

Priya Raj (2002) reported significant (P<0.05) effect of sequence of lactation on MY / day CI in crossbred cows of HF and Jersey with Desi under farmers' managemental condition in private dairy units located in and

around Patna (Bihar). She found that MY / day CI increased upto 3rd lactation after which it tended to decline.

Kumar[1] (2004) observed the effect of sequence of lactation on MY / day CI to be significnat (P<0.01) in cattle and buffalo under farmers' managemental condition in private dairy units located in and around Darbhanga (Bihar). He observed that the MY / day CI increased upto 3rd lactation after which it declined.

Kumar (2005) reported significant (P<0.01) effect of parity of lactation on MY / day CI in Desi, HFX and JX cows in the private dairy units located in and around Patna (Bihar). He observed that MY / day CI increased upto 3rd sequence of lactation, tended to decline in 4th lactation and significantly (P<0.05) decreased in 5th and 6th lactations.

Kumar (2006) studied the effect of sequence of lactation on MY / day CI in Desi, HFX and JX cows under farmers' managemental condition and reported that the average MY / day CI decreased in 7th lactation from 1st by 0.29 kg but increased in 3rd & 4th lactation (pooled together) after which it significantly (P<0.05) declined by 0.32 kg. He reported that although there was no any definite trend, yet the MY / day CI significantly (P<0.05) declined after 3rd & 4th lactations.

FARMING SYSTEM :

Kumar[1] (2004) reported non-significant influence of farming system on MY / day CI in cows and buffaloes under farmers' managemental condition in private dairy units located in and around Darbhanga (Bihar).

Kumar (2005) observed that farming system did not influence significantly the MY / day CI in Desi, HFX and JX cows in the private dairy units located in and around Patna (Bihar). However, he observed that the cows maintained in the dairy units integrated with agriculture farming

had higher MY / day CI in comparison to those maintained in the units involving dairying alone.

Sharan (2005) reported that parity of lactation had no significant influence on MY / day CI in Hariana cows and its crosses with Holstein Friesian.

Kumar (2006) could not find significant effect of farming system on MY / day CI in Desi, HFX and JX cows maintained under farmers' managemental condition in and around Biharsharif of Nalanda distirct (Bihar).

DRY PERIOD :

The average dry periods as mentioned by various investigators are summarised as below :

Table -8 : Average Dry period of various genetic groups.

Genetic Group	Dry period (days)	Author
Tharparkar	114.75±6.57	Vij et al. (1992)
Sahiwal Jersey x Sahiwal Red Dane x Sahiwal	164.70±8.74 106.15±8.74 89.15±8.74	Singh et al. (1993)
Jersey crossbreds	141.18±6.02	Deshmukh et al. (1995)
Friesian crossbreds	85.98±1.36	Shrivastava et al. (1996)
Hariana	228±5.4	Pundir and Raheja (1997)
Frisian crossbreds	167.07	Tomar et al. (1998)
½ JX ½ H > ½ JX < ½ H	166.8±13.3 158.3±19.9	Thakur et al. (1999)
Hariana	210±3.36	Dalal et al. (2002)
HF crossbreds	72.82±0.65	Akhter et al. (2003)
Hariana Pure HF < 50% HF 50% HF 62.5% HF 75% Jersey 50%	201.10±20.83 153.06±9.55 121.25±19.76 264.44±34.70 113.40±11.87 126.97±9.47	Kumar[2] (2004)
Desi HFX JX	115.38±5.49 77.25±4.30 70.44±5.05	Kumar (2005)
Desi HFX JX	114.96±2.35 74.99±1.97 72.85±2.16	Kumar (2006)

EFFECT OF GENETIC GROUP :

Singh et al. (1993) reported the effect of genetic group on 1st dry period to be non-significant in Sahiwal and its crosses with Jersey and Red Dane.

Thakur et al. (1999) studied the effect of genetic group on 1st dry period in nine genetic groups of different levels of Jersey inheritance in Jersey crosses with Red Sindhi, Sahiwal, Tharparkar and Hariana. They reported the effect of genetic group to be significant.

Priya Raj (2002) studied the effect of genetic group on dry period in HFX and JX cows under farmers' managemental condition in and around Patna (Bihar). They observed that genetic group had no significant effect on it.

Akhter et al. (2003) reported the effect of genetic group consisting of crossbred cows of three exotic breeds viz. HF, J and RD with three Zebu breeds viz. Sahiwal, Hariana and Red Sindhi on dry period to be significant ($P<0.05$).

Kumar[1] (2004) reported the effect of genetic group on dry period to be significant ($P<0.01$) in Desi, HFX and JX cows and buffaloes under farmer's managemental condition in and around Darbhanga (Bihar). He reported significantly ($P<0.01$) longer dry period in Desi cows than HFX and Jersey crossbred cows.

Kumar[2] (2004) observed significant ($P<0.01$) effect of genetic group on dry period in Hariana and its crosses with HF and Jersey. He observed that ½ HF ½ H and ½ J ½ H genetic groups had nearly half of the dry period in comparison to Hariana pure.

Kumar (2005) concluded that crossbreds of HF and Jersey with Zebu had significantly (P<0.01) shorter dry period by 38.13 days and 44.94 days respectively than Desi cows.

Kumar(2006) reported significant (P<0.01) effect of genetic group on dry period days in Desi, HFX and JX cows under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). The minimum dry period (72.85 days) was observed to be in JX cows followed by HFX (74.99 days) and Desi cows (114.96 days). However, the mean dry period days of HFX and JX did not differ significantly.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Priya Raj (2002) studied the effect of different zones on dry period in HFX and JX cows in the private dairy units located in and around Patna (Bihar). She reported that different zones had no significant influence on dry period.

Kumar[1] (2004) found the effect of different zones on dry period to be non-significant in Desi, crossbred cows and graded buffaloes under farmers' managemental condition.

Kumar (2005) reported the effect of different locations on dry period in Desi and crossbred cows under farmers' managemental condition in and around Patna to be non-significant.

Kumar (2006) observed significant (P<0.01) effect of location of herd on dry period days in Desi, HFX and JX cows maintained in private dairy units under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

HERD SIZE :

Priya Raj (2002) reported that the size of herd had no significant influence on dry period in HFX and JX cows under farmers' managemental condition in and around Patna (Bihar).

Kumar[1](2004) studied the effect of herd size on dry period in Desi, crossbred cows and graded buffaloes in and around Darbhanga (Bihar). He opined that herd size had no significant influence on dry period.

Kumar (2005) reported that the size of the herd had no significant influence on dry period in Desi and crossbred cows of HF and Jersey with Desi under farmers' managemental condition in and around Patna (Bihar).

Kumar(2006) observed that the size of the herd did not influence significantly the dry period (days) in Desi, HFX and JX cows under farmers' managemental condition in and 15 kms around Biharsharif of Nalanda district (Bihar).

HERD CONSTITUTION:

Kumar[1] (2004) reported non-significant effect of herd constitution on dry period in Desi, crossbred cows and buffaloes under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar (2005) reported that herd constitution had no significant influence on dry period in Desi, HFX and JX cows in private dairy units located in and around Patna (Bihar).

Kumar(2006) observed that the herd constitution had no significant role on dry period in Desi, HFX and JX cows maintained in private dairy units under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar).

SEASON OF CALVING :

Vij et al. (1992) observed that season of calving significantly ($P<0.05$) influenced the dry period in Tharparkar cows. They reported that December-February calvers had shorter dry period as compared to March-April, May-August and September-November calvers.

Singh et al.(1993) reported that the season of calving did not influence the 1st dry period significantly in Sahiwal and its crosses with Jersey and Red Dane.

Thakur et al. (1999) reported non-significant effect of season of calving on dry period in nine genetic groups of Jersey x Zebu crossbred cows.

Priya Raj (2002) reported non-significant influence of month of calving on dry period in HFX and JX cows under farmers' managemental condition in and around Patna (Bihar).

Akhter et al. (2003) observed the effect of season of calving on 1st dry period to be significant ($P<0.05$) in crosses involving three exotic breeds viz. HF, J and RD with three Zebu breeds viz. Sahiwal, Red Sindhi and Hariana. They reported that rainy calvers had the shortest dry period followed by spring, winter and summer.

Kumar[1] (2004) reported the effect of season of calving on dry period to be non-significant in Desi, crossbred cows and graded buffaloes under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar[2] (2004) observed non-significant effect of season of calving on dry period in Hariana and its crosses with HF and Jersey.

Kumar (2005) observed that season of calving did not influence dry period significantly in Desi, HFX and JX crossbred cows in private dairy

units situated in and around Patna (Bihar). However, he observed that winter calvers had the lowest dry period followed by rainy and summer calvers.

Kumar(2006) reported significant ($P<0.01$) effect of season of calving on dry period in Desi, HFX and JX cows under farmers' managemental condition in and 15 kms around Biharsharif of Nalanda district (Bihar). He found that the winter season had the shortest (83.09±2.11) and the rainy season had the longest (97.67±1.79) dry period days.

LACTATION ORDER :

Vij et al. (1992) reported significant ($P<0.01$) effect of parity of lactation on dry period in Tharparkar cows. They reported that the dry period decreased after 2nd lactation and again increased in 4th and 5th lactations.

Priya Raj (2002) reported significant ($P<0.05$) influence of sequence of lactation on the dry period in crossbred cows of HF and Jersey with Zebu under farmers' managemental condition in and around Patna (Bihar).

Kumar[1] (2004) reported that sequence of lactation did not influence significantly the dry period in Desi and crossbred cows under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar[2] (2004) observed non-significant influence of sequence of lactation on dry period in Hariana and its crosses with HF and Jersey in the organized farm.

Kumar (2005) reported that sequence of lactation did not influence significantly the dry period in Desi, HFX and JX cows under farmers' managemental condition in and around Patna (Bihar).

Kumar(2006) investigated the effect of the sequence of lactation on dry period in Desi, HFX and JX cows under farmers' managemental condition in and around Biharsharif of Nalanda district of (Bihar). He reported that the sequence of lactation order had significant ($P<0.01$) role on dry period. He found that the days of dry period significantly ($P<0.05$) decreased in 2nd and 3rd & 4th lactations from 1st after which it tended to increase. He observed the shortest dry period to be a in 3rd & 4th lactations taken together in his study.

FARMING SYSTEM :

Kumar[1] (2004) reported non-significant influence of farming system on dry period in Desi and crossbred cows and graded buffaloes under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar (2005) reported significant ($P<0.01$) effect of farming system on dry period. He observed that the cows maintained in the units involved in dairying alone had significantly ($P<0.01$) shorter dry period than those maintained in the units integrated with agriculture farming.

Kumar (2006) reported that system of farming had significant ($P<0.01$) effect on dry period in Desi, HFX and JX cows under farmers' managemental condition. He observed that the cows maintained in dairying alone had significantly ($P<0.01$) 12.38 days shorter dry period than those maintaining dairy units integrated with agriculture farming.

NET COST :

GENETIC GROUP :

Priya Raj (2002) concluded the average net cost of per kg milk production of HF crossbred cows to be significantly ($P<0.05$) lower than

Jersey crossbred cows in the private dairy units located in and around Patna (Bihar).

Kumar[1] (2004) reported significant (P<0.01) effect of genetic group on net cost of milk production. He found the lowest net cost per kg of milk production to be in HF crossbred cows followed by Jersey crossbred cows and Desi cows.

Kumar (2005) observed significant (P<0.01) effect of genotype on average net cost of per kg of milk production. He reported that HF crossbreds had the lowest cost of per kg milk production and they proved to be most economical. He further noted that the average net cost per kg of milk produced by HF crossbreds was significantly (P<0.01) lower by Rs. 1.04 and Rs. 1.68 than Jersey crossbred and Desi cows respectively. He also found that the net cost per kg of milk produced by Jersey crossbreds to be significantly (P<0.01) Re. 0.64 lower than produced by Desi cows.

Kumar (2006) reported significant (P<0.01) effect of genetic group on net cost of per kg of milk production in the dairy units maintained under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He observed the net cost per kg of milk production in Desi, HFX and JX cows to be Rs. 10.14±0.16, Rs. 8.60±0.13 and Rs. 9.33±1.15 respectively. He opined that the HF crossbreds were the most economical with respect to net cost per kg of milk production followed by Jersey crossbreds and Desi cows.

LOCATION OF HERD :

Singh (1984) reported the effect of location of herd on cost of milk production to be non-significant in Friesian x Zebu cows maintained in and around Ranchi (Jharkhand).

Priya Raj (2002) observed non-significant effect of cost of per kg milk production due to differences in location of Khatals in and around 15 kms of Patna (Bihar).

Kumar[1] (2004) reported significant ($P<0.01$) effect of zones on net cost of milk production in milch cows and buffaloes maintained in private dairy units in and around Darbhanga (Bihar).

Kumar (2005) reported that the location of herd had significant ($P<0.01$) effect on net cost per kg of milk production in Desi and crossbred cows of HF and Jersey maintained in the private dairy units located in and around Patna (Bihar).

Kumar (2006) observed that location of herd had significant ($P<0.05$) effect on average net cost per kg of milk production in private dairy units maintained under farmers' managemental condition.

HERD SIZE :

Singh (1984) reported significant ($P<0.05$) effect of the herd size on cost of milk production in Friesian x Zebu cows under farmers' managemental condition in and around Ranchi (Jharkhand).

Priya Raj (2002) observed significantly ($P<0.05$) lower net cost per kg of milk production in the private dairy units maintaining 8-12 and 13-17 crossbred cows than those maintaining 3-7 crossbred cows in and around Patna (Bihar).

Kumar[1] (2004) reported that herd size influenced the net cost per kg of milk production significantly ($P<0.01$) in Desi, HFX, JX cows and buffaloes under farmers' managemental condition in and around Darbhanga

(Bihar). He opined the herd size of 11-14 milch animals to be optimum for relatively cheaper milk production.

Kumar (2005) observed that the size of the herd had significant ($P<0.01$) influence on net cost per kg of milk production in Desi, HFX and JX cows maintained in the private dairy units located in and around 15 kms of Patna (Bihar). He observed that the average net cost per kg of milk production in the size of 7 & above milch cows to be significantly ($P<0.01$) 48 paise lower than the herd size of 3-6 cows.

Kumar (2006) reported that the herd size had significant ($P<0.01$) effect on net cost per kg of milk production. His findings revealed that cows maintained in the herd size of 7 & above had significantly ($P<0.05$) lower net cost per kg of milk production than the cows maintained in the herd sizes of 3-4 and 5-6.

HERD CONSTITUTION :

Kumar[1] (2004) reported the significant ($P<0.01$) effect of herd constitution on net cost of milk production in Desi, crossbred cows and graded buffaloes under farmers' managemental condition in and around Darbhanga (Bihar). He reported the average net cost of milk production to be significantly ($P<0.05$) higher in private dairy units having only buffaloes followed by those having only cows and both cows and buffaloes.

Kumar (2005) observed significant ($P<0.01$) effect of herd constitution on net cost per kg of milk production in Desi and crossbred cows maintained in the private dairy units located in and around Patna (Bihar). He observed that the dairy units having Desi along with Jersey crossbreds had the lowest net cost per kg of milk production than other herd constitution groups under study.

Kumar (2006) observed non-significant effect of herd constitution on net cost per kg of milk production in Desi, HFX and JX cows under farmers' managemental condition. However he observed the net cost per kg of milk production to be the lowest (Rs. 9.08) in the group having Desi along with HFX and highest (Rs. 9.77) in the group maintaining only Desi cows.

SEASON OF CALVING :

Singh (1984) reported significant ($P<0.05$) effect of season of calving on the net cost of milk production in Friesian x Zebu crosses in and around Ranchi (Jharkhand).

Priya Raj (2002) reported that the season of calving of HFX and JX cows had no significant influence on the net cost of per kg milk production in the private dairy units located in and around Patna (Bihar).

Kumar[1] (2004) reported that season of calving had significant ($P<0.01$) effect on net cost per kg of milk production in Desi, HFX and JX cows and graded buffaloes in and around Darbhanga (Bihar).

Kumar (2005) observed non-significant effect of season of calving on net cost per kg of milk production in Desi and crossbred cows of HF and Jersey in private dairy units under farmers' managemental condition in and around Patna (Bihar).

Kumar (2006) reported significant ($P<0.01$) influence of net cost per kg of milk production in Desi, HFX and JX cows under farmers' managemental condition. He further reported that winter and rainy calvers had significantly ($P<0.05$) Rs. 0.74 and Rs. 0.45 lower net cost per kg of milk production than summer calvers.

LACTATION ORDER:

Singh (1984) reported significant ($P<0.05$) effects of sequence of lactation on cost of milk production in Friesian x Zebu cows of private dairy farms maintained in and around Ranchi (Jharkhand).

Priya Raj (2002) observed significant ($P<0.01$) effect of lactation order on cost of per kg milk production in HFX and JX cows under farmers managemental condition in and around Patna (Bihar). She reported that the 3rd parity of lactation had significantly ($P<0.01$) lower net cost of per kg milk production than other sequence of lactation.

Kumar[1] (2004) reported that the net cost of per kg milk production during 3rd lactation was significantly ($P<0.05$) lower than all the sequences upto 5th parity in milch cows and graded buffaloes in and around Darbhanga (Bihar).

Kumar (2005) observed significant ($P<0.05$) influence of parity of lactation on the net cost per kg of milk production in Desi and crossbred cows under farmers' managemental condition in and around Patna (Bihar). He reported that the average net cost/kg of milk production significantly ($P<0.05$), decreased from 1st & 2nd to 3rd lactation.

Kumar (2006) reported that the lactation order did not influence the net cost per kg of milk production significantly. However, he observed that the net cost per kg of milk production tended to decrease in 3rd and 4th lactations from 1st and 2nd lactations and those by it increased in subsequent lactations.

FARMING SYSTEM:

Kumar[1] (2004) found that the milch animals maintained in the dairy units had significantly ($P<0.01$) higher net cost/kg of milk production as compared to those maintained in the units integrated with agriculture farming under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar (2005) reported non-significnat effect of farming system on net cost/kg milk production. However, he observed that the units involved in dairying alone had 18 paise higher net cost compared to the units maintaining dairy integrated with agriculture framing.

Kumar (2006) reported that the system of farming did not influence the net cost per kg of milk production in Desi, HFX and JX cows under farmets' managemental condition in and around Biharsharif of Nalanda district (Bihar).

ECONOMICS OF MILK PRODUCTION :

Singh et al. (1986[a]) observed that HF crossbreds were "Breed of choice" because of their higher average daily milk yield, docile nature, black coat colour, lower fat percentage etc. in and around Ranchi (Jharkhand). However, they reported the Jersey crossbred cows to be more economical milk producer, more adaptable, more resistant to stress condition and better performance of male calves.

Kalra et al. (1995) observed that feeds and fodder shared the maximum amount of the variable cost items in rural areas of Haryana. The feeds and fodder cost in buffalo, crossbreds and local cows were found to

be 58.08%, 56.22% and 63.64% respectively, whereas the corresponding percentages for the labour cost were obtained as 18.18, 19.45 and 16.95.

Badal and Dhaka (1998) also observed that among the various cost items of milk production, feed cost contributed maximum followed by labour cost, interest of fixed assets, depreciation of animal and veterinary and miscellaneous expenditure in different breeds of bovines of Gopalganj district in Bihar.

Chnadra and Agarwal (2000) reported that among the variable cost items, feeds and fodder contributed 69.8% and 68.2% of the gross cost of maintenance in crossbred cows and buffaloes respectively. They observed the labour cost to be 21,5% and 21,9% in cows and buffaloes respectively.

Priya Raj (2002) reported that feeds and fodders contributed 63.4% and 65.41% in HFX and JX cows respectively in private dairy units under farmers' managemental condition in and around Patna (Bihar).

Kumar[1] (2004) reported that the fixed cost contributed maximum amount of variable cost in Desi, HFX and JX cows. He observed the feed cost to be 66.64%, 66.03% and 66.71% of the gross cost per kg of milk production in Desi, HFX and JX cows respectively under farmers' managemental condition in and around Darbhanga (Bihar).

Kumar (2005) observed that among the variable cost items, feed cost shared 69.95%, 71.70% and 69.88% in Desi, HFX and JX cows respectively in private dairy units maintained under farmers' managemental condition in and around Patna (Bihar). The respective percentage of labour cost were found to be 12.79, 14.89 and 17.19.

Kumar (2006) reported that feed cost contributed 70.13%, 71.74% and 71.12% of the gross cost of per kg milk production in Desi, HFX and JX cows respectively under farmers' managemenatl condition in and around Biharsharif of Nalanda district (Bihar). He observed the labour cost to be 12.88%, 14.87% and 16.34% in Desi, HFX and JX cows respectively.

CONSTARINS IN LIVESTOCK FARMING:

Rajendran and Prabhaharan (1993) reported the main constraints to be higher incidence of repeat breeding followed be high capital investment, high frequency of illness of animals, costly feed and costly treatments of the animals in the management of crossbred cows in Tamil Nadu.

Savarkar et al. (2001) suggested the need of employing more extension efforts for following proper artificial insemination schedule by the dairy owners.

Priya Raj (2002) studied the constraints perceived by the dairy owners in the private dairy units located in and around Patna in rearing crossbred cows of HF and Jersey inheritance. She observed the main constraints to be high cost of crossbred cows followed by lack of proper housing, non-availability of green fodder and good dairy animals throughout the year, repeat breeding, costly feed and fodders, high cost of veterinary medicines, unsatisfactory results of AI., adulteration in cattle feed, cumbersome and tedious procedures in insurance and certification of crossbred cows, insufficient finance and credit facilities, low value of crossbred males and non-remunerative price of milk.

Mishra and Pal (2003) classified the main constraints in dairy sectors perceived by the respondents into four groups viz. technical, economic,

organizational and social. They noted the major technical constraints to be repeat breeding of cows, low conception rate through A.I., calf mortality and poor knowledge of heat detection. They reported the economic constrains to be lack of credit facilities, high cost of veterinary services and non-availability of green fodder. The major organizational constraints included distant location of A.I. center, lack of motivation by extension workers and non-availability of A.I. facility. The main social constraints perceived by the dairy farmers were illiteracy, lack of support from elders and social dogma.

Kumar [1] (2004) reported the major constraints perceived by the dairy owners under farmers' managemental condition to be costly crossbred cows, repeat breeding problems, costly feed and feed supplements, non-availability of green fodder throughout the year, high cost of veterinary medicines and services, non-availability of genetically improved dairy animals, sufficient land, lack of finance and credit facilities, very low price of crossbred male calves and non-remunerative price of milk.

Kumar (2005) investigated the major constraints perceived by the dairy farmers in the private dairy units located in and around Patna in rearing Desi, HFX and JX cows. He observed the major constraints to be high cost of crossbred cows, lack of proper housing due to costly land, non-availability of good dairy animals in the locality, high incidence of repeat breeding, non-availability of green fodder throughout the year, high cost of feeds, fodders and feed supplements, high cost of veterinary medicines, poor results of A.I., lack of finance/credit facilities, uneconomical crossbred male calves and non-remunerative price of milk

Kumar (2006) studied the major constraints perceived by the dairy farmers' under farmers' managemental condition in and around Biharsharif of Nalanda district (Bihar). He observed eleven major constraints which ranked in order as high cost of crossbred cows, non-availability of good dairy animals in the locality, high incidences of repeat breeding, high-cost of feeds fodders and feed supplements, high cost of veterinary medicines, poor results of A.I., lack of proper housing, availability of green fodders throughout the year, lack of finance/credit facilities, uneconomical crossbred male calves and non-remunerative price of milk.

CHAPTER - 3

MATERIALS AND METHODS

MATERIALS AND METHODS

Source of Data :

The present research study was carried out on Desi and HFX and Jersey crossbred cows maintained in private dairy units located in a radius of about 15 kms in and around Madhepura (Bihar).

Area of Experimentation :

The whole area under study was divided into four distinct zones which are tabulated below :

Table - 9 : Zone-wise villages / Mohalla of area of experimentation.

Sl. No.	Zone No.	Major Area	Villages / Mohalla
1	I	Madhepura Block	College chowk, Bhirkhi chowk, Karpuri chowk, Sahugarh, Tunyahi, Sukhashan, Budhma, Murho, Muchbakhra, Betona, Sadhwa, Ghodhala
2	II	Singheshwar Block	Rupauli, Dular, Singeon, Katiya, Bhawanipur, Jugwani, Rampatti, Satokhar, Larha, Itawa, Khar
3	III	Ghailarh Block	Ratanpura, Ramnagar, Srinagar, Basudeva, Itahari, Kamalpur, Bhaun, Tekthi, Lakhmanya, Mahua, Piprahi
4	IV	Shankarpur Block	Mauzma, Kalhua, Bairely, Shakarpura, Chaura, Kabyahi, Majha, Pasra

Primary Survey :

The primary survey was conducted in the private dairy units popularly known as 'Khatals' located in a radius of 15 kms in and around Madhepura. 'Khatals' consisting of at least 3 or more Desi or crossbred cows either alone or in combination were enumerated through a "door to door survey" method in this study. The animals were fed poor quality of roughages and there was deficiency of greens in the feed because the dairy

khatals owners had the only aim of profit. This study did not include the dairy units which were managed with exceptional superiority and which also consisted of buffaloes. A total of 935 cows consisting 498 Desi, 195 HFX and 242 JX cows were enumerated from 242 dairy units located in and around Madhepura (Bihar) which are tabulated below :

Table - 10 : Zone-wise distribution of enumerated dairy units of cows of different genetic groups.

Zones	Dairy units enumerated	Genetic groups			
		Desi	HFX	J X	Total
I	105	201	105	90	396
II	39	110	35	45	190
III	51	130	29	56	215
IV	47	57	26	51	134
Total	**242**	**498**	**195**	**242**	**935**

General managerials practices of dairy units :

There were no uniform managerial practices in the Khatals. The cows, in general, were stallfed with individual feeding. Cows were provided the concentrates depending upon their physical and physiological status such as size of the body, milk production, stage and sequence of lactations, dry period etc.

In general home made concentrate mixtures were fed to the animals, with few exceptions too. The most common items of dry fodder consisted of wheat bhoosa and choffed paddy. The main source of the green fodders included seasonal cultivated and un-cultivated grasses. There was general practice to add mineral mixture, vitamins and common salt to balance the ration. Majority of the dairy units did not follow the scientific schedule of

vaccination completely, However, the farmers considerably took prophylactic and curative measures against various diseases. Besides, A.I. was also in common practice for breeding the cows in the dairy units.

The housing pattern in the dairy units was not scientific. The cows were maintained in four types of houses such as Kachcha, ½ and ¾ pacca and also full pucca houses. The different types of houses are classified as follow.

Type A - Full kachcha house

Type B - Half kachcha house (only wall pucca without plaster)

Type C - 3/4th pucca house (walls, floors and feeding trough pucca)

Type D - Full pucca house (roof of CA / CI sheets).

Respondent Units :

Out of 242 enumerated units, only 208 units provided relevant informations. These units were defined as respondent units and data obtained from them were considered for further investigation. These respondent units consisted of 427 Desi, 155 HFX and 183 JX cows. The zone-wise distribution of the respondent units along with cows of different genetic groups are depicted in table-11.

Table - 11 : Zone-wise distribution of dairy units and cows of different groups in respondent units.

Zones	Respondent dairy units	Crossbred cows			
		Desi	HFX	J X	Total
I	94	175	101	75	351
II	38	92	22	36	150
III	46	118	20	41	179
IV	30	42	12	31	85
Total	**208**	**427**	**155**	**183**	**765**

Sampling of respondent units :

Out of the total 208 units, 50% i.e. 104 dairy units consisting of 417 cows of different genetic groups were randomly selected utilizing procedures of stratified random sampling with proportional allocation" (Snedecor and Cochran 1967). The zone-wise distribution of selected respondent units along with the number of Desi and crossbred cows and also the number of discarded cows have been depicted table-12.

A total of 247 cows were discarded due to their non-identified genetic architecture and/or non-completion of one calving-interval during the period of this study.

Table-12 : Zone-wise distribution of cows of different genetic groups in selected respondent units.

Particulars / Genetic group	Zones				Total
	I	II	III	IV	
No. of units selected	**47**	**19**	**23**	**15**	**104**
No. of cows studied					
Desi	95	50	61	23	229
HFX	52	13	11	09	85
JX	43	20	23	17	103
Sub Total (A)	**190**	**83**	**95**	**49**	**417**
Discarded Cows					
Desi	21	13	14	24	72
HFX	28	12	25	27	92
JX	24	19	18	22	83
Sub Total (B)	**73**	**44**	**57**	**73**	**247**
Total (A+B)					
Desi	116	63	75	47	301
HFX	80	25	36	36	177
JX	67	39	41	39	186
Grand Total	**263**	**127**	**152**	**122**	**664**

Collection of data :

Data were recorded from the cows of defined genetic groups and which also completed at least one calving-interval.

The information consisting of zone, herd size, herd constitution, farming system, genetic architecture, measures of production, reproduction and economic efficiencies were noted. The details are as below :

Information of the unit :

(a) Zonal location

(b) Herd-size

(c) Herd-constitution

(d) Farming system

Information on the cows :

(A) General

(a) Genetic architecture :

(i) Desi cows consisting of local and indigenous breeds of cows.

(ii) HF crossbred cows

(iii) Jersey crossbred cows

(b) Season of calving

(c) Lactation order

(B) Measures of production efficiency

(a) Lactation milk yield (kg)

(b) Lactation length (days)

(c) Peak yield (kg)

(d) Days to attain peak yield (days)

(e) Milk yield per day of lactation length (kg) (MY / day LL)

(f) Milk yield per day of calving interval (kg) (MY / day CI)

(C) Measures of Reproduction efficiency

(a) Dry period (days)

(b) Calving interval (days)

(D) Measure of economic efficiency

(a) Cost of milk production

The distribution of Desi, and crossbred cows with the details of herd size, herd constitution, season of calving, farming system and parity of lactation are depicted in table-13.

The selected respondent units were provided the schedule and questionnaires to record the information as per the objective of the present investigation. The selected respondent units were approached frequently for collection, monitoring and recording the data. Besides, the owners were also interviewed and information obtained from them was also included in this investigation.

Milk yield was recorded weekly upto the attainment of peak milk yield after which it was recorded fort-nightly.

The bi-weekly records during the lactation were averaged to find out the mean daily milk yield.

The lactation yield was obtained by multiplying the average daily milk yield with number of days the cow remained in milk. The directly observed economic traits like lactation length (LL), peak yield (PY), days to attain peak yield (DAPY), dry period (DP) and calving interval (CI) were recorded in the schedules.

Table - 13 : Distribution of cows of the selected units on the basis of genetic and various non-genetic factors in and around Madhepura (Bihar)

Genetic group	No. of animal	Total
Desi	229	417
HFX	85	
JX	103	
Non-Genetic group		
Zone		
I	190	417
II	83	
III	95	
IV	49	
Herd size		
3 - 4	249	417
5 - 7	97	
8 & above	71	
Herd constitution		
One group alone	65	417
D + HFX	94	
D + JX	120	
D + HFX + JX	138	
Lactation order		
1st	87	417
2nd	83	
3rd	125	
4th	78	
5th & above	44	
Season of Calving		
Winter	136	417
Summer	180	
Rainy	101	
Farming system		
Dairying alone	129	417
Agriculture + Dairying	288	

Cost of milk production :

The measure of cost of milk production of a cow was taken as the "net cost of maintenance of a cows for each kg of milk she produced in an inter-calving period". Thus, it was obtained as the ratio of average daily maintenance cost of a cow during an inter-calving period and average daily milk she produced during the inter-calving period i.e.

$$\text{Cost of per kg milk of a cow} = \frac{\text{Average maintenance cost (Rs. of cow during an inter-calving period (days)}}{\text{Value of average milk yield (Rs.)/per day of the inter-calving period (days)}}$$

The various expenditure items on maintenance of a cow were broadly categorized into

(a) Fixed cost items

(b) Variable cost items

(c) Miscellaneous cost items

(A) Fixed cost item :

(i) Depreciation on animals :

It was based on the market value of milch cows during the period of study. A general prediction formulae to estimate approximate market value of a lactating cow of Madhepura could be derived on the basis of exact purchase cost of 100 cows, their milk yield and lactation order at the time of purchase which is tabulated as below :

Table-14 : Prediction formula to estimate the approximate market value of lactating cows.

Lactation No.	Rate of calculating price (Rs.) cows
1	Milk yield (kg) x 1500.00
2	Milk yield (kg) x 1400.00
3	Milk yield (kg) x 1100.00
4	Milk yield (kg) x 900.00
5 & above	Milk yield (kg) x 600.00

Animals beyond 5th & above lactation were excluded from this study. A sum of Rs. 800.00 and Rs. 500.00 was added to the cost of a Friesian and Jersey crossbred cows respectively. Considering the productive life of a cow to be of five lactations, the depreciation was calculated @ 12% of the estimated cost per calving interval assuming that 40% of the cow's cost could be refundable even after completion of its fifth lactation as "salvage value". Per day depreciation value of a cow was obtained as the "ratio of 12% of the estimated cost of the cows and number of days in inter-calving period".

Depreciation on building / sheds :

Depreciation was based on categories of the houses built in and around Madhepura (Bihar). The following approximate rates were derived to estimate the cost of houses built up and utilized to run the Khatals in and around Madhepura (Bihar).

Table-15 : Cost of different types of housing.

Type of housing	Rate to build up per sft. covered area (Rs.)	Cost of troughs etc. (Rs.)	Total cost of housing / animal (Rs.)
Type A	30.00	100.00	1300.00
Type B	50.00	200.00	2200.00
Type C	90.00	500.00	4100.00
Type D	120.00	500.00	5300.00

The basic assumptions behind fixation of housing cost were to provide 40 sft. covered area to each cow. The construction cost of trough etc. varied according to the type of construction. The total life of (A) and (D) type houses were accounted to be 10 and 40 years respectively, whereas for (B) and (C) types it was 25 yrs. Depreciation on housing was estimated the ratio of "cost of housing per animal and the estimated life of that house in days". Depreciation per kg of milk produced by an animal was calculated as :

$$\text{Depreciation per kg of milk produced by an animal} = \frac{\text{Housing cost for an animal}}{\text{Estimated life of that house (in days) x A.V. daily milk produced by that animal for the}}$$

Depreciation on farm utensils, machineries, equipments and other assets except animals and housing :

The total cost of utensils, equipments, machineries and other assets of daily use such as chaff cutter, buckets, milk pots, electric motor etc. with each and every selected respondent unit was estimated. The depreciation was calculated @ 10% of the total cost per annum. The depreciation per kg of milk produced at the Khatals was reckoned as the ratio of "10 percent of the total cost of utensils, equipments, machineries etc. at a Khatal and 365 x

average milk yield (kg) / day of calving interval for that Khatal. It was done with the view that utensils, equipments, machineries etc. of a Khatal were equally used for every animal at that Khatal irrespective of its level of milk production. Therefore, this cost item was considered as fixed for every cow.

Interest on fixed capital :

Fixed capital included all the assets of a respondent unit including cost of animal, housing, utensils, machineries etc. in this study. The interest on the fixed capital was worked out @ 8% per annum.

Variable cost item :

(a) Cost of feeds and fodders : Average quantity of fodder fed per cow was obtained by dividing the total quantity of fodder supplied by the number of cows fed. The prevailing market rate including transportation cost was used as the purchase price for various green and dry fodders. For calculating the expenditure on concentrates, the rates of purchase of concentrate ration or its ingredient along with its transportation cost was taken into account. The seasonal variation in the market rates of different feed and fodders were also taken into account. Thus, the average daily expenditure for feed and fodders was worked out for each cow under investigation.

(b) Labour cost : The total labour cost of milk production was considered as the sum of paid (hired) and unpaid (family labourer). For family labourers the actual time spent daily on looking after the animals and other farm operations by each of the family members including women were recorded and apportioned for each animal. The wage of the hired labourer as well as family labourer was calculated @ Rs. 60=00/ day (8 hr.).

(c) Cost of A.I. and Veterinary aids : Cost of items for A.I. and veterinary aids included cost of medicines, vaccines, semen and other sanitary items as well as the remuneration paid to the veterinarians, inseminators etc. Since majority of the respondent units could not provide individual records of its expenditure on this cost item, the line of proposition of Tripathi et al. (1978) for veterinary and A.I. costs was utilized in this study.

(d) Miscellaneous cost item : The miscellaneous cost item consisted of electric and water tariff, the revenue of the land, cost of repair of building, utensils/machinery etc. as well as unforeseen minor contingent expenditures.

In the present study it was kept fixed @ Rs. 500.00/cow/calving interval. Finally, the cost on account of this component of expenditure was apportioned for each kg of milk produced by a cow as :

$$\text{Miscellaneous cost/kg milk} = \frac{500.00}{\text{Inter-calving period (days) of a cow x Average milk yield per day of calving interval of that cow.}}$$

Gross cost of maintenance :

The gross cost of maintenance of cow consisted of expenditure on all cost components viz. depreciation on animal, building/shed, equipment, machinery, farm utensils etc, interest on fixed capital, cost of feed and fodders, labour cost, cost of veterinary aids and A.I. as well as miscellaneous expenditures.

Income :

Farm yard manure (FYM) consisting of dung and other animal excreta and empty concentrate's bags were the only source of income other

than milk but it could not be possible to have precised record of income from individual cow on account of dung of FYM produced by Khatals. Therefore, assuming that an adult cow excretes on an average 20 kg wet dung (Reddy et al. 1972) and current market rate of wet dung in and around Madhepura (Bihar) being an average of Rs. 10/quintal, it was kept as a fixed income @ Rs. 2.00 per animal/day.

Net cost of maintenance :

If was obtained by deducting income from dung from the gross cost of maintenance. The net cost of maintenance per kg of milk produced per day of calving interval by particular cow was termed as "The cost of per kg milk production" for that cow.

Classification of data :

The data were classified on the basis of genetic group of the cows ,location of herd (Zones) , herd size, herd constitution , season of calving , lactation order and farming system for studying the effect of various genetic and non-genetic factors on the economic traits. The various factors affecting the traits under study were classified below :

(1) Genetic group :

The experimental units under study were classified under 3 genetic groups such as :

(i) Desi cows (ii) Friesian crossbred cows and (iii) Jersey crossbred cows.

(2) Location of herd (Zones) :

Zone I : Madhepura Block

Zone II : Singheshwar Block

Zone III : Ghailarh Block

Zone IV : Shankarpur Block

The details have been mentioned in "area of experimentation".

(3) Herd size :

Dairy units were classified into 3 groups of herd sizes :

(i) units having 3-4 cows.

(ii) units having 5-7 cows.

(iii) units having 8& above cows .

(4) Herd constitution :

The cows were grouped into four categories of herd constitution as mentioned below :

(i) one group alone

(ii) D +HFX

(iii) D + JX

(iv) D + HFX + JX

(5) Season of calving :

The year was classified into 3 as mentioned below :

(i) Winter : November - February

(ii) Summer : March - June

(iii) Rainy : July - October

(6) Lactation order :

Performance records of the cows were classified into five groups on the basis of sequences of lactation.

(i) 1st Parity

(ii) 2nd Parity

(iii) 3rd Parity

(iv) 4th parity

(v) 5th and above parity

(7) Farming system :

The dairy units were classified according to the system of farming adopted by the farmers which after mentioned as below:

(i) Only animal husbandry

(ii) Mixed farming (Animal husbandry integrated with agriculture).

Statistical Methods :

Statistical analysis of the data was done through computer in the Division of Livestock Economics and Statistics at Indian Veterinary Research Institute (IVRI), Izatnagar, Bareilly (UP).

Means and standard errors were calculated as per formulae given by Snedecor and Cochran (1967).

Stratified random sampling with proportional allocation :

Assuming that the population of size N is divided into K Strata (zones) of sizes N_1, N_2, N_3 .....N_k such that,

$$\sum_{i=1}^{K} N_i = N$$

Let sample of sizes $n_1, n_2, n_3 \ldots\ldots\ldots\ldots n_k$ be drown from these strata respectively so that,

$$\sum_{i=1}^{K} n_i = N$$

Let $n_i \ \alpha \ N_i$

Or $n_1 = C\, N_i$ .....(1)

Where,

C is the constant of proportionality.

After taking summation on both the sides, we get.

$$\sum_{i=1}^{K} n_i = C \sum_{i=1}^{K} n_i \neq n_i$$

Or, $n = C\, N$

Hence, $n/N = C$ (constant)

After substituting the value of C in the equation (1), we get :

$$n_i = \frac{(n)\, N_i}{(N)} \qquad (i = 1, 2, 3, \ldots\ldots\ldots\ldots, K)$$

Let Y_{ij} be the value of j^{th} unit in the i^{th} strata of population ($i = 1, 2, 3, \ldots\ldots\ldots\ldots, K$ and $j = 1, 2, 3, \ldots\ldots\ldots\ldots N_i$ and y_{ij} be the

corresponding sample observation (i = 1, 2, 3, ...K and j = 1, 2, 3, ...n_i), then population mean $\overline{Y}$ given by :

$$\overline{Y}_{ij} = 1/N \sum_{i=1}^{K} \sum_{i=1}^{N_i} \overline{y}_{ij}$$

$$= 1/N \sum_{i=1}^{K} N_i \overline{y}_i$$

Where,

$\overline{Y}_i = 1/N_i \sum_{j=1}^{N_i} \overline{y}_{ij}$, which is the mean of the i^{th} strata of the population.

The population variance

$$V(\overline{y}) = \sum_{i=1}^{N_i} \frac{(N_i)^2}{N} (1/n_i - 1/N_i) s_i^2$$

$$= \sum_{i=1}^{N_i} w_i^2 (1/n_i - 1/N_i) s_i^2$$

Where, $w_i = n_i/N$ and $s_i^2 = 1/(N_i-1) \sum_{j=1}^{N_i} (y_{ij} - \overline{Y}_i)^2$

Similarly, the sample mean can be defined as :

$$\overline{y}_i = 1/n_i \sum_{j=1}^{n_i} \overline{y}_i$$

Where,

$y_I = 1/k \sum_{i=1}^{K} y_{ij}$ i.e. the sample mean of the i^{th} strata and

$$V(\bar{y}) = \sum_{i=1}^{N_i} w_i^2 (1/n_i - 1/N_i) s_i^2$$

Since, $[E(S)^2 = S^2]$

$$s_i^2 = 1/n_i - 1 \sum_{j=1}^{n_i} (Y_{ij} - y_i)^2$$

Least squares analysis :

Data were subjected to least squares analysis (Harvey, 1966) to study the effect of genetic and various non-genetic factors on milk production efficiency traits. The following mathematical model was used :

$$Y_{ijklmnop} = \mu + G_i + HL_j + HS_k + HC_l + L_m + S_n + Z_o + e_{ijklmnop}$$

where,

$Y_{ijklmnop}$ = The value of p^{th} individual under i^{th} genetic group, j^{th} herd location, k^{th} herd size, l^{th} herd constitution, m^{th} lactation order, n^{th} season of calving and o^{th} farming system.

μ = Overall general mean

G_i = The effect of ith genetic group (i = 1, 2, 3)

HL_j = The effect of location of herd (j = 1, 2, 3, 4)

HS_k = The effect of herd size k = 1, 2, 3)

HC_l = The effect of herd constitution (l = 1, 2, 3, 4)

L_m = The effect of lactation order (m = 1, 2, 3, 4, 5)

S_n = The effect of season of calving (n = 1, 2, 3,)

Z_o = The effect of farming system (o = 1, 2)

$e_{ijklmnop}$= The random error which is distributed normally and independently with mean 0 and variance $\sigma^2 e$.

Duncan's Multiple Range (DMR) test as modified by Kramer, 1957 was used for pair-wise comparison of the least squares means at 5% level of probability.

Constraints in dairy farming :

The information on important technological and managemental problems perceived by the dairy farmers in maintaining the dairy units in and around Madhepura (Bihar) was noted. Garett's ranking technique was used to rank the problems. The order of merit, thus given by the respondents, were converted into ranks by using the following formulae (Garett & Woodworth, 1969).

$$\text{Percent position} = \frac{100\,(R_{ij} - 0.5)}{N_j}$$

Where R_{ij} = Rank given for i^{th} constraints by the j^{th} individual

N_j = Number of factors ranked by j^{th} individual.

The percent position of each rank was converted into scores by referring Garett's ranking table. The scores of individual respondents were added for each factor; the mean scores for all the factors were arranged in descending order. Lastly, the constraints were ranked on the basis of these scores.

CHAPTER - 4

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

LACTATION MILK YIELD (LMY) :

Least squares means of lactation milk yield in Desi, HFX and JX cows under genetic and various non-genetic factors have been depicted in table-17.

MEAN LACTATION YIELD :

The mean lactation milk yield (kg) of Desi, HFX and Jersey crossbred cows were found to be 1032.049±14.253, 2445.028±24.159 and 2036.113±22.857, respectively in this study table-17. These findings are observed to fall in the ranges of 693.2 kg (Parmar et al., 1986) to 1935.61 kg (Viz. et al., 1992) for Desi cows, 1933.2 kg (Parmar et al., 1986) to 3655.1 kg (Singh et al. 1986[a]) for Holstein Friesian crossbreds and 1256.8 kg (Thakur et al. 1999) to 2681.11 kg (Patel and Trivedi, 1989) for Jersey crossbred cows as mentioned in the literature and noted in (table-1). Variations in breeds of indigenous cows and levels of exotic inheritance for crossbreds along with mangemental and environmental differences might be attributed to variations in average lactation milk yield reported by various authors.

INFLUENCE OF GENETIC FACTORS :

As mentioned in table-16, least squares analysis of variance revealed significant ($P<0.01$) influence of genetic group on lactation milk yield. HF crossbred cows had the highest (2445.028 kg) lactation milk yield which was significantly ($P<0.05$) higher by 1412.979 kg and 408.915 kg than Desi and Jersey crossbred cows respectively. Besides, JX cows had also significantly ($P<0.05$) 1004.064 kg higher lactation milk yield than Desi

cows. The critical analysis of the lactation milk yielded by the cows of different genetic groups presented the fact that both HFX and JX cows had more than double LMY (kg) than those yielded by Desi cows. This reflected that both HFX and JX cows are well adapted in the agroclimatic region of Madhepura district of Bihar.

Table 16 : Least squares analysis of variance showing the effects of different genetic & non-genetic factors on Lactation milk yield (kg) and Lactation length (days).

Sources of variation	D.F.	Lactation milk yield (kg)		Lactation Length (days)	
		M.S.S	F	M.S.S	F
Zone	3	115462.1	3.700^{*}	1461.217	4.388005^{**}
Genetic group	2	65208860.0	2090.076^{**}	83268.49	250.0536^{**}
Herd size	2	40085.58	1.2848824^{NS}	306.8745	0.9215382^{NS}
Herd constitution	3	27384.98	0.877440^{NS}	975.0602	2.928087^{*}
Season of calving	2	31534.46	1.010743^{NS}	1487.923	4.468204^{*}
Lactation order	4	549549.0	17.61416^{**}	1295.503	3.890370^{**}
Farming system	1	3140668.0	100.6648^{**}	18977.36	56.98864^{**}
Error	399	31199.28	—	333.0025	—

* : **Significant (P<0.05)**
** : **Significant (P<0.01)**
NS : Non-significant

Raj Kumar (1985) also mentioned nearly double LMY in JX cows than Hariana cows.

Kumar (2005) reported the lactation milk yield of HFX and JX cows to be nearly 3 times more than Desi cows in and around Patna (Bihar). Besides, kumar (2006) also observed that both HFX and JX cows had more than double LMY than Desi cows in and around Biharsharif of Nalanda district (Bihar) under farmers' managemental condition. The findings of the present study also proved the superiority of HFX over JX cows with respect to LMY which might suggest more use of HFX than JX in and around Madehpura (Bihar).

Table 17 : Least squares means of Lactation milk yield (LMY) & Lactation length (LL) under different genetic and non-genetic factors.

Genetic and Non-genetic factors	Lactation milk yield (Kg) Mean ± SE	Lactation Length (days) Mean ± SE
Genetic factors		
Desi	$1032.049^{a} \pm 14.253$	$262.585^{a} \pm 1.473$
HF crossbred	$2445.028^{b} \pm 24.159$	$311.382^{b} \pm 2.496$
Jersey crossbred	$2036.113^{c} \pm 22.857$	$300.682^{c} \pm 2.361$
Non-genetic factors		
Location of herd (zones)		
I	$1799.410^{a} \pm 17.642$	$289.210^{a} \pm 1.823$
II	$1880.472^{b} \pm 23.160$	$295.805^{b} \pm 2.393$
III	$1835.141^{a} \pm 21.206$	$294.961^{b} \pm 2.191$
IV	$1835.896^{a} \pm 28.397$	$286.223^{a} \pm 2.934$
Herd size		
3 - 4	1857.887 ± 14.515	289.988 ± 1.500
5 - 7	1818.772 ± 21.968	290.361 ± 2.270
8 & above	1836.531 ± 28.300	294.299 ± 2.924
Herd constitution		
One group alone	1862.589 ± 26.261	$297.738^{a} \pm 2.713$
D + HFX	1819.846 ± 24.270	$289.826^{b} \pm 2.507$
D + JX	1823.324 ± 24.580	$290.594^{b} \pm 2.539$
D + HFX + JX	1845.161 ± 19.963	$288.041^{b} \pm 2.062$
Season of calving		
Winter	1854.959 ± 18.544	$293.141^{a} \pm 1.916$
Summer	1826.758 ± 18.117	$287.810^{b} \pm 1.872$
Rainy	1831.472 ± 21.054	$293.698^{a} \pm 2.175$
Lactation order		
1st	$1798.845^{a} \pm 22.269$	$289.367^{a} \pm 2.301$
2nd	$1819.893^{a} \pm 22.681$	$291.128^{a} \pm 2.343$
3rd	$1948.840^{b} \pm 19.211$	$297.405^{b} \pm 1.985$
4th	$1894.629^{c} \pm 22.813$	$293.066^{ab} \pm 2.357$
5th & above	$1726.442^{d} \pm 29.577$	$286.782^{a} \pm 3.056$
Farming system		
Dairying alone	$1739.246^{a} \pm 19.014$	$283.894^{a} \pm 1.964$
Agriculture + Dairying	$1936.214^{b} \pm 15.498$	$299.205^{b} \pm 1.601$

Trait-wise and column-wise means bearing different superscripts differ significantly (P<0.05).

Figure 1 : Lactation milk yield (kg) in HFX, JX and Desi cows.

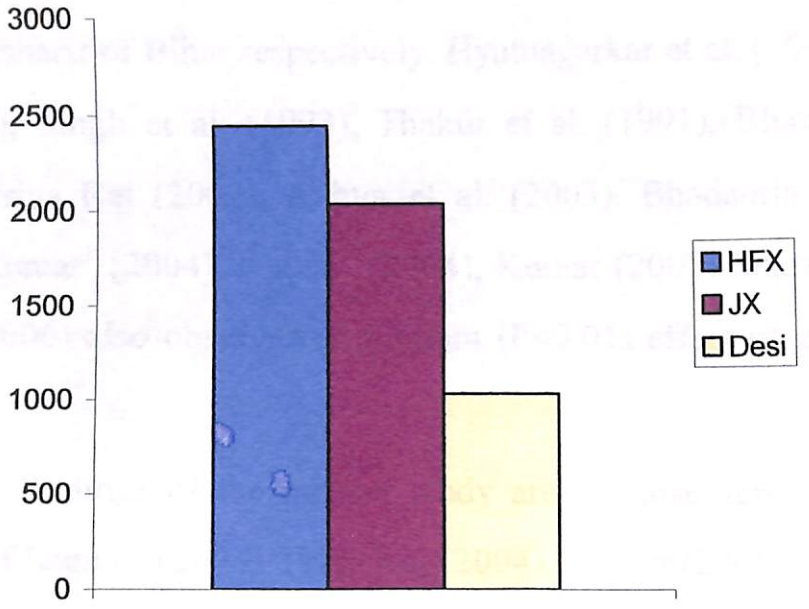
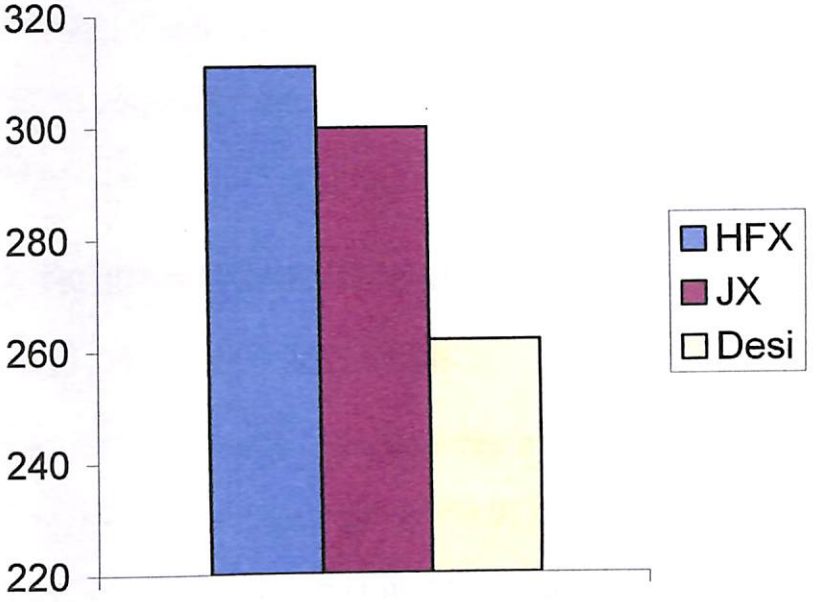


Figure 2 : Lactation length (days) in HFX, JX and Desi cows.



Kumar (2005) and Kumar (2006) also reported superiority of HFX over JX cows under farmers' managemental condition in and around Patna and Biharsharif of Bihar respectively. Hyatnagarkar et al. (1990), Jadhav et al. (1991), Singh et al. (1993), Thakur et al. (1991), Bhattcharya et al. (2002), Priya Raj (2002), Akhter et al. (2003), Bhadauria and Katpatal (2003), Kumar[1] (2004), Kumar[2] (2004), Kumar (2005) Sharan (2005) and Kumar (2006) also observed significant ($P<0.01$) effect of genetic groups on LMY.

The findings of the present study are in close agreement with the findings of Kumar[1] (2004), Priya Raj (2004), Kumar (2005), Sharan (2005) and Kumar (2006).

It is worth mentioning here that JX cows are also well adapted in Madhepura district as well as other districts of Bihar and yielded more than double LMY than Desi cows. During the questionnaires made from the farmers' of Madhepura district, many of them preferred JX cows over Holstein Friesian crossbred cows because of higher fat percentage in the milk of JX cows, more docile in nature and more use of Jersey crossbred male calves.

EFFECT OF NON-GENETIC FACTORS:

LOCATION OF HERD (ZONES):

As revealed through least squares of analysis of variance (table –16), different zones had significant ($P<0.05$) effect on lactation milk yield. Table-17 presented that zone-II had the highest (1880.472 kg) LMY, which was significantly ($P<0.01$) higher by 81.062 kg, 45.33 kg and 44.576 kg than LMY of zones I, III and IV respectively. The LMY of zone I, III & IV, however, did not differ significantly.

Hyatnagarkar et al. (1990), Jadhav et al. (1991), Kumar (2005) and Kumar (2006) also reported significant ($P<0.05$) effect of zones on LMY. The findings obtained in the present study are in conformity with the results obtained by the various authors mentioned above. However, Priya Raj (2002) and Kumar[1] (2004) reported non-significant effect of location of herd on LMY.

The reason for higher LMY might be attributed to better feeding and management of zone II cows in comparison to cows maintained in other zones.

HERD SIZE:

Least squares analysis of variance (table-16) revealed that the size of the herd did not influence LMY significantly. Priya Raj (2002) also observed non-significnat effect of herd size on LMY. However, Shrivastava et al. (1998), Kumar[1] (2004), Kumar (2005) and Kumar (2006) reported significant ($P<0.05$) effect of herd size on LMY.

HERD CONSTITUTION :

Herd constitution had no significant effect on lactation milk yield which is similar to the findings of Kumar (2004) and Kumar (2005). However, Kumar (2006), contrary to the finding of the present study, observed significant ($P<0.05$) effect of herd constitution on LMY.

SEASON OF CALVING :

Season of calving did not play significant role on LMY (table-16). However, winter season had the highest LMY followed by rainy and summer in this study. The findings of the present study are similar to the results obtained by Jadhav et al. (1991), Yadav and Rathi (1992), Singh et al. (1993), Raheja (1997), Thakur et al. (1999), Singh et al. (2000), Priya Raj (2002), Shiv Prasad (2003), Bhaduria and Katpatal (2003) and Kumar[2]

(2004). However, a few authors like Shettar and Govindaiah (1999), Akhter et al. (2003), Kumar[1] (2004) and Kumar (2006) observed significant ($P<0.05$) effect of the season of calving on LMY.

LACTATION ORDER :

Least squares analysis of variance presented significant ($P<0.01$) effect of lactation order (table-16) on LMY. The lactation order, observed in this study, presented a clear cut trend. The LMY increased with the increase of lactation order and attained the highest (1948.840 kg) in 3rd lactation and there after tended to decline gradually in subsequent lactations. The LMY increased by 21.048 kg in 2nd lactation from the 1st and also by 128.947 kg in 3rd lactation from 2nd after which the LMY declined in 4th and 5th & above lactations by 54.211 kg and 222.398 kg respectively from 3rd. Raj Kumar (1985), Priya Raj (2002), Shiv Prasad (2003) and Kulkarni et al. (2003) also reported significant ($P<0.01$) effect of lactation order on LMY. All the above authors also reported gradual increase in LMY with the advancement of lactation order which attained its maximum in 3rd sequence of lactation, a similar trend obtained in the present study. However, contrary to the finding of the present study, Kumar[2] (2004) and Kumar (2006) could not find significant effect of lactation order on LMY.

FARMING SYSTEM :

Least squares analysis of variance (table-16) presented significant ($P<0.01$) effect of farming system on LMY. Duncan's Multiple Range Test (DMRT) revealed that the cows maintained in the dairy units integrated with agriculture had significantly ($P<0.01$) 196.968 kg more LMY than those maintained in the units involving dairying alone in the private dairy units in and around Madhepura (Bihar). Kumar (2005) and Kumar (2006) also reported that the cows managed in the dairy units along with

agriculture farming had significantly (P<0.01) higher LMY than those units maintaining dairying alone.

However, Kumar[1] (2004) observed non-significant effect of farming system on LMY under farmers' managemental condition.

LACTATION LENGTH (LL) :

The least squares mean of LL (days) in Desi, HFX and JX cows were obtained as 262.585±1.473, 311.382±2.496 and 300.682±2.361 respectively (table-17). The ranges of LL (days) as reported in the literature varied from 268.82 days (Yadav and Rathi, 1992) to 385.3 days (Parmar et al., 1986) for indigenous cows, 247.87 days (Bhattacharya et al., 2002) to 432.87 (Parmar et al., 1986) for HFX and 306.08 days (Singh et al., 1993) to 472.69 days (Kumar[2], 2004) for JX cows. Except for Desi cows, the average LL days of HFX and JX cows fall in the ranges mentioned above. The average LL of desi cows obtained in this study was a little lower than mentioned in the literature. It is worth mentioning here that the above authors studied established indigenous breeds only whereas the present study was based on both local and established indigenous breeds. Besides, the finding of the present study is very close to the findings of Jadhav and Rathi (1992) for Desi cows, Singh et al. (1986[b]) for HFX and Deshmukh (1995) for JX cows.

EFFECT OF GENETIC GROUPS :

Least squares analysis of variance (table-16) presented significant (P<0.01) effect of genetic group on LL (days). DMRT revealed that HFX cows had significantly (P<0.05) 46.235 days and 10.70 days longer LL (days) than Desi and JX cows respectively. Besides, JX cows had also significantly (P<0.05) 38.097 days longer LL than Desi cows. Significant effect of genetic group on LL (days) have also been reported by Thakur et al. (1999), Priya Raj (2002), Kumar[2] (2004), Sharan (2005) and Kumar (2006) in different genetic groups of cows. However, contrary to the

finding of the present study, Raj Kumar (1985) in J x H (F_1), Singh et al. (1993) in Sahiwal and its crosses with Jersey and Red Dane, Shettar and Govndaiah (1999) in different levels of HF, J and Red Dane inheritance with indigenous cows and Kumar et al. (2007) in Desi, HFX and JX cows under farmers' managemental condition observed non-significant effect of genetic group on LL (days).

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Although there was significant ($P<0.05$) effect of zones on LL (days), yet the differences in LL days in various zones were found to be very small. The LL days ranged from 286.223 days in Zone-IV to 295.805 days in Zone-II. Jadhav et al. (1991) also reported significant ($P<0.01$) effect of location of farm on LL (days). However, Priya Raj (2002), Kumar[1] (2004), Kumar (2006) and Kumar et al. (2007) reported non-significant effect of zones on LL days in Desi and crossbred cows under farmers' managemental condition.

HERD SIZE :

Least squares analysis of variance (table-16) reflected non-significant effect of herd size on LL days. The LL days ranged from 289.988 days in the herd size of 3-4 to 294.299 days in 8 & above herd size. Priya Raj (2002) Kumar[1] (2004) and Kumar et al. (2007) also observed non-significant effect of herd size on LL (days) which are similar to the finding of the present study. However, Kumar (2006) reported significant ($P<0.05$) effect of herd size on LL (days).

HERD CONSTITUTION :

Least squares analysis of variance (table-16) presented significant ($P<0.05$) effect of herd constitution on LL days. The least squares means revealed the highest (297.738±2.713) LL days in 'one group alone' whereas

the lowest (288.041±2.062) LL (days) was observed to be in the group consisting of Desi, HFX and JX cows. Kumar et al. (2007) also reported significant ($P<0.05$) effect of herd constitution on LL (days). However, Kumar[1] (2004) and Kumar (2006) did not find any significant role of herd constitution on LL (days).

SEASON OF CALVING :

Season of calving played significant role ($P<0.05$) on Lactation length in Desi, HFX and JX cows under farmers' managemental condition in this study. Winter and rainy seasons of calving had significantly ($P<0.05$) 5.331 days and 5.888 days longer lactation lengths than summer calving. However, the average days of lactation of winter and rainy calvings did not differ significantly. Significant ($P<0.05$) effects of season of calving have also been reported by Jadhav et al. (1999), Priya Raj (2002), Kumar (2006) and Kumar et al. (2007) on LL days in Desi and crossbred cows. Priya Raj (2002) also reported longer LL days of winter calvers than summer which is in close agreement with the findings of the present study. However, Jadhav and Rathi (1992), Singh et al. (1993), Shettar and Govindaiah (1999), Thakur et al. (1999), Singh et al. (2000), Kumar[1] (2004), Kumar[2] (2004), Sharan (2005) and Kumar (2006) observed non-significant effect of season of calving on LL days in Desi and crossbred cows.

LACTATION ORDER :

Least squares analysis of variance (table-16) revealed significant ($P<0.01$) effect of lactation order on LL days. There was gradual increase in LL days from 1st to 3rd lactation after which it gradually declined in 4th and 5 & above lactations. The mean lactation length days increased by 1.761 days in 2nd lactation from 1st. However, this increase was non-significant. The mean LL days of 3rd lactation increased significantly ($P<0.05$) by 8.038

days and 6.277 days from 1st and 2nd sequences of lactation. The mean LL days of the 4th lactation decreased by 4.339 days from 3rd lactation whereas the mean LL days of 5th & above lactation decreased by 6.284 days from 4th lactation. Jadhav and Rathi (1992) in Hariana cows, Yadav et al. (1992) in Sahiwal cows, Singh and Nagarcenkar (1997) in sahiwal cows, Sethi et al. (2000) in Sahiwal cows, Singh et al. (2000) in different genetic groups of crossbred, Priya Raj (2002) in crossbred cows, Kumar[1] (2004) in different genetic groups of cows and Kumar (2006) in Desi, HFX and JX cows also observed significant effect of sequence of lactation on LL days. However, Kumar[2] (2004), Kumar (2005), Sharan (2005) and Kumar et al. (2007) found non-significant effect of lactation order on LL days in Desi and crossbred cows under farmers' managemental condition in Bihar.

FARMING SYSTEM :

Least squares analysis of variance (table-16) presented significant ($P<0.01$) effect of farming system on LL days in this study. The average lactation length days of the cows maintained in the dairy units integrated with agriculture farming was observed to be significantly ($P<0.01$) 15.311 days longer than those units maintaining in dairying alone. It is worth mentioning here that the average lactation milk yield of the cows maintained in agriculture integrated with dairying was significantly ($P<0.01$) 196.168 days higher than those maintained in dairying alone. Higher lactation milk yield and longer LL days in the cows maintained in dairy units integrated with agriculture might be attributed to the production of quality feeds and timely green fodders by the farmers for their dairy cows. Kumar (2006) and Kumar et al. (2007) also reported significant increase in LL days in the private dairy units integrated with agriculture than those maintained in dairying alone. The findings of above authors are

very similar to the findings obtained in the present study. However, Kumar[1] (2004) could not find significant effect of farming system on LL days.

PEAK YIELD :

Least squares means of peak yield (kg) in Desi, HFX and JX cows were obtained as 5.824±0.064, 11.296±0.108 and 9.846±0.102 respectively (table-19). Literature reveals the ranges of peak yield to be 4.21 (Kumar, 2005) to 9.22 kg (Yadav et al., 1992) for indigenous cows, 6.37 kg (Kumar[2] 2004) to 16.19 kg (Shiv Prasad, 2003) for HF crossbreds and 7.96 kg (Kumar, 2005) to 13.27 kg (Singh et al., 1993) for Jersey crossbred cows (table-3) in which the findings of the present study also fall. Variations in peak yield, as mentioned in the literature, might be attributed to the

Table 18 : Least squares analysis of variance showing the effects of different genetic & non-genetic factors on Peak yield and Days to attain peak yield (DAPY).

Sources of variation	D.F.	Peak yield (kg)		DAPY (days)	
		M.S.S	F	M.S.S	F
Zone	3	1.219273	1.951954^{NS}	12.28721	0.6695535^{NS}
Genetic group	2	1001.083	1602.650^{**}	1970.813	107.3933^{**}
Herd size	2	1.285902	2.058621^{NS}	18.91959	1.030965^{NS}
Herd constitution	3	2.527297	4.045989^{**}	75.62988	4.121217^{**}
Season of calving	2	0.8874456	1.420725^{NS}	45.64537	2.487303^{NS}
Lactation order	4	7.551007	12.08852^{**}	128.8637	7.022028^{**}
Farming system	1	26.17626	41.90598^{**}	1.910265	0.1040940^{NS}
Error	399	0.6246427	—	18.35135	—

** : **Significant (P<0.01)**
NS : **Non-significant**

differences in managemental and environmental factors, breeds of indigenous cow and exotic breeds used for cross breeding and also the levels of exotic inheritance of crossbreds.

Table 19 : Least squares means of Peak yield (PY) & Days to attain peak yield (DAPY) under various genetic and non-genetic factors.

Genetic and Non-genetic factors	Peak yield (kg) Mean ± SE	Days to attain Peak yield (DAPY) (days) Mean ± SE
Genetic factors		
Desi	5.824^{a} ±0.064	39.117^{a}±0.346
HF crossbred	11.296^{b} ±0.108	44.343^{b}±0.586
Jersey crossbred	9.846^{c} ±0.102	46.709^{c}±0.554
Non-genetic factors		
Location of herd (zones)		
I	8.865±0.079	43.265±0.428
II	9.106±0.104	42.924±0.562
III	8.922±0.095	43.821±0.514
IV	9.060±0.127	43.549±0.689
Herd size		
3 - 4	9.125±.065	43.379±0.352
5 - 7	8.920±.098	42.859±0.533
8 & above	8.920±.127	43.930±0.686
Herd constitution		
One group alone	8.957^{ab} ±.118	42.748^{a}±0.637
D + HFX	8.758^{a} ±.109	44.920^{b}±0.589
D + JX	9.039^{b} ±.110	42.961^{a}±0.596
D + HFX + JX	9.200^{b} ±.089	42.929^{a}±0.484
Season of calving		
Winter	9.077±.083	43.664±0.450
Summer	8.989±.081	42.735±0.439
Rainy	8.899±.094	43.771±0.511
Lactation order		
1^{st}	8.834^{ad} ±.100	42.317^{a}±0.540
2^{nd}	8.930^{b} ±.101	41.877^{a}±0.550
3^{rd}	9.399^{bc} ±.086	42.927^{a}±0.466
4^{th}	9.200^{c} ±.102	44.419^{b}±0.553
5^{th} & above	8.578^{d} ±.132	45.408^{b}±0.717
Farming system		
Dairying alone	8.704^{a} ±.085	43.467±0.461
Agriculture + Dairying	9.273^{b} ±.069	43.314±0.376

Trait-wise and column-wise means bearing different superscripts differ significantly (P<0.05).

Figure 3 : Peak yield (kg) in HFX, JX and Desi cows.

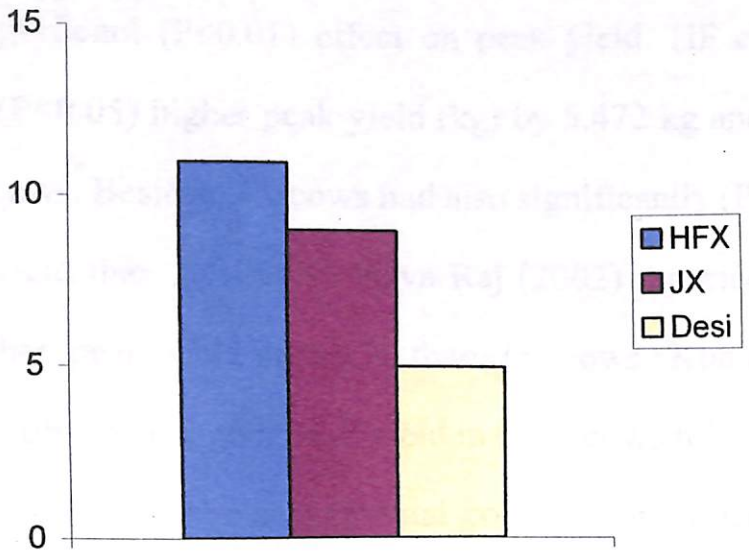
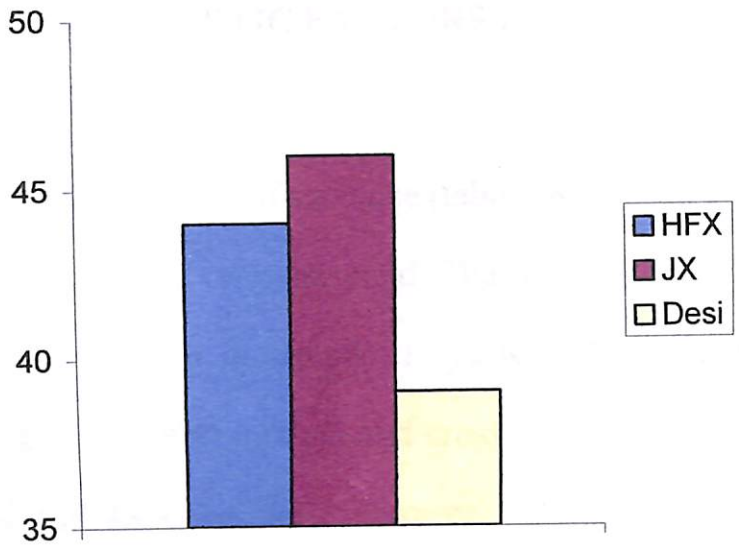


Figure 4 : Days to attain peak yield (days) in HFX, JX and Desi cows.



EFFECT OF GENETIC FACTORS :

As revealed by least squares analysis of variance (table-18), genetic group had significant ($P<0.01$) effect on peak yield. HF crossbreds had significantly ($P<0.05$) higher peak yield (kg) by 5.472 kg and 1.45 kg than Desi and JX cows. Besides, JX cows had also significantly ($P<0.05$) 4.02kg higher peak yield than Desi cows Priya Raj (2002) reported significantly ($P<0.01$) higher peak yield in HFX than JX cows. Kumar (2005) and Kumar (2006) observed higher peak yield in HFX cows followed by JX and Desi cows under farmers' managemental condition in Bihar which are in conformity with the findings of the present study. Significant effect of genetic groups on peak yield have also been reported by Dutt and Bushan (2001), Kumar[2] (2004) and Singh et al. (2004) which are similar to the findings of the present study.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Least squares analysis of variance (table-18) revealed non-significant effect of location of herd on peak yield. The peak yield varied from 8.865 kg in zone-I to 9.106 kg in zone-II. Priya Raj (2002) in HF and Jersey crossbreds, Kumar[1] (2004) in Desi and crossbred cows and Kumar (2005) in Desi, HFX and JX cows under farmers' managemental condition also reported non-significant influence of location of herd on peak yield which are in close agreement with the findings of the present study. It is worth mentioning here that the present study was under taken in a radius of 15 kms only in and around Madhepura which was divided into four zones and

therefore there might not be much variations in the agroclimatic conditions of the different zones under study. However, Jadhav et al. (1991) and Kumar (2006) reported significant effect of farms/zones on peak yield in cows.

HERD SIZE :

Table-18 revealed that herd size did not play any significant role on peak yield in cows. The peak yield ranged from 8.920 to 9.125 kg in this study. Priya Raj (2002) in HFX and JX cows, Kumar[1] (2004) in Desi and crossbred cows and Kumar (2005) in Desi, HFX and JX cows under farmers' managemental condition in Bihar also reported non-significant effect of herd size on peak yield which are in conformity with the findings of the present study. However, contrary to the findings of this study, Kumar (2006) reported significant ($P<0.01$) effect of herd size on peak yield.

HERD CONSTITUTION :

Least squares of analysis of variance (Table-18) revealed significant ($P<0.01$) effect of herd constitution on peak yield. The peak yield ranged from 8.758 kg in the herd constituting Desi and HFX cows to 9.20 kg in the herd constitution group consisting of Desi, HFX and JX cows. However, kumar[1] (2004), Kumar (2005) and Kumar (2006) could not find significant effect of herd constitution on peak yield in Desi HFX and JX cows maintained under farmers managemental condition in Bihar.

SEASON OF CALVING :

Least squares analysis of variance (Table-18) presented non-significant effect of season of calving on peak yield However, peak yield

was observed to be lowest (8.899 kg) in rainy calvers and highest (9.077 kg) in winter calvers. Singh et al. (1993) in Sahiwal and it crosses with Jersey and Red Dane, Singh et al. (2000) in crosses of Hariana with HF,BS and Jersey. Dutt and Bhusan (2001) in half breeds and three breeds grades of HF, BS with Hariana, Kumar[2] (2004) in Hariana and its crosses with HF and Jersey and Kumar (2005) in Desi. HFX and JX cows also reported non-significant effect of season of calving on peak yield which are in conformity with the findings of the present study. However, Jadhav et al. (1991) in HF x Sahiwal grades, Priya Raj (2002) in HFX and JX cows and Singh et al. (2004) in crosses of Hariana with Friesian, Brown swiss and Jersey observed significant ($P<0.05$) effect of season of calving on peak yield.

LACTATION ORDER :

Least squares analysis of variance (table-18) presented significant ($P<0.05$) effect of lactation order on peak yield. Peak yield was observed to be the lowest (8.834 kg) in Ist lactation and the highest (9.399kg) in 3rd lactation. The peak yield increased significantly ($P<0.05$) by 0.096 kg in 2nd lactation from Ist and by 0.469 kg in 3rd lactation from 2nd. It decreased by 0.199 kg in 4th lactations from 3rd and also by 0.622 kg in 5th & above lactations from 4th. The trend revealed that peak yield had gradual increasing tendency from 1st lactation which attained its maximum in 3rd lactation after which it tended to gradual decline in subsequent lactations. It is worth mentioning here that LMY (kg) and LL (days) also increased gradually upto 3rd lactation after which they tended to decline in subsequent lactations in this study, a similar trend obtained for peak yield in the present

investigation. Singh et al (2000) and Priya Raj (2002) also reported significant ($P<0.05$) effect of lactation order on PY in crossbred cows, a trend very similar to the trend obtained in the present study. However, Yadav et al. (1992), Bhattacharya et al. (1999), Kumar[2] (2004) and Kumar (2006) could not find significant effect of lactation order on peak yield.

FARMING SYSTEM :

As depicted in least squares analysis of variance (Table-18) farming system had significant ($P<0.01$) effect on peak yield. An appraisal of (Table-19) revealed that dairy units integrated with agriculture had significantly ($P<0.01$) 0.569 kg more peak yield than those maintaining dairying alone. It is worth mentioning here that dairy units integrated with agriculture had also significantly ($P<0.05$) higher lactation milk yield and lactation length than those maintaining dairying alone. This increase might be attributed to timely and quality cultivation of feed and green fodders by the farmers maintaining dairy units along with agriculture. Kumar (2005) and Kumar (2006) also reported higher peak yield in the dairy units integrated with agriculture than those practicing dairying alone in Desi, HFX and JX cows maintained under farmers' managemental condition in Bihar, which are in close agreement with the findings of the present study. However, Kumar[1] (2004) reported non-significant effect of farming system on peak yield.

DAYS TO ATTAIN PEAK YIELD (DAPY) :

Days to attain peak yield (DAPY) plays an important role in the economics of dairy enterprises. Earlier attainment of peak yield and its longer persistency are the desire of dairy farmers for economic gain.

AVERAGE DAPY :

Least squares means (table-19) of DAPY for Desi, HFX and JX cows were obtained on 39.117±0.346 days, 44.343±0.586 days and 46.709±0.554 days respectively. As reported in literature (table-4), the DAPY (days) ranged from 39.72 (Kumar[2], 2004) to 54.25 (Rathi, 1975) for HFX and 35.35 (Kumar[2], 2004) to 56.60 (Singh et al., 2004) for Jersey crossbred cows. The findings of the present study obtained for HFX and JX cows fall in the ranges mentioned above. However, the DAPY for Desi cows obtained in this study is a little lower than mentioned in the range which might be possibly due to the differences in the breeds of indigenous cows.

EFFECT OF GENETIC FACTORS :

Least squares analysis of variance (table-18) revealed significant ($P<0.01$) effect of genetic group on DAPY (days). An appraisal of (table-19) disclosed that Desi had the lowest DAPY (days) followed by HFX and JX cows. Desi had significantly ($P<0.05$) 5.226 days and 7.592 days lower DAPY than HFX and JX cows respectively. Besides, HFX had also significantly ($P<0.05$) 2.366 days lower DAPY than JX cows. Kumar[1] (2004) also reported that Desi cows had significantly ($P<0.01$) shorter DAPY (days) than HFX and JX cows under farmers' managemental condition in Bihar which is in close agreement with the findings of the present study.

Kumar[2] (2004), Kumar (2005) and Kumar (2006) reported significantly ($P<0.05$) lower DAPY in HFX cows than JX which are in conformity with the findings of the present study. However, Singh et al.

(1993) observed non-significant effect of genetic group on DAPY in Sahiwal and its crosses with Jersey and Red Dane.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Least squares analysis of variance as depicted in (table-18) revealed non-significant effect of location of herd on DAPY. The DAPY ranged from 42.924 days in Zone-II to 43.821 days in Zone-III. Kumar[1] (2004) also reported non-significant effect of location of herd on DAPY in private dairy units under farmers' managemental condition which is similar to the findings of the present study. It might be mentioned here that all the four zones under study were located in a radius of 15 Kms. in and around Madhepura having similar agroclimatic condition and also there might not have been differences in the managemental practices maintained in all the four zones. However, contrary to the findings of the present study, Kumar (2005) and Kumar (2006) reported non-significant effect of location of herd on DAPY.

HERD SIZE :

As depicted in (table-18), the size of the herd did not influence DAPY significantly. The DAPY ranged from 42.859 days in the herd size of 5-7 to 43.930 in 8 & above herd size. Kumar[1] (2004) in Desi and crossbred cows, Kumar (2005) in Desi, HFX and JX cows and also Kumar (2006) in Desi, HFX and JX cows maintained under farmers' managemental condition in different districts of Bihar reported non-significant effect of herd size on DAPY which are in conformity with the findings of the present study.

HERD CONSTITUTION :

Least squares analysis of variance (table-18) presented significant ($P<0.01$) effect of herd constitution on DAPY. Least squares means (table-19) revealed that Desi along with HFX had higher DAPY than all other herd constitution groups. Besides, the DAPY of all other groups did not differ significantly. Kumar (2006) also reported that Desi along with HFX herd constitution had significantly ($P<0.05$) higher DAPY than many other groups which is in conformity with the findings of the present study However, Kumar[1] (2004) observed non-significant effect of herd constitution on DAPY in Desi, HFX and JX cows under farmers' managemental condition which is contrary to the findings of the present study.

SEASON OF CALVING :

Least squares analysis of variance (table-18) revealed non-significant effect of season of calving on DAPY. The DAPY ranged from 42.735 days in summer calvers to 43.771 days in rainy. Singh et al. (1993) also reported non-significant effect of season of calving on DAPY which is in agreement with the findings of the present study. However, contrary to the findings of the present study, Singh et al. (2000), Kumar[1] (2004), Kumar (2005) and Kumar(2006) observed significant ($P<0.05$) effect of season of calving on DAPY.

LACTATION ORDER :

As depicted in table –18, least squares analysis of variance presented significant ($P<0.01$) effect of lactation order on DAPY. The DAPY decreased by 0.44 days in 2nd lactation from 1st. However, there were no

significant differences in the mean DAPY days from 1st to 3rd sequences of lactation. The mean DAPY (days) increased significant (P<0.05) by 1.492 days and 2.481 days in 4th and 5th & above lactations respectively from the 3rd lactation order. The findings had a clear trend that the average DAPY significantly (P<0.05) increased from 4th and onward lactations. Kumar(2005) also reported that DAPY (days) tended to increase after 3rd sequence of lactation in Desi, HFX and JX cows under farmers' managemental condition which is in close agreement with the findings of the present study. Kumar (2006) also reported significantly (P<0.05) lower DAPY in 3rd & 4th lactation (pooled together) in Desi and crossbreds cows under farmers' managemental condition. However, Kumar[2] (2004) could not find significant (P<0.05) effect of lactation order on DAPY in Hariana and its crosses with HF and Jersey. It is worth mentioning here that lactation milk yield (kg), lactation length (days) and peak yield (kg) had the highest value in the 3rd lactation in this study after which these values tended to decline. Increase in the attainment of DAPY (days) after 3rd lactation obtained in this study has the same trend as mentioned above and also suggestive of economy upto 3rd lactation in dairy enterprises.

FARMING SYSTEM :

The system of farming had no significant role on average DAPY under (table-18) in this study. However, the cows maintained in the dairy units along with agriculture had lower average DAPY than those maintaining dairying alone. Kumar[1] (2004), Kumar (2005) and Kumar (2006) in Desi, HFX and JX cows under farmers' managemental condition in different districts of Bihar also reported non-significant effect of farming

system on DAPY which are in conformity with the findings of the present study.

MILK YIELD PER DAY LACTATION LENGTH (MY/day LL) :

AVERAGE MY/day LL (Kg) :

The average MY/day LL (kg) of Desi, HFX and JX cows were observed to be 3.811±0.040, 7.617±0.068 and 6.691±0.064 respectively which fall in ranges of 2.64 kg (Sharan 2005) to 6.02 kg (Yadav et al. 1992) for Desi, 2.82 kg (Kumar[2] 2004) to 9.09 kg (Shrivastava et al. 2000) for HFX and 5.03 kg (Kumar[2] 2004) to 7.11 kg (Singh et al. 1993) for JX cows as reported in the literature. The variations in MY/day LL (kg) might be attributed to the difference in indigenous cows and exotic bulls used, the level of exotic inheritance for crossbreds and also managemental and environmental variations.

EFFECT OF GENETIC FACTORS.:

Least squares analysis of variance (table-20) presented significant ($P<0.01$) effect of genetic group on MY/day LL. As depicted in (table-21) least squares means presented the highest MY/day LL (kg) to be in HF crossbred cows which was significantly ($P<0.05$) higher by 3.807 kg and 0.926 kg than Desi and Jersey crossbred cows respectively. Besides, JX cows had also significantly ($P<0.05$) 2.881 kg higher milk yield than Desi cows. An appraisal of least squares means, as depicted in table-21, revealed that HF crossbreds had more than double and Jersey crossbreds had nearly double MY/day LL than Desi cows. It is worth mentioning here that the

lactation milk yield of HFX and JX cows were also observed to be more than double and nearly double than Desi cows respectively in this study.

Table 20 : Least squares analysis of variance showing the effects of different genetic & non-genetic factors on Milk yield per day lactation length (MY/day LL) and Calving interval (CI).

Sources of variation	D.F.	Milk yield per day lactation length (kg)		Calving interval (days)	
		M.S.S	F	M.S.S	F
Zone	3	0.3287725	1.326636^{NS}	1776.375	4.364800^{**}
Genetic group	2	494.4113	1995.009^{**}	16112.02	39.58947^{**}
Herd size	2	0.8726552	3.521268^{*}	696.8740	1.712316^{NS}
Herd constitution	3	0.3446832	1.390838^{NS}	1760.117	4.324851^{**}
Season of calving	2	0.2499063	1.008402^{NS}	748.9166	1.840192^{NS}
Lactation order	4	3.538811	14.27952^{**}	1388.862	3.412627^{**}
Farming system	1	15.01540	60.58893^{**}	447.4365	1.099414^{NS}
Error	399	0.2478241	—	406.9774	—

*** : Significant (P<0.05)**
**** : Significant (P<0.01)**
NS : Non-significant

Besides, HFX had also significantly (P<0.05) higher MY/day LL than JX cows. Significant effects of genetic group on MY/day LL have also been reported by (Hyatnagarkar et al. 1990); Jadhav et al., 1991; Singh et al., 1993; Thakur et al. 1999 ; Shrivastava and Singh (2000); Singh et al., 2000; Bhattacharya et al. 2002; Priya Raj 2002; Akhter et al. 2003; Kumar[1] 2004; Kumar[2] 2004 ; Kumar 2005; Sharan 2005 and Kumar 2006 which are in close agreement with the findings of the present study. The superiority of HF crossbreds over Jersey crossbreds with respect to MY/day LL have also been reported by Priya Raj (2002), Akhter et al. (2003), Kumar (2005) and Kumar (2006) which are in conformity with the findings of the present study. Kumar (2005) and Kumar (2006) also reported MY/day LL (kg) of

Table 21 : Least squares means of Milk yield per day of lactation length (MY/day LL) and Calving interval (CI) under various genetic and non-genetic factors.

Genetic and Non-genetic factors	MY /day LL (kg) Mean ± SE	Calving interval (days) Mean ± SE
Genetic factors		
Desi	$3.811^{a} \pm 0.040$	$474.981^{a} \pm 1.628$
HF crossbred	$7.617^{b} \pm 0.068$	$428.609^{b} \pm 2.759$
Jersey crossbred	$6.691^{c} \pm 0.064$	$418.374^{c} \pm 2.611$
Non-genetic factors		
Location of herd (zones)		
I	5.961±0.050	$413.423^{a} \pm 2.015$
II	6.056±0.065	$421.719^{b} \pm 2.645$
III	6.029±0.060	$420.667^{bc} \pm 2.422$
IV	6.113±0.080	$413.477^{ac} \pm 3.243$
Herd size		
3 - 4	$6.156^{a} \pm 0.041$	419.235±1.658
5 - 7	$6.001^{b} \pm 0.062$	414.276±2.509
8 & above	$5.961^{b} \pm 0.080$	418.453±3.232
Herd constitution		
One group alone	6.023±0.074	$424.991^{a} \pm 2.999$
D + HFX	6.021±0.068	$416.905^{b} \pm 2.772$
D + JX	5.970±0.069	$413.095^{b} \pm 2.807$
D + HFX + JX	6.144±0.056	$414.294^{b} \pm 2.280$
Season of calving		
Winter	6.080±0.052	418.552±2.118
Summer	6.052±0.051	414.674±2.069
Rainy	5.986±0.059	418.738±2.405
Lactation order		
1^{st}	$5.896^{ac} \pm 0.063$	$413.961^{ac} \pm 2.543$
2^{nd}	$6.035^{a} \pm 0.064$	$411.538^{a} \pm 2.591$
3^{rd}	$6.306^{b} \pm 0.054$	$419.699^{bc} \pm 2.194$
4^{th}	$6.197^{b} \pm 0.064$	$419.147^{bc} \pm 2.606$
5^{th} & above	$5.764^{c} \pm 0.083$	$422.261^{b} \pm 3.378$
Farming system		
Dairying alone	$5.824^{a} \pm 0.054$	416.146±2.172
Agriculture + Dairying	$6.255^{b} \pm 0.044$	418.497±1.770

Trait-wise and column-wise means bearing different superscripts differ significantly (P<0.05).

Figure 5 : MY / day LL (kg) in HFX, JX and Desi cows.

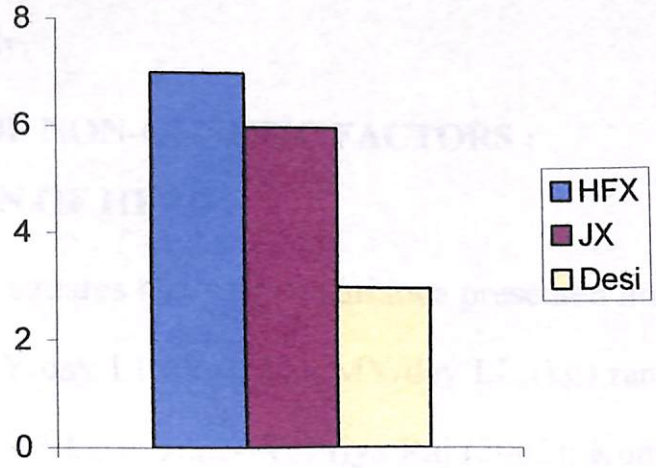
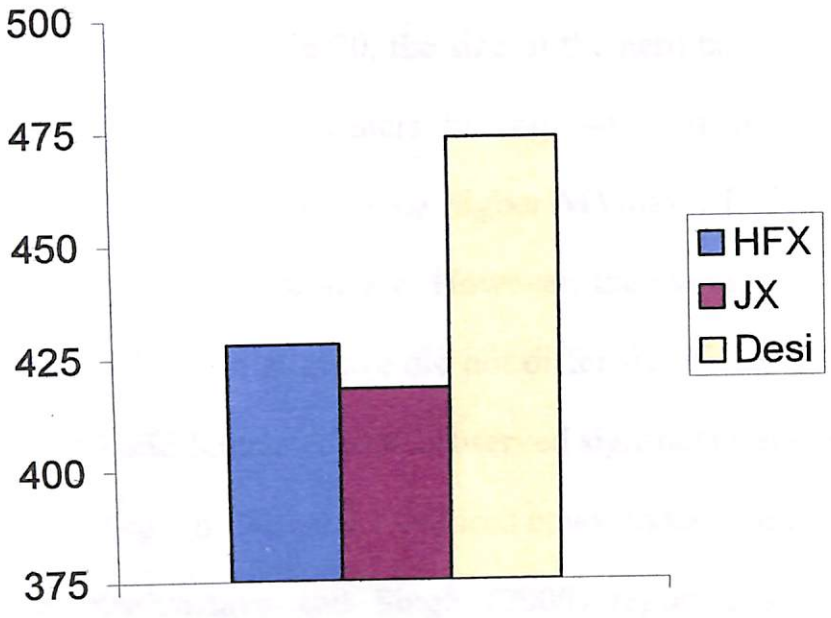


Figure 6 : Calving interval (days) in HFX, JX and Desi cows.



HFX and JX cows to be more than double and nearly double than Desi cows respectively which are in close agreement with the findings of the present study.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Least squares analysis of variance presented non-significant effect of zones on MY/day LL (kg). The MY/day LL (kg) ranged from 5.961 kg in zone-I to 6.113 kg in zone-IV. Priya Raj (2002); Kumar[1](2004) and Kumar (2006) also did not find significant effect of zones on MY/day LL which are similar to the findings of the present study. However, Shrivastava and Singh (2000) and Kumar (2005) observed significant effect of location of herd on MY/day LL under farmers' managemental condition.

HERD SIZE :

As depicted in table-20, the size of the herd had significant ($P<0.05$) effect on MY/day LL. Farmers having 3-4 herd size had significantly ($P<0.05$) 0.155 kg and 0.195 kg higher MY/day LL than those having a herd size of 5-7 and 8 & above. However, the average MY/day LL of the herd size of 5-7 and 8 & above did not differ significantly. Shrivastava and Singh (2000) and Kumar[1] (2004) observed significant effect of herd size on MY/day LL (kg) in Desi and crossbred cows under farmers' managemental condition. Shrivastava and Singh (2000) reported significantly higher MY/day LL of the herd size upto 5 than 6 & above herd size groups which is in close agreement with the findings of the present study. However, Priya Raj (2002), Kumar (2005) and Kumar (2006) reported non-significant

effect of herd size in Desi and crossbred cows under farmers' managemental condition.

HERD CONSTITUTION :

As depicted in table-20, the herd constitution did not effect MY/day LL significantly. The MY/day LL ranged from 5.970 kg in the herd consisting of Desi and Jersey crossbred cows to 6.144 kg in the herd having Desi, HFX and JX cows. Kumar[1] (2004), Kumar (2005) and Kumar (2006) also reported non-significant effect of herd constitution on MY/day LL (kg) in Desi, HFX and JX cows under farmers' managemental condition which are in conformity with the findings of the present study.

SEASON OF CALVING :

Least squares analysis of variance (table-20) presented non-significant effect of season of calving on MY/day LL (kg). The MY/day LL (kg) ranged from 5.986 kg in rainy calvers to 6.080 kg in winter calvers. Yadav and Rathi (1992), Yadav et al. (1992), Singh et al. (1993), Thakur et al. (1999), Shrivastava and Singh (2000), Priya Raj (2002), Akhter et al. (2003), Kumar[2] (2004), Kumar (2005) and Kumar (2006) also observed non-significant effect of season of calving on MY/day LL (kg) which are in conformity with the findings of the present study. However, Kumar[1] (2004) observed that season of calving significantly ($P<0.01$) influenced MY/day LL (kg) in Desi and crossbred cows.

LACTATION ORDER :

The sequence of lactation had significant ($P<0.01$) effect on MY/day LL in Desi, HFX and JX cows (table-20). The MY/day LL increased by 0.139 kg in 2nd lactation from 1st. However, there was no significant difference between average MY/day LL of 1st and 2nd sequences of

lactations. The MY/day LL (kg) of 3rd lactation significantly (P<0.05) increased by 0.271 kg from 2nd lactation. The MY/day LL (kg) of 4th lactation decreased by 0.109 kg from 3rd lactation. However, the differences in the average MY/day LL of 3rd and 4th lactations did not differ significantly. The MY/day LL (kg) of 5th & above lactations decreased significantly (P<0.05) by 0.542 kg and 0.443 kg from 3rd and 4th sequences of lactations respectively. The trend revealed that there was significant (P<0.05) increase in MY/day LL (kg) from 2nd lactation to 4th which significantly (P<0.05) tended to decline from 5th & above sequences of lactations. Shrivastava and Singh (2000), Singh et al. (2000), Priya Raj (2002) and Kumar[1] (2004) reported significant (P<0.05) increase in the average MY/day LL upto 3-4 lactations after which it tended to decline, the trend of which is similar to the trend obtained in this study. However, Kumar[2] (2004) and Kumar (2006) reported non-significant effect of sequence of lactation in Desi, HFX and JX cows under farmers' managemental condition in different districts of Bihar.

FARMING SYSTEM :

As depicted in (table-20) least squares analysis of variance revealed significant (P<0.01) effect of farming system on MY/day LL (kg). The average MY/day LL (kg) in the dairy units integrated with agriculture had significantly (P<0.01) 0.431 kg higher value than those having dairying alone. Kumar (2005) also reported higher MY/day LL (kg) in the cows maintained in dairy units integrated with agriculture than those units maintaining dairying alone which is in conformity with the findings of the present study. However, Kumar[1] (2004) and Kumar (2006) reported non-significant effect of farming system on MY/day LL. It may be pointed out here that average lactation milk yield and lactation length of the cows

maintained in the dairy units integrated with agriculture were also higher than those units maintaining dairying alone. The increase in MY/day LL (kg) of the cows maintained in dairy units integrated with agriculture might be attributed to the quality and timely green fodder production by the farmers for their cows.

CALVING INTERVAL (CI) :

Calving interval plays an important role in the economics of dairy enterprises as it is one of the important economic indicators. Apart from these, it also reflects on healthy reproductive status of the cows.

AVERAGE CALVING INTERVAL :

The average calving interval (days) of Desi, HFX and JX cows were obtained as 474.98±1.628, 428.609±2.759 and 418.374±2.611 respectively. As reported in the literature, the ranges of average CI days were found to be 416.57 (Yadav and Rathi 1992) to 570.70 (Sharan 2005) for indigenous cows. 378.7 (Akhter et al. 2003) to 538.97 (Sharan 2005) for HFX and 396.87 (Akhter et al. 2003) to 451.70 (Chaudhari et al. 1995) for JX cows in which the findings of the present study also fall. Variations in nutritional, managemental, environmental, reproductive status and genetic architecture of the cows might be attributed to differences in calving interval.

EFFECT OF GENETIC FACTORS :

Least squares analysis of variance (table-20) presented significant ($P<0.01$) effect of genetic group on calving interval. An appraisal of the least squares means, depicted in table-21, revealed the lowest calving interval days in Jersey crossbreds cows followed by HF crossbred cows and Desi. It was observed that Jersey crossbred cows had significantly ($P<0.05$) 10.235 days and 56.607 days less CI than HFX and Desi cows respectively.

Besides, HFX had also significantly (P<0.05) 46.372 days lower calving interval than Desi cows. The findings of the present study clearly indicated the superiority of Jersey crossbred cows over HF crossbred cows with respect to this reproductive status. Apart from these both the crossbreds were observed to be superior to Desi cows. Jadhav et al. (1991) in various genetic grades of Holstein x Sahiwal inheritance, Singh et al. (2000) in crossbreds of HF, BS and Jersey with Hariana cows, Priya Raj (2002) in HFX and JX cows, Kumar (2005) in Desi, HFX and JX cows, Sharan (2005) in crosses of HF with Hariana and Kumar (2006) in Desi, HFX and JX cows also reported significant (P<0.05) effect of genetic groups on CI days which are in agreement with findings of the present study. However, Akhter et al. (2003) observed the effect of various genetic grades of crossbred cows on CI to be non-significant.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Least squares analysis of variance (table-20) revealed significant (P<0.01) effect of location of herd on CI days. The CI days ranged from 413.423 days in zone-I to 421.719 days in zone-II. However, the average CI days of zones-I and IV, zones-II and III and zones-III and IV did not differ significantly. Jadhav et al. (1991) in various HF and Sahiwal grades of 1st lactation and Kumar (2006) in Desi, HFX and JX cows in private dairy units under farmers' managemental condition also reported significant (P<0.05) effect of location of farm/herd which are in conformity with the findings of the present study. However, Priya Raj (2002), Kumar[1] (2004) and kumar (2005) in Desi and crossbred cows maintained in the private dairy units under farmers' managemental condition could not find significant role of location of herd on calving interval. Variations in

nutritional managemental and reproductive status of the cows might be attributed to the differences in CI days of the cows maintained in different zones.

HERD SIZE :

As depicted in table-20, least squares means presented non-significant effect of herd size on calving interval. The calving interval ranged from 414.276 days in herd size of 5-7 to 419.235 days in 3-4 herd size. Priya Raj (2002) in HFX and JX cows, Kumar[1] (2004) in Desi and crossbred cows and Kumar (2005) in Desi, HFX and JX cows under farmers' managemental condition reported non-significant effect of herd size on calving interval days which are in conformity with the findings of the present study. However, contrary to the findings of the present study, Kumar (2006) observed significant ($P<0.01$) effect of herd size on calving interval days.

HERD CONSTITUTION :

Least squares analysis of variance (table-20) presented significant ($P<0.01$) effect of herd constitution on CI days. The average CI days of Desi along with HFX, Desi along with JX and Desi along with HFX and JX cows were observed to be significantly ($P<0.05$) lower by 2.423, 5.798 and 5.186 days than when considered 'only one group alone' respectively. However, all the groups of herd constitution other than 'one group alone' did not differ significantly with respect to calving interval days. Kumar (2006) also reported significant effect of herd constitution on CI in Desi, HFX and JX cows maintained under farmers' managemental condition which is in conformity with the findings of the present study. However, Kumar[1] (2004) and Kumar (2005), contrary to the findings of the present study, reported non-significant effect of herd constitution on CI days.

SEASON OF CALVING :

As mentioned in table-20, season of calving did not play significant role on calving interval days. The CI days ranged from 414.674 in the cows calved during summer to 418.738 in rainy calvers. Yadav et al. (1992), Yadav and Rathi (1992), Singh et al. (2000) and Priya Raj (2002) observed non-significant effect of season of calving on calving interval days which are in agreement with the findings of the present study. However, Jadhav et al. (1991), Kumar (2005) and Kumar (2006) observed significant ($P<0.05$) effect of season of calving on calving interval days.

LACTATION ORDER :

As depicted in table-20, lactation order played significant ($P<0.01$) effect on calving interval days. The calving interval decreased by 2.423 days in 2nd lactation from 1st. However, the differences between mean calving interval days of 1st and 2nd lactations did not differ significantly. After 2nd lactation the calving interval days significantly ($P<0.05$) increased. The average CI days of 3rd, 4th and 5th & above lactations were observed to be significantly ($P<0.05$) higher by 8.161 days, 7.609 days and 10.723 days from 2nd lactation. However, the mean CI days of 3rd, 4th and 5 & above lactations did not differ significantly. Significant effect of lactation order on CI days have also been reported by Yadav et al. (1992), Yadav and Rathi (1992), Singh et al. (2000), Priya Raj (2002), Kumar[1] (2004), Kumar (2005) and Kumar (2006) in Desi and crossbred cows under farmers' managemental condition.

It may be mentioned here that Priya Raj (2002), Kumar[1] (2004) and Kumar (2005) also could not find any definite trend, with respect to the effect of sequence of lactation on CI days. However, Sharan (2005)

reported non-significant effect of parity of lactation in Hariana and its crosses with HF.

FARMING SYSTEM :

Least squares analysis of variance (table-20) presented non-significant effect of farming system on CI days. Kuamr[1] (2004) also reported non-significant effect of farming system on CI days in Desi, HFX and JX cows under farmers' managemental condition which is in conformity with the findings of the present study. However, Kumar (2005) and Kumar (2006) observed significant ($P<0.01$) effect of farming system on calving interval days in Desi, HFX and JX cows under farmers' managemental conditions.

MILK YIELD PER DAY OF CALVING INTERVAL (MY/day CI) :

AVERAGE MY/DAY CI :

MY/day CI is considered to be one of the most economic criteria for milk production efficiency. The average MY/day CI of Desi, HFX and JX cows were observed to be 2.525±0.032 kg, 5.725±0.054 kg and 4.866±0.051 kg respectively (table-23) which fall in the ranges of 1.65 kg (Sharan, 2005) to 4.94 kg (Viz et al., 1992) for Desi cows, 2.95 kg (Sharan, 2005) to 9.4 kg (Singh et al; 1986) for HF crossbred cows, 4.53 kg (Hyatnagarkar et al; 1990) to 6.52 kg (Akhter et al; 2003) for Jersey crossbred cows. Variations in MY/day CI in different genetic groups might be attributed to the differences in breeds of indigenous cows and exotic bulls, levels of exotic inheritance for crossbreds and managemental and environmental factors.

Table 22 : Least squares analysis of variance showing the effects of different genetic & non-genetic factors on Milk yield per day Calving interval (MY/day CI) and Dry period (DP).

Sources of variation	D.F.	MY / day CI (kg)		DP (days)	
		M.S.S	F	M.S.S	F
Zone	3	0.4615624	3.013716^{*}	17.66976	0.2475938^{NS}
Genetic group	2	341.1032	2227.193^{**}	31528.72	441.7896^{**}
Herd size	2	0.01466407	0.09574732^{NS}	112.0992	1.570767^{NS}
Herd constitution	3	0.1625427	1.061303^{NS}	71.01381	0.9950662^{NS}
Season of calving	2	0.05181254	0.3383038^{NS}	67.13277	0.9406839^{NS}
Lactation order	4	2.535997	16.55849^{**}	1278.202	17.91054^{**}
Farming system	1	14.19762	92.70167^{**}	10059.15	140.9518^{**}
Error	399	0.1531539	—	71.36591	—

* : **Significant (P<0.05)**
** : **Significant (P<0.01)**
NS : Non-significant

EFFECT OF GENETIC FACTORS :

As depicted in table-22, least squares analysis of variance revealed significant (P<0.01) effect of genetic factor on MY/day CI. An appraisal of least squares means (table-23) revealed that HF crossbreds had highest MY/day CI which was significantly (P<0.05) higher by 3.2 kg and 0.859 kg than Desi and Jersey crossbred cows respectively. Besides, Jersey crossbred cows had also significantly (P<0.05) 2.341 kg higher MY/day CI than Desi cows. A critical analysis of least squares means (table-23) revealed that HF crossbred cows had more than double and Jersey crossbreds had also nearly double MY/day CI than Desi cows. It is worth mentioning here that HF crossbred cows had also more than double LMY (kg) and LMY/day LL (kg) in the present investigation. Besides, Jersey crossbred cows had also nearly double LMY (kg) and LMY/day LL (kg) obtained in this study.

Table 23 : Least squares means of milk yield per day of Calving interval (MY/day CI) and Dry period (DP) under various genetic and non-genetic factors.

Genetic and Non-genetic factors	MY /dayCI (kg) Mean ± SE	Dry Period (days) Mean ± SE
Genetic factors		
Desi	2.525^{a}±0.032	143.289^{a}±0.682
HF crossbred	5.725^{b}±0.054	115.084^{b}±1.155
Jersey crossbred	4.866^{c}±0.051	117.868^{b}±1.093
Non-genetic factors		
Location of herd (zones)		
I	4.309^{a}±0.039	125.633±0.844
II	4.463^{b}±0.051	125.783±1.108
III	4.327^{a}±0.047	124.793±1.014
IV	4.389^{ab}±0.063	125.446±1.358
Herd size		
3 - 4	4.384±0.032	126.650±0.694
5 - 7	4.379±0.049	124.668±1.051
8 & above	4.353±0.063	124.924±1.353
Herd constitution		
One group alone	4.355±0.058	126.299±1.256
D + HFX	4.315±0.054	125.040±1.161
D + JX	4.417±0.054	124.180±1.176
D + HFX + JX	4.401±0.044	126.138±0.955
Season of calving		
Winter	4.391±0.041	124.682±0.887
Summer	4.377±0.040	125.321±0.866
Rainy	4.348±0.047	126.239±1.007
Lactation order		
1^{st}	4.299^{a}±0.049	122.720^{a}±1.065
2^{nd}	4.366^{a}±0.050	122.205^{a}±1.085
3^{rd}	4.605^{bc}±0.043	122.166^{a}±0.919
4^{th}	4.493^{c}±0.051	125.793^{b}±1.091
5^{th} & above	4.096^{d}±0.066	134.186^{c}±1.415
Farming system		
Dairying alone	4.162^{a}±0.042	130.987^{a}±0.909
Agriculture + Dairying	4.581^{b}±0.034	119.840^{b}±0.741

Trait-wise and Column-wise means bearing different superscripts differ significantly (P<0.05).

Figure 7 : MY/day CI (kg) in HFX, JX and Desi cows.

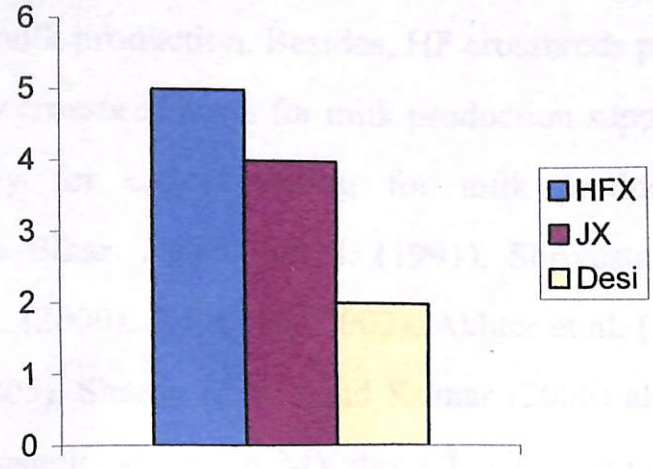
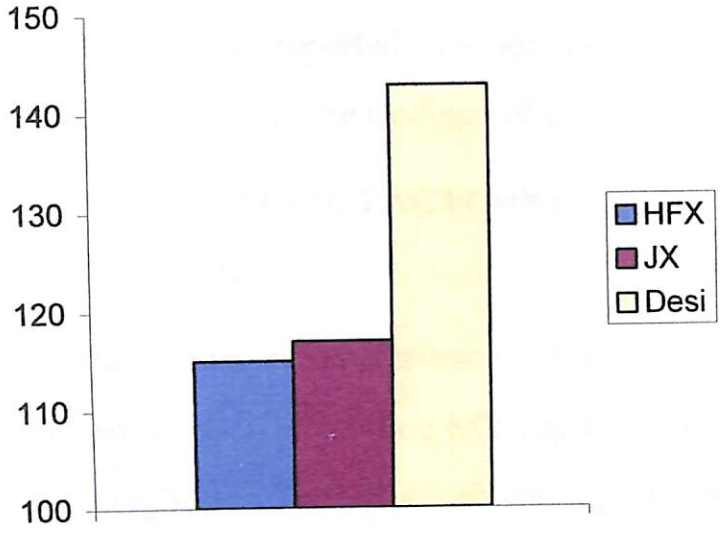


Figure 8 : Dry period (days) in HFX, JX and Desi cows.



These findings suggested that both HFX and JX cows are well adapted in the agroclimatic region of Madhepura district of Bihar with respect to milk production. Besides, HF crossbreds proved their superiority over Jersey crossbred cows for milk production supporting more use of HF than Jersey for cross-breeding for milk production in and around Madhepura Bihar. Jadhav et al. (1991), Shrivastava and Singh (2000), Singh et al. (2000), Priya Raj (2002), Akhter et al. (2003), Kumar[1] (2004), Kumar (2005), Sharan (2005) and Kumar (2006) also reported significant effect of genetic group on MY/day CI which are in agreement with the findings of the present study. Kuamr[1] (2004), Kumar (2005) and Kumar (2006) also found highest (nearly double) MY/day CI in HFX followed by JX cows under farmers' managemental condition in different districts of Bihar which proved superiority of HF crossbred cows over JX for milk yield. These findings are in close agreement with the results obtained in the present study. Besides, Hyatnagarkar et al. (1990), Singh et al. (2000) and Priya Raj (2002) have also reported superiority of HFX cows over JX cows which are in conformity with the findings of the present study.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Least squares analysis of variance (table-22), presented significant ($P<0.05$) effect of location of herd on MY/day CI. The average MY/day CI was found to be highest in Zone-II which was significantly ($P<0.05$) higher by 0.154 kg and 0.136 kg than Zones-I and III respectively. Significant effects of location of herd on MY/day CI have also been reported by Jadhav et al. (1991), Shrivastava and Singh (2000) and Kumar (2005) which are in conformity with the findings of the present investigation. The variations in MY/day CI might be attributed to differences in managemental practices

used in different zones. However, Priya Raj (2002), Kumar[1] (2004) and Kumar (2006) did not find significant effect of location of herd on MY/day CI in Desi, HFX and JX cows in different districts of Bihar under farmers' managemental condition.

HERD SIZE :

The size of the herd had no significant effect on MY/day CI (table-22). The MY/day CI ranged from 4.453 kg in the herd size of 8 & above to 4.384 kg in the herd size of 3-4. Priya Raj (2002), Kumar[1] (2004) and Kumar (2005) observed non-significant effect of herd size on MY/day CI in Desi, HFX and JX cows under farmers' managemental condition which are in conformity with the findings of the present study. However, contrary to the findings of the present study, Shrivastava and Singh (2000) and Kumar (2006) reported significant effect of herd size on MY/day CI.

HERD CONSTITUTION :

Least squares analysis of variance (table-22) presented non-significant effect of herd constitution on MY/day CI. The MY/day CI ranged from 4.315 kg in the herd consisting of Desi and HFX cows to 4.417 kg in the herd having Desi and Jersey crossbred cows. Kumar[1] (2004) and Kumar (2005) reported non-significant effect of herd constitution on MY/day CI in Desi, HFX and JX cows under farmers' managemental condition in different districts of Bihar which are in conformity with the findings of the present study. However, Kumar (2006) reported that the cows maintained in the herd size of 7 & above had significantly ($P<0.05$) higher MY/day CI than those maintained in the lower sizes.

SEASON OF CALVING :

As depicted in table-22, least squares analysis of variance presented non-significant effect of season of calving on MY/day CI. The average MY/day CI ranged from 4.348 kg in rainy calvers to 4.391 kg in winter calvers. Yadav et al. (1992), Yadav and Rathi (1992), Shrivastva and Singh (2000), Singh et al. (2000), Priya Raj (2002), Akhter et al. (2003) and Kumar (2005) observed non-significant effects of season of calving on MY/day CI which are in conformity with the findings of the present study. However, Jadhav et al. (1991), Kumar[1] (2004) and Kumar (2006) reported significant effect of season of calving on MY/day CI.

LACTATION ORDER :

As depicted in table-22, the sequence of lactation had significant ($P<0.01$) effect on MY/day CI. The MY/day CI increased by 0.067 kg in 2nd lactation from 1st and by 0.239 kg in 3rd lactation from 2nd. There after there was a gradual decline. The MY/day CI of 4th lactation decreased by 0.112 kg from 3rd and by 0.397 kg in 5th & above lactations from 4th sequence of lactation. The results obtained in this study presented a clear cut trend. The MY/day CI increased gradually upto 3rd sequence of lactation where it attained its maximum value after which it declined gradually. The similar trend was also obtained for LMY (kg), LL (days), peak yield (kg), and MY/day LL (kg) in this study. Vij et al. (1992), Yadav and Rathi (1992), Singh et al. (2000), Priya Raj (2002), Kumar[1] (2004), Kumar (2005) and Kumar (2006) observed significant effect of sequence of lactation on MY/day CI which are in close agreement with the findings of the present study. Priya Raj (2002), Kumar[1] (2004) and Kumar (2005) reported that MY/day CI increased gradually upto 3rd sequence of lactation

after which it tended to decline, the trend of which is similar to the trend obtained in this study.

FARMING SYSTEM :

A evident from least squares analysis of variance (table-22), the system of farming played significant (P<0.01) role on MY/day CI in the present study. The MY/day CI of the cows maintained in the dairy units integrated with agriculture farming had significantly (P<0.01) 0.491 kg higher MY/day CI than those units maintaining dairying alone. It may be pointed out here that the dairy units integrated with agriculture had also more LMY (kg), LL (days), Peak yield (kg) and MY/day LL than those maintaining dairying alone in this study which might be attributed to the timely and quality production of green fodders by the farmers for their cows.

DRY PERIOD :

Dry period is the number of days from the cessation of milk yield to the subsequent parturition for each lactation. It plays an important role in the economy of dairy enterprises. Shorter the dry period more economical is the milk production.

AVERAGE DRY PERIOD :

The least squares means of dry period (days) as depicted in table –23, were obtained as 143.289±0.682, 115.084±1.155 and 117.868±1.093 for Desi, HFX and JX cows respectively. Literature revealed ranges of dry period from 114.75 days (Vij et al. 1992) to 228.0 days (Pundir and Raheja 1997) for Desi cows, 72.82 days (Akhter et al. 2003) to 264.44 days (Kumar[2] 2004) for HFX and 70.44 days (Kumar 2005) to 166.8 days (Thakur et al. 1999) for JX cows in which the findings of the present study

also fall. Variations in managemental and environmental factors along with genetic architecture of the cows might be attributed to differences in the days of dry period.

EFFECT OF GENETIC FACTORS. :

Least squares analysis of variance (table-22) presented significant ($P<0.01$) effect of genetic group on dry period. HF crossbred and Jersey crossbred cows had significantly ($P<0.05$) 28.205 days and 25.421 days shorter dry periods than Desi cows. HFX cows had also 2.784 days shorter dry periods than JX cows. However, the average dry period days of HFX and JX cows did not differ significantly. Significant effect of genetic group on dry period days have also been reported by Thakur et al. (1999), Akhter et al. (2003), Kumar[1] (2004), Kumar[2] (2004), Kumar (2005) and Kumar (2006). Kumar (2005) and Kumar (2006) also observed longer dry period days in Desi cows than HFX and JX cows and also non-significant differences in the mean dry period days of HFX and JX cows under farmers' managemental condition, which are in closse agreement with the findings of the present study. Priya Raj (2002) also reported non-significant differences between average dry period of HFX and JX cows under farmers' managemental condition which is in conformity with the findings of the present study. However, Singh et al. (1993) could not find significant effect of genetic group on dry period days in Sahiwal and its crosses with Jersey and Red Dane.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Least squares analysis of variance (table-22) revealed non-significant effect of location of herd on dry period (days). The average dry period days ranged from 124.793 days in zone-III to 125.783 days in zone-II. Priya Raj

(2002), Kumar[1](2004) and Kumar (2005) observed non-significant effect of location of herd on dry period in private dairy units of different districts of Bihar under farmers' managemental condition which are in conformity with the findings of the present study. However, Kumar (2006) reported significant ($P<0.01$) effect of location of herd on dry period days in Desi, HFX and JX cows maintained in private dairy units which is contrary to the findings of the present study.

HERD SIZE :

As evident from least squares analysis of variance (table –22), herd size did not play significant role on dry period days. The average dry period days ranged from 124.688 days in the herd size of 5-7 to 126.650 days in 3-4 herd size. All the findings reported in the literature (Priya Raj, 2002; Kumar[1], 2004; Kumar, 2005 and Kumar, 2006) in Desi, HFX and JX cows under farmers' managemental condition revealed non-significant effect of herd size on dry period days which are in close agreement with the findings of the present study.

HERD CONSTITUTION :

Least squares analysis of variance (table-22) showed non-significant effect of herd constitution on dry period days. The least squares means of dry period days (table-23) varied from 124.180 in Desi along with JX cows to 126.299 days when 'one genetic group alone' was considered. Kumar[1] (2004), Kumar (2005) and Kumar (2006) also reported non-significant effect of herd constitution on dry period days in Desi, HFX and JX cows under farmers' managemetnal condition which are in conformity with the findings of the present study.

SEASON OF CALVING :

Least squares analysis of variance (table-22) presented non-significant effect of season of calving on dry period days. As evident from least squares means (table-23) dry period days ranged from 124.682 days in winter calvers to 126.239 days in rainy. Singh et al. (1993), Thakur et al. (1999), Priya Raj (2002), Kumar[1] (2004), Kumar[2] (2004) and Kumar (2005) observed non-significant effect of season of calving on dry period days which are in close agreement with the findings of the present study. Vij et al. (1992) and Kumar (2006) reported significantly ($P<0.05$) shorter dry period in winter clavers than other seasons. The trend obtained in the present study, although non-significant, is similar to the trend obtained by both the authors mentioned above.

LACTATION ORDER :

Least squares analysis of variance (table-22) presented significant effect of lactation order on dry period days. The dry period days of 2nd lactation decreased by 0.515 days from 1st and 0.039 days in 3rd lactations from 2nd. However, mean dry period (days) of 2nd and 3rd sequences of lactation did not differ significantly. The average dry period days of 4th lactation significantly ($P<0.05$) increased by 3.627 days from 3rd whereas the mean dry period days of 5th & above lactations significantly ($P<0.05$) increased by 8.393 days from 4th sequence of lactation. The findings of the present study revealed the trend that there was gradual decline in dry period days upto 3rd sequence of lactation after which it significantly increased. Vij et al. (1992), Priya Raj (2002) and Kumar (2006) also reported

significant (P<0.05) effect of sequence of lactation on dry period days. They further observed that dry period days had gradual decline upto 3rd lactation after which it tended to increase. The trend of the findings obtained in the present study is similar to the trend observed by the above authors. It may be pointed out here that the lactation milk yield, peak yield, MY/day LL and MY/day CI increased upto 3rd lactation after which they had a declining tendency. The similar trend has also been reflected for dry period in which DP days decreased upto 3rd lactation after which it tended to increase. However, Kumar[1] (2004), Kumar[2] (2004) and Kumar (2005) could not find significant effect of sequence of lactation on dry period days in Desi, HFX and JX cows under farmers' managemental condition.

FARMING SYSTEM :

The system of farming had significant (P<0.01) effect on dry period days (table-22). An appraisal of least squares means (table-23) revealed that the cows maintained in the dairy units integrated with agriculture had significantly (P<0.01) 11.147 days shorter dry period than those maintaining dairying alone. It is worth mentioning here that the LMY (kg), peak yield (kg), MY/day LL (kg) and MY/day CI (kg) were observed to be significantly (P<0.05) higher in the cows maintained in the dairy units integrated with agriculture than those maintained in the dairying alone is this study. The similar trend has also been obtained for this trait also. The decrease in dry period days in the cows maintained in the dairy units integrated with agriculture might be attributed to better managemental conditions in terms of providing green fodders to them. However, Kumar[1]

(2004) could not find significant effect of farming system on dry period days.

NET COST :

AVERAGE :

The average net cost per kg of milk production for Desi, HFX and JX cows were obtained as Rs. 10.051±0.032, 8.428±0.055 and 9.221±0.052 respectively. Kumar (2005) and Kumar (2006) reported the average net cost per kg of milk production in Desi cows to be Rs. 10.28 and Rs. 10.14 respectively under farmers' managemental condition in different districts of Bihar which are very close to the findings of the present study. Both the authors observed average net cost per kg of milk production for HFX to be

Table 24 : Least squares analysis of variance showing the effects of different genetic & non-genetic factors on Net cost of milk production (NCMP).

Sources of variation	D.F.	M.S.S	F
Zone	3	0.3031261	1.895935^{NS}
Genetic group	2	73.04388	456.8608^{**}
Herd size	2	0.9241359	5.780107^{**}
Herd constitution	3	0.01534979	0.09600692^{NS}
Season of calving	2	0.3585560	2.242627^{NS}
Lactation order	4	2.451081	15.33055^{**}
Farming system	1	21.50859	134.5278^{**}
Error	399	0.1598821	—

** : **Significant (P<0.01)**
NS : **Non-significant**

Rs. 8.60 whereas they found the price for Jersey crossbred cows to be Rs. 9.64 and 9.33 respectively which are also very close to the findings of the present study. Variations in managemental conditions, year of calculation and cost of different components to the place might be attributed as the important factors for price variation.

EFFECT OF GENETIC FACTOR :

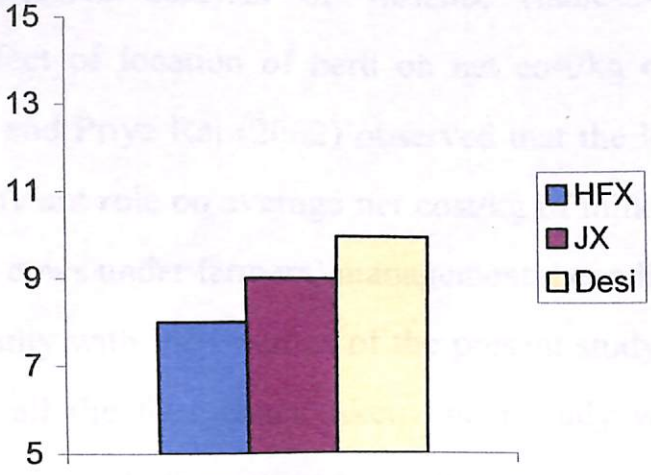
Least squares analysis of variance (table –24) revealed significant ($P<0.01$) effect of genetic groups on Net cost per kg of milk production in this study. An appraisal of least squares means (table-25) revealed that HF crossbred cows were most economical with respect to net cost per kg of milk production. The HF crossbred cows had the lowest net cost per kg of milk production followed by Jersey crossbreds and Desi cows. The HF crossbred cows had significantly ($P<0.05$) Rs. 1.623 and Re. 0.793 lower net cost per kg of milk production than Desi and JX cows respectively. Besides, JX cows had also significantly ($P<0.05$) Re. 0.83 lower net cost per kg of milk production than Desi cows. Kumar (2005) and Kumar (2006) also reported the lowest net cost per kg of milk production to be in HFX cows followed by JX and Desi cows which are in close agreement with the findings of the present study. Besides, Priya Raj (2002) also reported the net cost/kg of milk production of HFX to be significantly ($P<0.05$) lower than JX cows under farmers' managemental condition which are in conformity with the findings of the present study. No doubt, the net cost/kg of milk production of HF crossbred cows was observed to be lower than the net cost/kg of milk production of Jersey crossbred cows. However, it requires to be mentioned here that during the questionnaires the dairy farmers revealed that Jersey crossbred cows had more milk fat percentage and better reproductive performance than HF crossbred cows.

Table 25 : Least squares means of Net cost of per kg milk production under various genetic and non-genetic factors.

Genetic and Non-genetic factors	Net cost/Kg of milk production (Rs) Mean ± SE
Genetic factors	
Desi	10.051^{a}±.032
HF crossbred	8.428^{b}±.055
Jersey crossbred	9.221^{c}±.052
Non-genetic factors	
Location of Herd (zones)	
I	9.310±.040
II	9.231±.052
III	9.199±.048
IV	9.194±.064
Herd size	
3 - 4	9.321^{a}±.033
5 - 7	9.296^{a}±.050
8 & above	9.083^{b}±.064
Herd constitution	
One group alone	9.209±.059
D + HFX	9.242±.055
D + JX	9.235±.056
D + HFX + JX	9.248±.045
Season of calving	
Winter	9.187±0.042
Summer	9.214±0.041
Rainy	9.298±0.048
Lactation order	
1^{st}	9.271^{a}±0.050
2^{nd}	9.215^{ac}±0.051
3^{rd}	9.023^{b}±0.043
4^{th}	9.103^{b}c±0.052
5^{th} & above	9.555^{d}±0.067
Farming system	
Dairying alone	9.491^{a}±0.043
Agriculture + Dairying	8.976^{b}±0.035

Trait-wise and column-wise means bearing different superscripts differ significantly (P<0.05).

Figure 9 : Net cost per kg of milk production (Rs.) in HFX, JX and Desi cows.



EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Least squares analysis of variance (table-24) presented non-significant effect of location of herd on net cost/kg of milk production. Singh (1994) and Priya Raj (2002) observed that the location of herd did not play significant role on average net cost/kg of milk production in Desi and crossbred cows under farmers' managemental condition in Bihar which are in conformity with the findings of the present study. It may be pointed out here that all the four zones taken under study were located in and around 15 kms of Madhepura and therefore there might not have been significant differences in feeds and fodder and hired labours in all the zones under study. However, Kumar[1] (2004), Kumar (2005) and Kumar (2006) observed significant ($P<0.05$) effect of location of herd on average net cost/kg of milk production.

HERD SIZE :

Table-24, presented significant ($P<0.01$) effect of herd size on net cost/kg of milk production. The average net cost/kg of milk production of herd size 8 & above was observed to be significantly ($P<0.05$) lower by Re. 0.238 and 0.213 than the herd sizes of 3-4 and 5-7 respectively. However, the mean net cost/kg of milk production of 3-4 and 5-7 did not differ significantly. Significant effects of herd size on average net cost/kg milk production have also have been reported by Singh (1994), Priya Raj (2002), Kumar[1] (2004), Kumar (2005) and Kumar (2006) under farmers' managemental condition. Priya Raj (2002), Kumar[1] (2004), Kumar (2005) and Kumar (2006) also reported that the cows maintained in the herd size of 7 & above had significantly ($P<0.05$) lower net cost per kg of milk production than the cows maintained in lower herd sizes. The findings of

above authors are in close agreement with findings obtained in the present study.

HERD CONSTITUTION :

Least squares analysis of variance (table-24) reflected non-significant effect of herd constitution on net cost/kg of milk production in this study. The average net cost/kg of milk production ranged from Rs. 9.209 in the group when considered alone to Rs. 9.248 in the group consisting of Desi, HFX and JX cows, Kumar(2006) observed non-significant effect of herd constitution on net cost/kg of milk production in Desi, HFX and JX cows under farmers' managemental condition which is in conformity with the findings of the present study. However, Kumar[1] (2004) and Kumar (2005) observed significant ($P<0.01$) effect on net cost/kg of milk production in Desi and crossbred cows.

SEASON OF CALVING :

As evident from least squares analysis of variance (table-24), season of calving did not play any significant role on net cost/kg of milk production. The average net cost/kg of milk production ranged from Rs. 9.187 in winter calvers to Rs. 9.298 in rainy calvers. Priya Raj (2002) and Kumar (2005) observed non-significant influence of season of calving on net cost/kg of milk production in private dairy units under farmers' managemental condition which are in conformity with the findings of the present study. However, contrary to the findings of this investigation, Singh (1994), Kumar[1] (2004) and Kumar (2006) observed significant ($P<0.05$) effect of season of calving on average net cost/kg of milk production.

LACTATION ORDER :

Least squares analysis of variance (table-24) presented significant ($P<0.01$) effect of lactation order on average net cost/kg of milk production. The net cost/kg of milk production decreased by Re. 0.056 in 2nd lactation from 1st. However, the average net cost/kg of milk production of 1st and 2nd lactations did not differ significantly. The average net cost/kg of milk production decreased significantly ($P<0.05$) by Re. 0.192 in 3rd lactation from 2nd. The average net cost/kg of milk production increased non-significantly by Re. 0.08 in 4th lactation from 3rd. The average net cost/kg of milk production of 5th & above lactations increased significantly ($P<0.05$) by Re. 0.452 than 4th lactation. The lactation order presented very clear trend that there was gradual decline in average net cost/kg of milk production upto 3rd lactation after which it tended to increase gradually. It is worth mentioning here that LMY (kg), peak yield (kg), MY/day LL (kg) and MY/day CI increased upto 3rd lactations and there after declined gradually suggesting optimum economy upto 3rd – 4th sequences of lactation after which it tended to increase. The trend obtained in the present study is similar to the trend obtained by the above mentioned authors. However, Kumar (2006), contrary to the findings of the present study, could not find significant effect of lactation order on net cost/kg of milk production.

FARMING SYSTEM :

The system of farming played significant ($P<0.01$) role on net cost/kg of milk production. The average net cost/kg of milk production of cows maintained in the dairy units integrated with agriculture was found to be significantly ($P<0.01$) lower by Re. 0.515 than the units maintaining dairying alone. Kumar (2004) also observed lower net cost/kg of milk

production in dairy units integrated with agriculture farming which is in conformity with the findings of the present study. It requires to be pointed out here that the LMY (kg), peak yield (kg), MY/day LL (kg) and MY/day CI (kg) were significantly ($P<0.05$) higher in the dairy units integrated with agriculture than those units maintaining dairying alone which might have resulted into lower net cost/kg of milk production of the units integrated with agriculture. However, Kumar (2005) and Kumar (2006), contrary to the findings of the present study, did not find significant effect of farming system on net cost/kg of milk production.

ECONOMICS OF MILK PRODUCTION :

COST COMPONENTS:

Cost components and their relative contributions to gross cost of milk production in different genetic groups of cows have been presented in table-26. The various cost components included feed cost, labour cost, depreciation cost, veterinary and A.I. cost, interest on fixed capital and miscellaneous cost. The variable cost components were calculated relative to their gross cost. The average gross cost of milk production in Desi, HFX and JX cows were obtained as Rs. 10.311, Rs. 8.535 and Rs. 9.312 respectively. Among various variable cost items, feed cost was found to be the major cost component which contributed 70.817%, 72.700% and 70.929% of their respective gross costs in Desi, HFX and JX cows respectively. The second major cost component was observed to be the labour cost which contributed 12.607%, 14.645% and 16.108% of their respective gross costs in Desi, HFX and JX cows respectively. The interest on fixed capital ranked 3rd which contributed 4.655%, 4.979% and 4.832% of their respective gross costs respectively. The depreciations on fixed assests like depreciations on housing equipments, machinery and animals

were taken together as one item namely "Depreciation" which were observed to be 4.364, 4.686 and 4.317 percentages of their respective gross costs respectively. The veterinary and A.I. cost shared 2.996%, 1.757% and 1.610% of their respective gross cost of milk production in Desi, HFX and JX cows respectively. The respective values for miscellaneous cost were observed to be 4.073%, 1.230%, 2.203% of their respective gross cost in Desi, HFX and JX cows respectively. The dung was the only source of income other than milk to the dairy farmers, which contributed 2.512%, 1.253% and 0.977 of their respective gross costs in Desi, HFX and JX cows respectively.

Table-26: Average of different cost components and their relative contribution to the gross cost of milk production in cows of different genetic groups in the area of investigation.

Cost Items	Means (Rs.) per kg of milk production			Overall
	Desi	HFX	JX	
Feed cost	7.302 (70.817)	6.205 (72.700)	6.605(70.929)	6.704 (71.425)
Labour cost	1.300 (12.600)	1.250 (14.645)	1.500 (16.108)	1.350 (14.383)
Depreciation	0.450 (4.364)	0.400 (4.686)	0.402 (4.317)	0.417 (4.442)
Veterinary and A.I. cost	0.309 (2.996)	0.150 (1.757)	0.150 (1.610)	0.203 (2.162)
Interest on fixed capital	0.480 (4.655)	0.425 (4.979)	0.450 (4.832)	0.451 (4.805)
Miscellaneous cost	0.420 (4.073)	0.105 (1.230)	0.205 (2.201)	0.243 (2.588)
Gross cost of milk production(A)	10.311	8.535	9.312	9.386
Income from dung (B)	0.260 (2.521)	0.107 (1.253)	0.091 (0.977)	0.153 (2.657)
Net cost of milk production (A-B)	10.051	8.428	9.221	9.233

Figures in parentheses indicate percentage of respective gross cost.

Badal and Dhaka (1998), Priya Raj (2002), Kumar[1] (2004), Kumar (2005) and Kumar (2006) reported a similar trend of cost component to the trend obtained in the present investigation. However, Kalra et al. (1995) reported lower percentage of cost contribution in feed cost than obtained in the present study. Besides, Chandra and Agarwal (2000) observed higher labour cost than observed in this study.

Variable managemental practices in different dairy units, variable feeds and fodder used in different ecological conditions, variations in degree of demand from place to place influencing price of milk, variable sample size and different degree of sampling, different ecological regions, period of study, genetic group of cows inflation rate etc. might be responsible for variations in the estimate of contribution of different cost items to the gross cost per kg of milk production.

CONSTRAINTS PERCEIVED BY THE OWNERS OF DAIRY UNITS :

Table-27: Constraints perceived by the owners of dairy units in and around Madhepura (Bihar) in rearing Desi, HF and Jersey crossbred cows.

Sl.No.	Constraints	Rank
1	High cost of crossbred cows	I
2	High cost of feeds, fodders and feed supplements	II
3	Non-availability of good dairy animals in the locality	III
4	High incidence of repeat breeding	IV
5	Poor results of A.I.	V
6	High cost of veterinary medicines	VI
7	Lack of proper housing	VII
8	Non availability of green fodders throughout the year	VIII
9	Uneconomical crossbred male calves	IX
10	Lack of finance / credit facility	X
11	Non-remunerative price of milk	XI

The livestock owners of various dairy units under study in and around Madhepura (Bihar) were interviewed to enumerate the constraints related to feeding, management, breeding, disease control, results of artificial insemination, finance/credit facilities, availability of good dairy animals, price of milk etc. in order of priority. These constraints varied according to location of the dairy units, genetic groups of the cows used, herd size, herd constitution farming system etc. The common constraints as reported by the dairy owners were identified and ranked on the basis of frequency of dairy unit owners who expressed the same. These ranks of the constraints have seen presented in table-27.

High cost of crossbred cows was observed to rank 1st in the constraints perceived by the owners of various dairy units in and around Madhepura. This might be probably due to non-availability of good dairy animals in the locality which has also been ranked as 3rd constraint in this study. Since there is very thin population of HFX and JX cows in the present Bihar, after its division into Bihar & Jharkhand, the owners of the dairy units have to purchase high producing crossbred cows of superior genetic architecture from out side the state mostly form Haryana and Punjab resulting into high cost of crossbred cows.

High cost of feeds, fodders and feed supplements ranked 2nd in this study. The small dairy unit owners, in general and below poverty line owners, in particular, were unable to purchase quality feeds and fodders resulting into high incidences of deficiency diseases. Besides, it also caused poor health and low production of the cows.

High incidences of repeat breeding ranked as the 4th constraint perceived by the dairy owners which might be possibly due to poor health

of the cows, non-availability of quality feeds and fodders to them and lack of mineral supplements.

It was observed, in general, that artificial insemination was not very successful in and around Madhepura district of Bihar, and that is why poor results of A.I. ranked as 5th major constraint perceived by the dairy owners. Poor results of A.I. might be attributed to the lapses in timely detection of heat and timely insemination with quality semen by trained personnels. It may be pointed out here that many of the dairy farmers preffered natural services by the bulls to A.I. However, the A.I. requires improvement in managerial practices for which the farmers as well as A.I. workers have to be educated.

Costly veterinary medicine, ranked as 6th major constraint perceived by the dairy owners. Many of the poor farmers could not provide better treatment to their ailing animals.

Lack of proper housing ranked as 7th major constraint perceived by the dairy owners. The dairy units in the rural areas have mostly kachha houses without proper drainage and sanitation facilities, whereas in urban areas there was lack of sufficient surface area mainly because of high cost of land.

The non-availability of "green fodders" throughout the year ranked as 8th major constraint which might have resulted into poor dairy performances as well as high incidence of repeat breeding of the cows.

The dairy owners reported the crossbred male calves to be unsuitable for farm operations. It was observed that most of the owners of the dairy units used to sale the crossbred male claves before the age of castration on non-remunerative prices.

Although there are many nationalised commercial banks including Kshetriya Gramin Bank located in and around Madhepura Bihar, yet the dairy farmers of the area could not be benefitted much mainly because of complexity of the procedures of financing.

The last but not the least major constraint perceived by the dairy farmers was observed to be "non-remunertaive price of milk". The dairy owners also complained about the exploitation by the middle men.

However, the results obtained in this study could not be compared with similar studies conducted elsewhere in the country as the constraints varied from place to place, one dairy units to another, genetic architecture of the cows, availability of feed, fodders and feed supplements, administrative and managerial control of A.I. centres, awareness and education of the dairy farmers, availability of crossbred cows etc. which might have resulted into variations in the ranks of constraints perceived by the dairy farmers.

CHAPTER - 5

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSIONS

The present investigation was conducted on 104 randomly selected private dairy units consisting of 229 Desi, 85 HFX and 103 JX cows utilizing the procedures of "stratified random sampling with proportional allocation" (Snedecor and Cochran, 1967) in and around Madhepura (Bihar). The main aim of this investigation was to study the effects of genetic and various non-genetic factors on milk production efficiency traits. Apart from these, various constraints perceived by the dairy farmers were also studied to suggest a suitable package of dairy practices for economic milk production.

The milk production efficiency traits consisted of lactation milk yield (LMY, Kg), lactation length (LL, days), peak yield (kg), days to attain peak yield (DAPY, days) milk yield per day of lactation length (MY/day LL) and milk yield per day of calving interval (MY/day CI). The reproduction efficiency traits under study included dry period (DP, days) and calving interval (CI, days). Besides, cost of milk production was also taken into account as economic efficiency trait in this study.

The genetic groups included Desi, HFX and JX cows, whereas the non-genetic factors consisted of location of herd, herd size, herd constitution, season of calving, sequence of lactation and farming system.

The experiment was planned with the following main objectives :

1. To estimate the phenotypic parameters of some of the milk production efficiency measures of Desi, HF crossbred cows and Jersey crossbred cows maintained in un-organized farm in and around Madhepura (Bihar).

2. To study the nature and magnitude of variation in various measures of milk production efficiency under consideration due to genetic and non-genetic factors in and around Madhepura (Bihar).

3. To study the various constraints perceived by the dairy farmers in and around Madhepura in rearing high yielding cows.

4. To provide suggestions for suitable dairy practices for economic milk production to the dairy farmers in and around Madhepura (Bihar).

Data were subjected to statistical analysis through computer in ARIS (Agricultural Research Information System) cell of Indian Veterinary Research Institute, Izzatnagar, Barielly (U.P.). Least squares analysis (Harvey, 1966) was utilized to study the genetic and various non-genetic factors on all the milk production efficiency traits, whereas Duncan's Multiple Range Test (DMRT) as modified by kramer, 1957 was used for pair-wise comparison of the least squares means at 0.05 level of probability.

The average lactation milk yield (kg) of Desi, HFX and JX cows were observed to be 1032.049±14.253, 2445.028±24.159 and 2036.113±22.857 respectively. Genetic group had significant ($P<0.05$) effect on LMY (kg). HFX and JX cows had more than double LMY (kg) than those yielded by Desi cows reflecting that both HFX and JX cows are well adapted in the agro-climatic region of Madhepura district of Bihar. Besides, HFX cows had also significantly ($P<0.05$) 408.915 kg more LMY (kg) than JX cows suggesting more use of HF than Jersey for crossbreeding for milk production in and around Madhepura (Bihar).

Location of herd, Lactation order and farming system played significant ($P<0.05$) role on LMY, whereas herd size, herd constitution and season of calving had no significant influence on it. The highest (1880.472

kg) and the lowest (1799.410 kg) of LMY were observed to be in Zones-II and I respectively.

The LMY increased with the increase of lactation order and attained the highest (1948.840 kg) in 3rd lactation after which it tended to decline gradually in subsequent lactations. The cows maintained in the dairy units integrated with agriculture farming yielded significantly (P<0.01) 196.968 kg more LMY than those maintained in the units involving dairying alone.

The least squares means of lactation length were found to be 262.585±1.473, 311.382±2.496 and 300.682±2.361 days in Desi, HFX and JX cows respectively. Genetic group, location of herd, herd constitution, season of calving, lactation order and farming system had significant (P<0.05) effect on LL (days), whereas herd size did not influence the trait significantly. HFX cows had significantly (P<0.05) 46.235 days and 10.70 days longer LL than Desi and JX cows respectively. Besides, JX cows had also significantly (P<0.05) 38.097 days longer LL than Desi cows. The LL (days) ranged from 286.223 days in Zone-IV to 295.805 days in Zone-II. The highest (297.738 days) LL days were observed in "one group alone" group whereas, the lowest (288.041 days) LL days was found to be in the group consisting of Desi, HFX and JX cows. Winter and rainy seasons of calving had significantly (P<0.05) 5.331 days and 5.888 days longer lactation length than summer calving. There was increase in LL days from 1st to 3rd lactations after which it gradually declined in subsequent lactations. The average LL days of the cows maintained in dairy units integrated with agriculture farming was found to be significantly (P<0.01) 15.311 days longer than those maintained in the dairying alone.

The average peak yield (kg) in Desi, HFX and JX cows were obtained as 5.824±0.064, 11.296±0.108 and 9.846±0.102 respectively.

Genetic factor, herd constitution. lactation order and farming system had significant ($P<0.05$) effect on peak yield whereas, location of herd, herd size and season of calving did not influence it significantly. HF crossbreds had significantly ($P<0.05$) 5.472 kg and 1.45 kg higher PY than Desi and JX cows. Besides, JX cows had also significantly ($P<0.05$) 4.02 kg higher peak yield than Desi cows. The peak yield ranged from 8.758 kg in the herd consisting of Desi and HFX cows to 9.20 kg in the herd containing Desi, HFX and JX cows. The trend of effect of lactation order on peak yield was similar to those obtained for LMY (Kg) and LL (days). The peak yield increased gradually from 1st to 3rd lactations where it attained its maximum after which it tended to gradual decline in subsequent lactations. The dairy units integrated with agriculture had significantly ($P<0.01$) 0.569 kg more PY than those maintaining dairying alone. This increase might be attributed to timely and quality cultivation of feed and green fodders by the farmers maintaining dairy units along with agriculture.

The average days to attain peak yield (DAPY days) in Desi, HFX and JX cows were obtained as 39.117±0.346, 44.343±0.586 and 46.709±0.554 respectively. Genetic group, herd constitution and lactation order had significant ($P<0.05$) effect on DAPY whereas, location of herd, herd size, season of calving and farming system did not play significant role on it. Desi cows had significantly ($P<0.05$) 5.226 days and 7.592 days lower DAPY than HFX and JX cows respectively. Besides, HFX had also significantly($P<0.05$) 2.366 days lower DAPY than JX cows. Desi along with HFX herd constitution group had higher DAPY days than all other herd constitution groups. The DAPY days increased significantly in 4th and onward lactations from 1st to 3rd sequences of lactations.

The average MY/day LL (kg) of Desi HFX and JX cows were obtained as 3.811±0.040, 7.617±0.068 and 6.691±0.064 respectively. Genetic group, herd size, lactation order and farming system had significant ($P<0.05$) effect on MY/day LL (kg) whereas, location of herd, herd constitution and season of calving had no significant effect on it. Like LMY (kg), HFX had more than double and JX had nearly double MY/day LL than Desi cows. Besides, HFX had also significantly ($P<0.05$) higher MY/day LL than JX cows. Farmers having 3-4 herd size had significantly ($P<0.05$) 0.155 kg and 0.195 kg higher MY/day LL than those having herd size of 5-7 and 8 & above. Like LMY (kg), LL (days) and PY (kg), the MY/day LL (kg) also increased upto 3rd lactation after which it tended to decline. The MY/day LL (kg) in the dairy units integrated with agriculture had higher value than those having dairying alone.

The average calving interval (days) in Desi, HFX and JX cows were obtained as 474.981±1.628, 428.609±2.759 and 418.374±2.611 respectively. Genetic group, location of herd, herd constitution and lactation order significantly ($P<0.01$) influenced the calving interval whereas, herd size, season of calving and farming system had no significant role on it. JX had significantly ($P<0.05$) 10.235 and 56.607 days shorter calving interval than HFX and Desi cows respectively whereas, HFX had also 46.362 days shorter CI (days) than Desi cows. Zone-I had the lowest CI days which was significantly ($P<0.05$) lower by 8.296 days and 7.244 days than Zone-II and Zone-III respectively. All the herd constitution groups had significantly ($P<0.05$) lower CI (days) than the group when considered alone. The CI (days) was observed to be the lowest in 2nd lactation after which it significantly increased in subsequent lactations.

The MY/day of CI (kg) in Desi, HFX and JX cows were found to be 2.525±0.032, 5.725±0.054 and 4.866±0.051 respectively. Genetic group, location of herd, lactation order and farming system had significant role on MY/day CI whereas, herd size, herd constitution and season of calving did not influence it significantly. HF crossbreds had the highest MY/day CI which was significantly ($P<0.05$) 3.2 kg and 0.859 kg higher than Desi and JX cows respectively. Besides, JX cows had also significantly ($P<0.05$) 2.341 kg higher MY/day CI than Desi cows. These findings suggested well adaptation of HFX and JX cows in the agro climatic region of Madhepura district of Bihar with respect to milk production and also more use of HF than Jersey for crossbreeding for milk production in this area. Zone-II had the highest MY/day CI which was significantly ($P<0.05$) higher by 0.154 kg and 0.136 kg than Zones-I and III respectively. The MY/day CI increased gradually upto 3rd sequence of lactation after which it tended to decline in subsequent lactations. The cows maintained in the dairy units integrated with agriculture farming had significantly ($P<0.01$) 0.419 kg higher MY/day CI than those units maintaining dairying alone.

The average dry period (days) in Desi, HFX and JX cows were observed to be 143.289±0.682, 115.084±1.155 and 117.868±1.093 respectively. Genetic group, lactation order and farming system played significant ($P<0.01$) effect on dry period (days) whereas, zone, herd size, herd constitution and season of calving had no significant effect on it. HF crossbred and Jersey crossbred cows had significantly ($P<0.05$) 28.205 days and 25.421 days shorter dry period than Desi cows. The dry period (days) had the tendency to decline upto 3rd sequence of lactations after which it increased significantly. The cows maintained in the dairy units integrated with agriculture had significantly ($P<0.01$) 11.147 days shorter

dry period than those maintaining dairying alone which might be attributed to better managemental condition in terms of providing green fodders to them.

The average net cost per kg of milk production for Desi, HFX and JX cows were observed to be Rs. 10.051±0.032, Rs. 8.428±0.055 and Rs. 9.221±0.052 respectively. The HF crossbred cows had the lowest net cost / kg of milk production followed by Jersey crossbred and Desi cows. The HF crossbred cows had significantly ($P<0.05$) Rs. 1.623 and Rs. 0.793 lower net cost per kg of milk production than Desi and JX cows respectively. Besides, JX cows had also significantly ($P<0.05$) Re. 0.83 lower net cost per kg of milk production than Desi cows. Location of herd, herd constitution and season of calving had no significant effect on net cost / kg of milk production. The cows maintained in the herd size of 8 & above had significantly ($P<0.05$) Re. 0.238 and Re. 0.213 lower net cost / kg of milk production than the herd sizes of 3-4 and 5-7 respectively. The average net cost / kg of milk production was observed to be the lowest (Rs. 9.023) in 3rd lactation after which it tended to increase. However, the net cost per kg of milk production of 3rd and 4th sequences of lactations did not differ significantly. The average net cost / kg of milk production of cows maintained in the dairy units integrated with agriculture was observed to be significantly ($P<0.01$) lower by Re. 0.515 than the units maintaining dairying alone.

The farmers of the dairy units located in and around Madhepura (Bihar) perceived eleven constraints of which high cost of crossbred cows ranked 1st followed by high cost of feed, fodders and feed supplements, non availability of good dairy animals in the locality, high incidence of repeat breeding, poor results of A.I., high cost of veterinary medicines, lack of

proper housing, non-availability of green fodder throughout the year, un-economical crossbred male calves, lack of finance / credit facilities and non-remunerative price of milk which need to be given due consideration on priority basis.

RECOMMENDATION :

On the basis of findings of the present study, it was observed that both HFX and JX cows are well adapted in the agro climatic region of Madhepura (Bihar). However, HF crossbred cows should be preferred to Jersey crossbred cows for lactation milk yield, lactation length, peak yield, DAPY, MY / day LL, MY / day CI and net cost per kg of milk production suggesting more use of HF than Jersey for crossbreeding in and around Madhepura (Bihar). Besides, the herd size of 8 & above cows upto 4^{th} sequence of lactation would be optimum for relatively economic milk production in this area. Apart from these, dairying integrated with agriculture farming should be preferred to dairying alone.

CHAPTER - 6

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