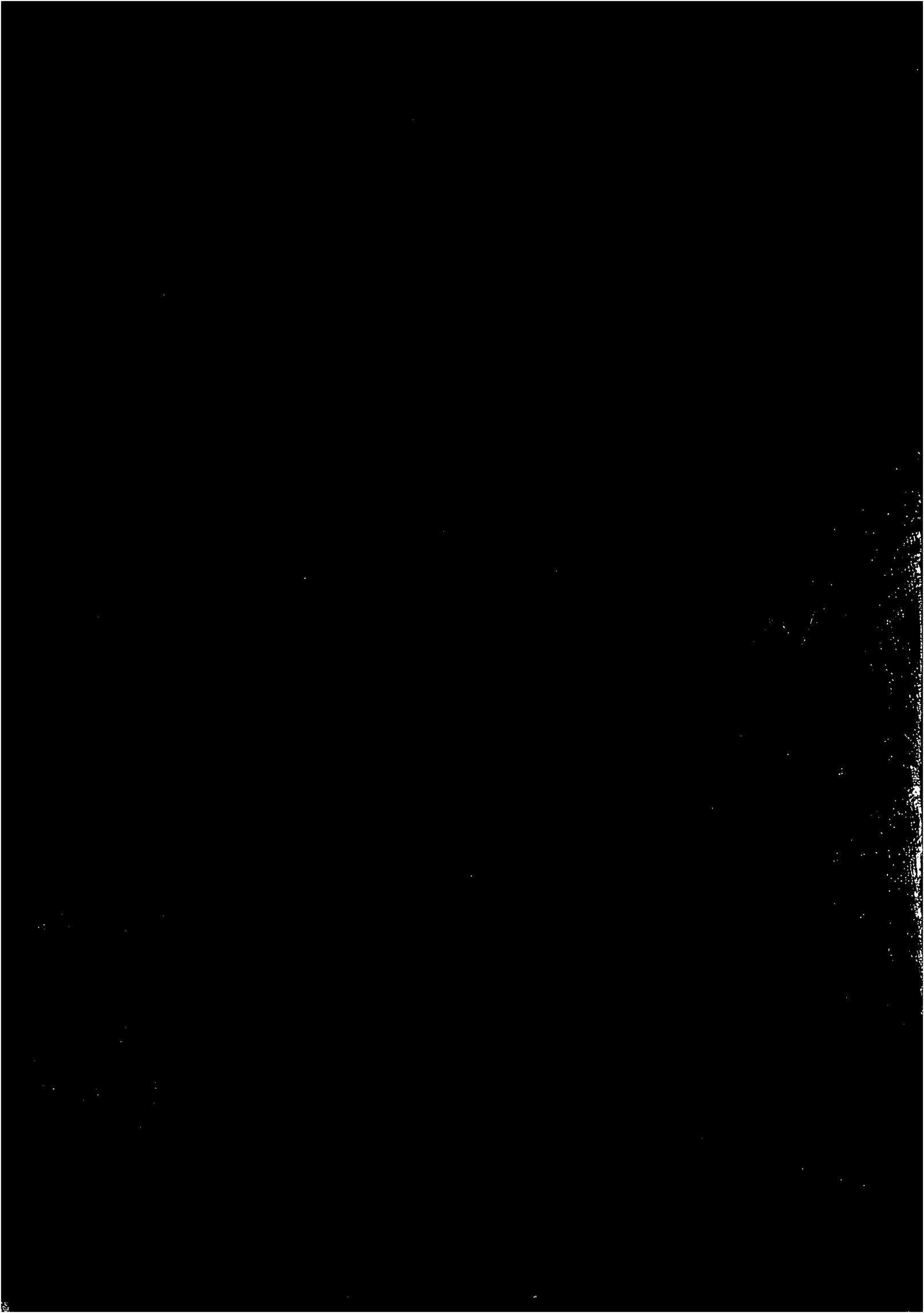

INFLUENCE OF GENETIC AND NON-GENETIC FACTORS ON MILK PRODUCTION EFFICIENCY OF CATTLE IN AND AROUND JEHANABAD (BIHAR)

THESIS

SUBMITTED TO THE

RAJENDRA AGRICULTURAL UNIVERSITY

(FACULTY OF VETERINARY AND ANIMAL SCIENCES)
PUSA (SAMASTIPUR) BIHAR

By

Dr. Ranjit Kumar
Registration No. M/VBG/48/2007-2008

In partial fulfillment of the requirement
FOR THE DEGREE OF

Master of Veterinary Science

(Animal Breeding & Genetics)

DEPARTMENT OF ANIMAL BREEDING & GENETICS
BIHAR VETERINARY COLLEGE
P A T N A (BIHAR)

2009

DEPARTMENT OF ANIMAL BREEDING & GENETICS
BIHAR VETERINARY COLLEGE, PATNA – 14
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CERTIFICATE – I

This is to certify that the thesis entitled "***Influence of genetic and non-genetic factors on milk production efficiency of cattle in and around Jehanabad (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. Ranjit Kumar, Registration No. M/VBG/48/2007-08,** 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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Chairman of the Department

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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. Ranjit Kumar** Registration No. **M/VBG/48/2007-2008**, 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 "***Influence of genetic and non-genetic factors on milk production efficiency of cattle in and around Jehanabad (Bihar)***" may be submitted by **Dr. Ranjit Kumar** in partial fulfilment of the requirements for the degree.

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CERTIFICATE – III

This is to certify that the thesis entitled "***Influence of genetic and non-genetic factors on milk production efficiency of cattle in and around Jehanabad (Bihar)***" submitted by **Dr. Ranjit Kumar , Registration No. M/VBG/48/2007-08** 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 ..... / ..... / 2009.

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Dedicated
to
my beloved
parents

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Place: Bihar Veterinary College
Date: 06/06/09

Ranjit Kumar 06/06/09
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INTRODUCTION

INTRODUCTION

Although India is the largest milk production country in the world producing about 97.1 million tonnes of milk per annum (India, 2008), yet there is a big gap between availability and requirement of milk mainly because of steep rise in human population which has crossed the mark of 100 crores in 2001 itself and poor genetic potentialities of indigenous dairy animals along with improper management. Therefore, intensive efforts are being made to increase the milk production by improving the genetic architecture of indigenous cows through crossbreeding and grading up and providing balanced feeding, health care and better management of milch animals.

Animal husbandry assumes predominant role in Indian economy by providing employment, income and livelihood for the rural people on one hand and necessary livestock products for general consumers and industries on the other hand. Dairy farming plays an important role by providing gainful employment to landless, small and marginal farmers who supplement their income through it. Thus, dairying not only improves the milk production in India but also plays significant role by alleviating poverty of rural poor and changing the socio-economic structure of rural people.

It is well known fact that after creation of Jharkhand state, the remaining Bihar has become deficient in industries, minerals and forest resources and is left over mainly with agriculture and animal husbandry for economic achievement. Besides, Kosi and other rivers in North Bihar bring huge economic loss due to flood. Apart from these, poor irrigation facilities due to poor generation of electricity and lack of canal facilities hamper agriculture production to a great extent. Therefore, in such a situation,

animal husbandry in general and dairying in particular remains the main tool for eradication of poverty in the state.

Jehanabad is a historic place and its description is found in the famous book 'aine-e-akbari', This place was badly affected by famine in the 17th century and people were dying of hunger. The Moghul emperor Aurangzeb established a Mandi for relief of the people and named it as 'JAHANARA'. In the course of time the place came to be known as JAHANARABAD' and later as 'JEHANABAD'. The city of Jehanabad, which is the head quarter of the district, is situated at the confluence of the rivers Dardha and Yamuna. The rivers namely Sone, Phalgu, Dardha and Yamuna cris-cross the district. The river Phalgu has got religious importance where the Hindus offer 'PIND DAN' to their fore fathers. The district is situated in between 25-0' to 25-15 degree north latitude and 84-31' to 85-15' eastern north latitude. The average rainfall of the district is 1074.5 mm and the economy of the people is agriculture based. Besides, people show keen interest in animal husbandry and dairying. According to 2003 census there are more than eighty eight thousand indigenous cattle including the crossbreds in this district. The dairy cows produce large quantity of milk which caters the need of people of Jehanabad. The growing population of Jehanabad town has significantly increased the demand of milk and resultantly a large number of unorganized dairy units (Khatals) have cropped up and become operational in and around Jehanabad.

Milk producing efficiency of cow is dependent upon genetic and various non-genetic factors. Although many studies have been conducted in milk production efficiency of cows in organized farms, yet the information on the cows maintained in unorganized dairy units is very scanty. Besides, such studies conducted in different agro-climatic regions, will provide important tool in formulation and improvement of the cattle breeding policy

for the whole state. The present study conducted in the district of Jehanabad is one of the rings in the chain of study for formulation and improving the cattle breeding policy for unorganized dairy sector of the state.

The pattern of livestock rearing including dairy farming varies over space and time. Presently there are very few organized dairy farming in Bihar and thus milk production in the state is mainly under the control of landless, marginal and small farmers which maintain their dairy animals in unorganized farm. Besides, a large number of Khatals have cropped up in and around district and sub divisional towns where the dairy farmers are keeping Desi as well as crossbred cows. Thus, there is need to provide best technological and managemental knowhow to these unorganized private dairy sectors for which suitable strategies are to be formulated for maximizing milk production. Therefore, this 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 cross-bred cows and Jersey cross-bred cows maintained in unorganized farm in and around Jehanabad, Bihar.

2. To study the nature and magnitude of variation in various measures of milk production efficiency due to genetic and non-genetic factors in and around Jehanabad, Bihar.

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

4. To provide suggestions for suitable dairy practices for economic milk production to the dairy farmers in and around Jehanabad, Bihar.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

LACTATION MILK YIELD :

AVERAGE : The average lactation milk yield (kg) as reported by various authors are mentioned 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)
Local cows JX HFX	Lactation yield	948.87±61.87 litres 1963.64±33.15 litres 2520.66±86.15 litres	Surya Presad et al. (1991)
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)
Desi HF crossbred Jersey crossbred		1032.049±14.253 kg 2445.028±24.159 kg 2036.113±22.857 kg	Prabhakar, P. (2007)
Crossbred having 50-75% exotic inheritance	1st 305 days Lactation milk yield	2410.38±27.52 kg	Kumar et al. (2009)

GENETIC AND NON-GENETIC FACTORS AFFECTING LACTATION YIELD :

EFFECT OF GENETIC GROUP :

Panda and Sadhu (1983) reported significant (P<0.01) effect of genetic group on lactation yield. They observed 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) reported almost double higher lactation milk yield in Jersey x Hariana halfbreds than Hariana cows.

Singh et al. (1986b) reported significant (P<0.05) effect of genetic grades of cows on the lactation yield in small dairy units maintained under farmers' managemental conditions in and around Ranchi (Jharkhand).

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

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

Surya Prasad et al. (1991) studied the performance of indigenous and crossbred cows under village conditions in Chittoor district of Andhara Pradesh. They observed highly significant (P<0.01) effect of breed group on lactation milk yield. They further reported average lactation yield of local, JX and HFX cows to be 948.87±61.87 litres, 1963.64±33.15 litres and 2520.65±86.15 litres respectively.

Singh et al. (1993) observed 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) reported significant (P<0.01) effect of genetic group on 300 days or less lactation milk yield in nine genetic groups of Jersey x Zebu crossbreds.

Bhattacharya et al. (2002) reported the lactation milk yield of F_1 crossbreds of Holstein Friesian to be better than Indian born Holstein Friesian and also F_2 crossbreds of HF x Tharpakar.

Priya Raj (2002) reported that genetic group had significant (P<0.01) effect on lactation milk yield of cows maintained under farmers' managemental conditions in and around Patna and observed 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) and Red Dane (RD) with three Zebu breeds viz. Sahiwal (S), Hariana (H) and Red Sindhi (RS) and found significant (P<0.01) effect of genetic group on 1st lactation milk yield. They observed that the highest and 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) observed significant (P<0.01) effect of genetic grades of Friesian and Sahiwal crosses on 300 days milk yield of 1st lactation. They found 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) conducted research to study 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 observed that ½ HF ½ H genetic group produced the highest milk followed by ½ J ½ H genetic group.

Kumar[2] (2004) observed that ½ HF ½ H genetic group had highest lactation milk 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, HF 50%, HF 62.5% and HF 75% genetic groups.

Kumar (2005) conducted an experiment to study the effect of genetic group on lactation milk yield in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar). He observed that HF crossbreds had significantly (P<0.01) 1795.01 kg and 630.9 kg higher milk yield that Desi and Jersey crossbred cows respectively. He further reported that HFX and JX cows had nearly 3 times more lactation yields than Desi cows.

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

Kumar (2006) conducted research to study the effect of genetic group on lactation milk yield in cattle in and around Biharsharif of Nalanda district (Bihar). He found highly significant (P<0.01) effect of genetic group on it. He reported that HFX had the highest lactation yield followed by JX and

Desi cows. He observed that both HFX and JX had more than double LMY than Desi cows.

Prabhakar (2007) studied the effect of genetic group consisting of local, HFX and JX cows maintained under farmers' managemental conditions on 300 days lactation milk yield in and around Madhepura (Bihar). He reported highly significant ($P<0.01$) effect of genetic group on LMY and found that the highest LMY was yielded by HFX followed by JX and local cows. He reported that both HFX and JX cows yielded more than double LMY than Desi cows.

Hussain et al. (2008) studied the effect of genetic group of cattle viz. Jersey x local, Holstein Friesian x local and local cattle under field conditions of Assam and reported highly significant ($P<0.01$) effect of genetic group on 1st lactation monthly milk yield. They observed that Holstein Friesian x local cattle had highest first lactation monthly milk yield.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Singh et al. (1986[b]) found significant ($P<0.01$) effect of location of herd on lactation milk yield in Friesian crossbred cows maintained under farmers' managemental conditions in and round Ranchi (Jharkhand).

Hayatnagarkar et al. (1990) conducted research to study the effect of location of herd on total milk yield and found significant ($P<0.01$) effect of location of herd on it 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) found that farm had significant ($P<0.01$) effect on 1st lactation 300 days milk yield in various Holstein x Sahiwal grades.

Priya Raj (2002) studied the effect of location of herd on lactation milk yield in crossbred cows under farmers' managemental conditions and observed non-significant effect of location on it.

Bhadauria and Katpatal (2003) reported non-significant influence of farm on 1st lactation 300 days milk yield in Friesian x Sahiwal crosses.

Kumar[1] (2004) studied the effect of location of herd on lactation milk yield in Desi and crossbred cows under farmers' managemental conditions in and around Darbhanga (Bihar). He reported non-significant effect of location of herd on lactation milk yield.

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

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). He reported significant ($P<0.05$) effect of location of herd (Zones) on lactation milk yield (LMY).

Prabhakar (2007) studied the effect of location of herd on lactation milk yield in cattle under farmers' managemental conditions and reported that out of the four zones, the LMY in three zones did not differ significantly, however, one of the zone had significantly ($P<0.05$) lower LMY than others.

HERD SIZE :

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

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

Kumar[1] (2004) found that herd size had significant ($P<0.01$) effect 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 under farmers' managemental conditions in and around Patna. He found 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) studied the effect of herd size on lactation milk yield in Desi, HFX and JX cows and reported significant ($P<0.01$) effect of herd size on it.

Prabhakar (2007) studied the effect of herd size on lactation milk yield in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Madhepura (Bihar). He reported non-significant effect of herd size on LMY.

SEASON OF CALVING :

Jadhav et al. (1991) found that season of calving did not influence lactation milk yield significantly in six grades of Holstein x Sahiwal cows.

Yadav and Rathi (1992) reported that season of calving did not influence 1st three lactations of Hariana breed significantly.

Singh et al. (1993) reported that season of calving had no significant effect 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) could not find 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) reported significant ($P<0.05$) effect of season of calving on 305 days and total lactation milk yields in crossbred cows.

Thakur et al. (1999) observed 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) observed 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 non-significant influence of season of calving on lactation milk yield in crossbred cows under farmers' managemental conditions in and around Patna (Bihar).

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

Akhter et al. (2003) found that season of calving influenced significantly ($P<0.05$) 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) observed that season of calving did not influence the 300 days milk yield of 1st lactation in Friesian x Sahiwal crosses.

Kumar[1] (2004) found that season of calving influenced significantly ($P<0.01$) the lactation milk yield in cattle and buffalo under farmers' managemental conditions in and around Darbhanga (Bihar).

Kumar[2] (2004) found that season of calving did not influence significantly the 300 days or less milk yield in six genetic grades of Hariana and its crosses with Holstein Friesian and Jersey.

Kumar (2005) observed significant ($P<0.01$) effect of season of calving on lactation milk yield in cattle maintained in private dairy units located in and around 10 km of Patna, Bihar.

Sharan (2005) observed significant ($P<0.05$) influence of season of calving on lactation yield in Hariana and its crosses with Holstein Friesian. He found 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) found significant ($P<0.05$) effect of season of calving on LMY in Desi, HFX and JX cows maintained in the private dairy units in and around Nalanda district (Bihar). He found the highest LMY to be in the cows calved during rainy season. He observed 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.

Prabhakar (2007) reported non-significant effect of season of calving on lactation milk yield in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Madhepura (Bihar). However, he observed that winter calvers had the highest lactation milk yield followed by rainy and summer calvers.

Singh and Singh (2008) reported non-significant effect of season in later parts of lactation in Karan Fries cattle

Thorat et al. (2008) studied the effect of season of calving on lactation milk yield in Holstein Friesian x Gir and Jersey x Gir half breds. They observed non-significant effect of season of calving on lactation milk yield and opined uniform management of lactating animals under same animal husbandry and feeding practices.

LACTATION ORDER :

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

Priya Raj (2002) observed that sequence of lactation influenced lactation milk yield significantly ($P<0.01$) in crossbred cows maintained under farmers' managemental conditions in and around Patna (Bihar). She found the highest lactation milk yield to be in 3rd lactation after which it tended to decline.

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

Kulkarni et al. (2003) observed 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 found that the lactation yield increased with the increase of sequence of lactation which attained its maximum in 3rd lactation.

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

Kumar (2005) reported significant ($P<0.01$) effect of parity of lactation on lactation milk yield in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar). He studied 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) found that parity of lactation did not influence lactation milk yield significantly in Hariana and its crosses with Holstein Friesian.

Kumar (2006) conducted research to study the effect of parity of lactation on milk yield in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar). He reported that parity of lactation did not influence LMY significantly.

Prabhakar (2007) observed significant ($P<0.05$) influence of lactation order on lactation milk yield in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Madhepura (Bihar).

FARMING SYSTEM :

Kumar[1] (2004) conducted research to study the effect of farming system on lactation milk yield in cattle maintained in private dairy units in

and around Darbhanga (Bihar) and observed that there was non-significant effect of farming system on the lactation milk yield.

Kumar (2005) found that farming system had significant ($P<0.05$) effect on lactation milk yield in Desi, HFX and Jersey crossbred cows maintained under farmers' managemental conditions in and around 10 km of Patna (Bihar).

Kumar (2006) reported significant ($P<0.05$) effect of farming system on LMY in cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) reported significant ($P<0.01$) effect of farming system on lactation milk yield in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Madhepura (Bihar) and observed that cows maintained in dairy units integrated with agriculture had higher LMY than those maintained in the units involving dairying alone.

LACTATION LENGTH :

AVERAGE : Lactation length is one of the most important economic characters influencing production efficiency. 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	385.3±16.3	Parmar et al. (1986)
Hariana x HF (F_1)	432.7±10.4	
HF ≥ 50%	310.2±1.6	Singh et al. (1986[a])
50%	305.3±2.4	
≤ 50%	292.8±3.0	
HF crossbred	30208±1.4	Singh et al. (1986[b])
½ HF ½ Hariana	344.4±5.3	Chopra (1990)
½ Jersey ½ Hariana	328.3±6.5	
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 et al. (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 62.5% 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 et al. (2007)
Desi HFX JX	262.585±1.473 311.382±2.496 300.682±2.361	Prabhakar (2007)

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) compared lactation lengths of HFX and JX cows and observed that Jersey crossbreds had significantly (P<0.01) longer lactation length than HF crossbreds maintained under farmers' managemental conditions in and around Patna.

Akhter et al. (2003) studied the effect of genetic group on lactation length and observed the longest and shortest 1st lactation lengths to be 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.

Sharan (2005) observed significant (P<0.01) effect of genetic group on lactation length in different exotic inheritance of HF x Hariana cows. He found 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) observed that Desi cows maintained under farmers' managemental conditions in the private dairy units in and around Nalanda district (Bihar) had significantly (P<0.05) 20.40 days and 9.41 days longer LL than HFX and JX cows respectively. He also noted 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) observed that genetic group did not influence lactation length significantly in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar).

Prabhakar (2007) reported significant (P<0.05) effect of genetic group on lactation length in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Madhepura (Bihar). He observed the longest lactation length to be in HFX cows followed by JX and Desi cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATIONS/ZONES :

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

Priya Raj (2002) reported that different zones had non-significant effect on lactation length in different crossbred cows under farmers' managemental conditions in and around Patna.

Kumar[1] (2004) reported that the zones did not affect significantly the lactation length in different genetic groups of cattle under farmers' managemental conditions in and around Darbhanga (Bihar).

Kumar (2006) studied the effect of different zones on milk production efficiency traits in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around 15 kms of Biharsharif of Nalanda district (Bihar) and observed that zones had no significant role on lactation length (days).

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

Prabhakar (2007) reported significant (P<0.05) effect of zones on LL (days) in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Madhepura (Bihar). However, he observed the variations of very little magnitude. Besides, the LL days of zones I & IV as well as II & III did not differ significantly.

HERD SIZE :

Priya Raj (2002) reported non-significant effect of size of herd on lactation length of crossbred cows maintained under farmers' managemental conditions in and around Patna.

Kumar[1] (2004) reported non-significant effect of herd size on lactation length in different genetic groups of cattle in and around Darbhanga (Bihar).

Kumar (2006) observed that the cows maintained under farmers' managemental conditions 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 herds having the size of 5-6 respectively.

Kumar et al. (2007) reported non-significant effect of the size of the herd on the lactation length in Desi, HFX and Jersey crossbred cows maintained under farmers' managemental conditions in and around Patna.

Prabhakar (2007) reported non-significant effect of herd size on lactation length (days) in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Madhepura (Bihar). However, he observed that the LL days ranged from 289.977 days in the herd size of 3-4 to 294.299 days in 8 & above.

SEASON OF CALVING :

Jadhav et al. (1991) observed that summer and spring calvers had significantly ($P<0.05$) longer lactation lengths than those calved during other seasons in different genetic grades of Holstein Friesian and Sahiwal.

Yadav et al. (1992) reported non-significant effect of the season of calving on lactation length in Sahiwal cows.

Yadav and Rathi (1992) reported that season of calving did not influence significantly the lactation length in Hariana.

Singh et al. (1993) observed that season of calving had no significant influence on the 1st lactation length in Sahiwal and its crosses with Jersey and Red Dane.

Shettar and Govindaiah (1999) reported that season of calving had no significant effect on 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) reported non-significant effect of different seasons of calving on 1st lactation length in nine genetic groups of Jersey x Zebu crossbreds.

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

Priya Raj (2002) reported that the season of calving had significant ($P<0.01$) influence on lactation length of HFX and Jersey cross-bred cows maintained under farmers' managemental conditions 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 that season of calving did not influence significantly the 1st lactation length in crossbred cows involving three exotic and three Zebu breeds.

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

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

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

Kumar (2006) observed that season of calving had significant ($P<0.01$) effect on lactation length in Desi, HFX and JX cows maintained in private dairy units under farmers' managemental conditions. He observed that rainy calvers had the longest lactation length (days) followed by summer and winter calvers.

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

Prabhakar (2007) although reported significant ($P<0.05$) effect of season of calving on LL days in Desi, HFX and JX cows maintained under farmers' managemental conditions, yet the LL days of winter and rainy season did not differ significantly.

LACTATION ORDER :

Yadav 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 seven genetic groups of crossbreds involving Holstein Friesian, Brown Swiss, Jersey and Hariana, Priya Raj (2002) in HFX and JX cows under farmers' managemental conditions and Kumar[1] (2004) in different genetic groups of cattle reported significant ($P<0.05$) effect of sequence of lactation on lactation length (days).

Kumar[2] (2004) reported that the parity of lactation had non-significant effect on 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 did not influence the lactation length significantly.

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

Kumar et al. (2007) observed that sequence of lactation had non-significant effect on lactation length in Desi, HFX and Jersey crossbred cows maintained under farmers' managemental conditions in and around Patna (Bihar).

Prabhakar (2007) found significant ($P<0.01$) effect of lactation order on LL days. He observed that there was gradual increase in LL days from 1st to 3rd lactations after which it tended to decline in 4th and 5th & above lactations.

FARMING SYSTEM :

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

Kumar (2006) reported significant ($P<0.01$) effect of farming system on LL (days). He observed 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) found significant ($P<0.01$) effect of farming system on lactation length in Desi, HFX and JX cows maintained under

farmers' managemental conditions 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.

Prabhakar (2007) observed significantly (P<0.01) 15.311 days longer LL of the cows maintained in the dairy units integrated with agriculture farming than those units maintaining dairying alone in Desi, HFX and JX cows reared at farmers' door in and around Madhepura (Bihar).

PEAK YIELD :

AVERAGE : The average peak milk yield of cows under various genetic groups as reported by different authors are depicted 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 ± 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	10.40 ± 0.17 8.87 ± 0.24	Singh et al. (2004)

JH	8.82 ± 0.25	
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)
Desi HFX JX	5.824 ± 0.064 11.296 ± 0.108 9.846 ± 0.102	Prabhakar (2007)
Crossbreds having 50-75% exotic inheritance	10.58±0.12 kg	Kumar et al. (2009)

EFFECT OF GENETIC GROUP :

Jadhav et al. (1991) studied the effect of genetic group on peak yield in six Holstein x Sahiwal grades and reported 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) observed that grades of Hariana and its crosses with exotic dairy breeds had significant ($P<0.05$) effect on peak yield.

Dutt and Bhusan (2001) observed that genetic grade influenced significantly ($P<0.05$) the peak yield in half breds of HF, BS and Jersey with Hariana. However, they could not find significant effect of three breed grades on peak yield.

Priya Raj (2002) observed that the peak yield of crossbred cows of HF x local was significantly ($P<0.01$) higher than those of Jersey x local

crossbreds under farmers' managemental conditions in and around Patna (Bihar).

Kumar[2] (2004) studied the effect of genetic group on peak yield and observed 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) conducted an experiment to study 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 found the peak yield to be significantly ($P<0.05$) higher in ½ HF ½ H group in all the lactations. However, there was no 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 conditions in and around Patna (Bihar). He observed significant effect ($P<0.05$) of genotypes on peak yield. He further reported the highest peak yield (12.19kg) to be in HF crossbreds followed by Jersey crossbreds and Desi cows.

Kumar (2006) observed 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 reported 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 than Desi cows.

Kumar et al. (2007) compared the performance of crossbred progenies from the young bulls having 50-75% exotic inheritance under field conditions at KAU Trichur and PAU, Ludhiana. They reported the peak yield of cross bred progenies to be 10.58±0.12 kg.

Prabhakar (2007) studied the effect of genetic group consisting of crossbred cows of HF x local, Jersey x local and Desi cows maintained under farmers' managemental conditions in and around Madhepura (Bihar). He found significant effect ($P<0.01$) of genetic group on peak yield and observed that HF crossbreds had significantly ($P<0.05$) 5.472 kg and 1.45 kg higher peak yields than Desi and JX cows. Besides, JX cows had also significantly ($P<0.05$) 4.02 kg higher peak yield than Desi cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD:

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

Priya Raj (2002) reported that the different zones did not influence significantly the peak milk yield in HFX and Jersey crossbred cows maintained under farmers' managemental conditions in and around Patna.

Kumar[1] (2004) reported that the genetic group consisting of HFX, JX and Desi cows maintained in different zones under farmers' managemental conditions in and around Darbhanga (Bihar) had no significant effect on peak yield. .

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

Kumar (2006) found significant ($P<0.01$) effect of location of herd on peak yield in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) observed non-significant effect of location of herd on peak yield in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Madhepura (Bihar).

HERD SIZE :

Priya Raj (2002) studied the effect of size of herd on average peak milk yield in HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar). She observed non-significant effect of herd size on peak yield.

Kumar[1] (2004) reported that the size of the herd did not influence significantly the peak milk yield in different genetic groups of cattle maintained under farmers' managemental conditions in and around Darbhanga (Bihar).

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

Kumar (2006) found significant ($P<0.01$) effect of herd size on peak yield in Desi, HFX and JX cows maintained under farmers' managemental conditions in private dairy units. 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, the mean PY of the herd size of 9 & above and 7-8 did not differ significantly.

Prabhakar (2007) reported that peak yield of milk ranged from 8.920 kg to 9.125 kg in Desi, HFX and JX cows maintained under different herd

size groups at farmers' door in and around Madhepura (Bihar). He observed that herd-size did not play significant role on peak yield.

SEASON OF CALVING :

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

Singh et al. (1993) reported 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 non-significant effect of season of calving on peak milk yield in seven genetic groups involving HF, BS and Jersey crosses with Hariana cows.

Dutt and Bhusan (2001) observed that season of calving did not influence significantly the peak milk yield among half breds but it was the significant source of variation in three breed grades involving HF, BS and Jersey with Hariana.

Priya Raj (2002) observed 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.

Kumar[2] (2004) observed that season of calving did not influence significantly the peak milk yield in Hariana and its crosses with HF and Jersey.

Singh et al. (2004) found 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 non-significant effect of season of calving on peak milk yield in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar).

Das et al. (2006) reported that season of calving did not exert significant effect on peak yield in Jersey and Red Dane cows maintained at the Instructional livestock farm, College of veterinary science, Assam Agriculture University, Khanapara.

Kumar (2006) reported significant (P<0.05) effect of season of calving on peak yield in Desi, HFX and JX cows maintained under farmers' managemental conditions. 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.

Prabhakar (2007) reported non-significant effect of season of calving on peak yield in crossbred cows of HF x Desi, Jersey x Desi and Desi cows maintained at farmers' door in and around Madhepura (Bihar).

LACTATION ORDER :

Yadav et al. (1992) reported non-significant effect of sequence of lactation on peak milk yield in Sahiwal cows.

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

Zaman et al. (1998) observed significant (P<0.01) effect of lactation order on peak yield in Jersey cattle of Assam.

Bhattacharya et al. (1999) could not find significant effect of sequence of lactation on peak milk yield in Hariana cows.

Singh et al. (2000) observed significant ($P<0.01$) effect of sequence of lactation on peak milk yield in crossbred cows involving HF, BS and Jersey with Hariana up to 3 lactations. They reported 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, Desi and Jersey x Desi cows maintained in the private dairy units under farmers' managemental conditions. She found that the peak milk yield increased with the increase of the sequence of lactation up to 3rd lactation after which it tended to decline gradually.

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

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

Kumar (2006) observed that sequence of lactation had no significant effect on peak milk yield in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) reported significant ($P<0.05$) effect of lactation order on peak milk yield in Desi, HFX and JX cows maintained in private dairy units under farmers' managemental conditions in and around Madhepura (Bihar) He found the peak milk yield to be the lowest (8.834 kg)

in 1st lactation and the highest (9.399 kg) in 3rd lactation after which it tended to gradual decline in subsequent lactations.

FARMING SYSTEM :

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

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

Kumar (2006) observed 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 conditions in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) reported that dairy units integrated with agriculture had significantly ($P<0.01$) 0.569 kg higher peak yield than those maintaining dairying alone in Desi, HFX and JX cows under farmers' managemental conditions in and around Madhepura (Bihar).

DAYS TO ATTAIN PEAK MILK YIELD (DAPY) :

Table 4 : The average 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	Singh et al. (1993)
Hariana	51.83 ± 2.48	Bhattacharya 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)
Desi HFX JX	39.117 ± 0.341 44.343 ± 0.566 46.709 ± 0.554	Prabhakar (2007)

DAYS TO ATTAIN PEAK MILK YIELD (DAPY) :

EFFECT OF GENETIC GROUP :

Singh et al. (1993) observed that genetic group had no significant effect on DAPY in Sahiwal and its crosses with Jersey and Red Dane.

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

Kumar[2] (2004) found 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 significantly (P<0.01) influenced 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) conducted research to study the effect of genetic group on DAPY in Desi, HFX and Jersey crossbred cows maintained under farmers' managemental conditions in and around Patna (Bihar). He observed that HFX cows had significantly (P<0.05) shorter DAPY than Jersey crossbreds and Desi cows. He further reported that Jersey crossbreds had significantly (P<0.05) 9.82 days shorter DAPY than Desi cows.

Kumar (2006) observed that genetic group had significant (P<0.01) effect on DAPY in HFX, JX and Desi cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar). He observed that HFX had significantly (P<0.05) 9.03 days and 2.71 days lower DAPY than Desi and JX cows respectively. He further noted that JX cows had also significantly (P<0.05) 6.32 days lower DAPY than Desi cows.

Prabhakar (2007) reported significant (P<0.01) effect of genetic group in Desi, HFX and JX cows maintained in private dairy units under

farmers' managemental conditions in and around Madhepura (Bihar). He, observed that Desi cows had significantly (P<0.01) 5.226 days and 7.592 days lower DAPY than HFX and JX cows respectively. He further reported that HFX had also significantly (P<0.01) 2.366 days lower DAPY than JX cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Kumar[1] (2004) reported that different locations of herd did not influence the DAPY significantly in private dairy units maintained under farmers' managemental conditions.

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

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

Prabhakar (2007) reported non-significant effect of location of herd on DAPY in Desi, HFX and JX cows maintained in private dairy units under farmers' managemental conditions in and around Madhepura (Bihar).

HERD SIZE :

Kumar[1] (2004) conducted research to study the effect of size of herd on DAPY in cattle maintained under farmers' managemental conditions in and around Darbhanga (Bihar). He reported that the herd size had no significant effect on DAPY.

Kumar (2005) reported that the size of herd had no significant role on DAPY in Desi, HFX and JX cows in private dairy units maintained under farmers' managemental conditions in and around Patna (Bihar).

Kumar (2006) observed that the size of the herd did not influence the DAPY significantly in Desi, HFX and JX cows maintained under farmers' managemental conditions located in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) could not find any significant influence of herd size on DAPY in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Madhepura (Bihar).

SEASON OF CALVING :

Singh et al. (1993) observed that season of calving did not play significant role on DAPY in Sahiwal and its crosses with Jersey and Red Dane.

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

Kumar[1] (2004) reported 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 conditions. He further 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) reported the average DAPY to be the highest and the lowest during winter and summer seasons of calving respectively in Hariana and its cross with HF and Jersey.

Kumar (2005) reported that rainy calvers had significantly ($P<0.05$) lower days to attain peak yield than winter and summer calvers in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar).

Das et al. (2006) studied genetic and non-genetic factors affecting lactation milk yield of Jersey and Red Dane cows and observed that season of calving had no significant effect on days to attain peak yield.

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

Prabhakar (2007) studied the effect of genetic and non-genetic factors on milk production efficiency traits under farmers' managemental conditions in and around Madhepura (Bihar). He observed non-significant effect of season of calving in DAPY which ranged from 42.735±0.439 to 43.771±0.511 days.

LACTATION ORDER :

Zaman et al. (1998) reported non-significant effect of lactation order on days to attain peak yield in Jersey cattle of Assam.

Kumar[1] (2004) reported 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 conditions.

Kumar[2] (2004) observed that lactation order did not play significant role on DAPY in Hariana and it crosses with HF and Jersey.

Kumar (2005) observed that sequence of lactation had significant ($P<0.05$) effect on DAPY in Desi, HFX and JX cows maintained under farmers' managemental conditions. He found 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) reported significant ($P<0.01$) effect of lactation order on DAPY in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar). He found that 3rd & 4th lactations had significantly ($P<0.05$) lower DAPY than 1st, 2nd and 5th & above lactations.

Prabhakar (2007) reported that DAPY significantly ($P<0.05$) increased in 4th and above lactations than up to 3rd lactations in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Madhepura (Bihar).

FARMING SYSTEM

Kumar[1] (2004) observed that system of farming had no-significant effect on DAPY in Desi, HFX and JX cows maintained in private dairy units under farmers' managemental conditions.

Kumar (2005) reported that system of farming did not influence significantly the DAPY in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Patna.

Kumar (2006) reported that system of farming had non-significant role on DAPY in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharshrif of Nalanda district (Bihar).

Prabhakar (2007) obsrved that system of farming had no significant effect on DAPY in Desi, HFX and Jersey cows maintained under farmers' managemental conditions in and around Madhepura (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 depicted 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)
HF x 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)
Friesian crossbred	6.75	Tomar et al. (1998)
Friesian 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)
Desi HFX JX	3.811 ± 0.040 7.617 ± 0.068 6.691 ± 0.064	Prabhakar (2007)

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

EFFECT OF GENETIC GROUP :

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

Jadhav et al. (1991) observed that genetic group played significant (P<0.01) role on MY / day LL and reported that the production traits increased up to ½ grades after which they tended to decline gradually.

Thakur et al. (1999) observed that genetic groups involving Jersey and four indigenous breeds viz. Red Sindhi, Sahiwal, Tharparkar and Hariana had significant (P<0.05) effect on MY / day LL. They reported 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 conditions. They found 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) reported significant (P<0.01) influence 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 crossbred cows of HF and Jersey genetic groups respectively.

Bhattacharya et al. (2002) observed 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) reported significantly (P<0.01) higher MY / day LL in HFX than JX in un-organized private dairy units under farmers' managemental conditions in and around Patna (Bihar).

Akhter et al. (2003) studied 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 found 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. Besides, they also concluded that Friesian crosses were superior to all Jersey crossbreds.

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

Kumar[2] (2004) conducted an experiment to study the effect of different grades of HF and Jersey on MY / day LL. He observed that ½ HF ½ H had significantly (P<0.05) higher MY / day LL than all the genetic groups. He found 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) reported that both HFX and JX cows had significantly (P<0.05) more than double MY / day LL than Desi cows maintained in un-organized farm in and around Patna (Bihar). Besides, he also observed that HFX had significantly (P<0.05) 1.99 kg more MY / day LL than JX cows.

Sharan (2005) conducted research to study 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) observed significant (P<0.01) effect of genetic group on MY / day LL in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar). He reported 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 found that JX cows had also significantly (P<0.05) 2.88 kg higher MY / day LL than Desi cows.

Prabhakar (2007) reported significant (P<0.01) effect of genetic group on MY/day LL in HFX, JX and Desi cows maintained under farmers' managemental conditions in and around Madhepura (Bihar). He observed the highest MY/day LL 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 MY/day LL than Desi cows. He opined that HF crossbreds had more than double and Jersey crossbreds had nearly double 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-organized herd of Friesian and Zebu crossbreds and reported significant (P<0.05) effect of location of herd on it.

Priya Raj (2002) could not find significant effect of location on MY / day LL in crossbreds of HF and Jersey under farmers' managemental conditions in and around Patna (Bihar).

Kumar[1] (2004) observed that different locations did not play significant role on MY / day LL in Desi, HFX and JX cow in and around Darbhanga (Bihar).

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

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

Prabhakar (2007) could not find significant effect of different locations on MY/day LL in Desi, HFX and JX cows maintained under farmers' managemental conditions.

HERD SIZE :

Shrivastava and Singh (2000) studied the effect of herd size on MY/day LL and found that the size of the herd up to 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 conditions in and around Ranchi (Jharkhand).

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

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

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

Kumar (2006) conducted research to study the effect of herd size on MY / day LL in cows of different genetic groups maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar) and observed that the size of the herd had no significant effect on MY / day LL.

Prabhakar (2007) studied the effect of herd-size on MY/day LL in HFX, JX and Desi cows maintained under farmers' managemental conditions and reported that 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 respectively. However, he noted that the average MY/day LL of the herd size of 5-7 and 8 & above did not differ significantly.

SEASON OF CALVING :

Yadav and Rathi (1992) observed that season of calving had no significant role on MY / day LL in Hariana cows.

Yadav et al. (1992) reported that season of calving did not play significant role on MY / day LL in Sahiwal cows.

Singh et al. (1993) observed that season of calving had non-significant effect 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 that season of calving had non-significant effect 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 did not play significant role in MY / day LL in Friesian x Zebu crossbreds of un-organized farm located in and around Ranchi (Jharkhand).

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

Akhter et al. (2003) observed that season of calving did not play significant role 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) found significant ($P<0.01$) effect of season of calving on MY / day LL in Desi, HFX and JX cows maintained in un-organized dairy units located in and around Darbhanga (Bihar). He reported that calving during November-February had significantly ($P<0.01$) higher MY / day LL than those cows calved during other seasons.

Kumar[2] (2004) reported that season of calving had no significant effect on MY/day LL in Hariana and its crosses with HF and Jersey.

Kumar (2005) reported that season of calving did not play significant role on MY / day LL in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar).

Kumar (2006) reported that season of calving had non-significant effect on MY / day LL in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) studied the effect of season of calving on MY/day LL in HFX, JX and Desi cows maintained under farmers' managemental

conditions. He reported that season of calving had non-significant effect on MY/day LL.

LACTATION ORDER :

Yadav and Rathi (2002) found that both 2nd and 3rd lactations had significantly (P<0.05) higher MY / day LL than 1st lactation in Hariana cows.

Yadav et al. (1992) observed significant (P<0.05) effect of sequence of lactation on MY / day LL in Sahiwal cows.

Shrivastava and Singh (2000) reported that the MY / day LL increased significantly (P<0.05) up to 3rd lactation in Zebu cows crossed with Friesian maintained under farmers' managemental conditions in and around Ranchi (Jharkhand). They further reported that there were no significant differences in MY / day LL of 3rd to 5th lactations.

Singh et al. (2000) found that the 3rd lactation had significantly (P<0.05) higher MY / day LL than 1st & 2nd lactations in crossbreds of HF, Jersey and BS with Hariana.

Priya Raj (2002) observed that MY / day LL significantly (P<0.01) increased up to 3rd lactation after which it tended to decline in HFX and Jersey crossbred cows maintained in un-organized private dairy units located in and around Patna (Bihar).

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

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

Kumar (2005) reported that the average MY / day LL from 1st to 4th lactations did not differ significantly in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar) However, 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 reported that lactation order had no significant effect on MY / day LL.

Prabhakar (2007) observed significant ($P<0.01$) effect of MY/day LL in HFX, JX and Desi cows maintained under farmers' managemental conditions. He reported significant increase of MY/day LL up to 3rd lactation after which it tended to decline.

FARMING SYSTEM :

Kumar[1] (2004) reported that system of farming had no significant effect on MY / day LL in Desi and crossbred cows in un-organized private dairy units located in and around Darbhanga (Bihar).

Kumar (2005) observed 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-organized dairy units located in and around Patna (Bihar).

Kumar (2006) reported that system of farming had no significant effect on MY / day LL in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) reported that average MY/day LL of HFX, JX and Desi cows maintained in private dairy units integrated with agriculture had

significantly (P<0.01) 0.431 kg higher value than those having dairying alone.

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%		Sharan (2005)

HF 50% HF < 50% Hariana Pure	538.97±24.06 528.70±16.75 570.70±34.22	
Desi HFX JX	466.18±5.44 405.63±4.56 416.03±5.02	Kumar (2006)
Desi HFX JX	474.981±1.628 428.609±2.759 418.374±2.611	Prabhakar (2007)

EFFECT OF GENETIC GROUP :

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

Singh et al. (2000) studied the 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 and reported significant (P<0.01) effect of genetic group on it.

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

Akhter et al. (2003) observed 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.

Kumar (2005) observed 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 maintained under farmers' managemental conditions in and around Patna (Bihar). However, he

reported that the mean days of calving interval of HFX and Jersey crossbred cows did not differ significantly.

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

Kumar (2006) 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 maintained under farmers' managemental conditions.

Prabhakar (2007) reported significant ($P<0.01$) effect of genetic group on calving interval days in HFX, JX and Desi cows maintained under farmers' managemental conditions. He 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, he also found that HFX had also significantly ($P<0.05$) 46.372 days lower calving interval than Desi cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

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

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

Kumar[1] (2004) observed that different zones did not influence significantly the calving interval in Desi and crossbred cows under farmers' managemental conditions in and around Darbhanga (Bihar).

Kumar (2005) could not find significant effect of the location of herd on the calving interval in Desi and crossbred cows of HF and Jersey under farmers' managemental conditions in and around Patna (Bihar).

Kumar (2006) reported significant ($P<0.05$) effect 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 (Bihar).

Prabhakar (2007) observed significant ($P<0.01$) effect of location of herd on CI days in Desi and crossbred cows of HF x Desi and Jersey x Desi maintained in private dairy units under farmers' managemental conditions.

HERD SIZE :

Priya Raj (2002) reported that the size of herd did not influence significantly the calving interval in crossbred cows maintained under farmers' managemental conditions in and around Patna (Bihar).

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

Kumar (2005) could not find significant effect of size of herd on CI in Desi and crossbred cows of private dairy units maintained under farmers' managemental conditions in and around Patna (Bihar). However, he noted 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) observed significant ($P<0.01$) effect of herd size on CI in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) reported non-significant effect of herd size on calving interval days in HFX, JX and Desi cows maintained under farmers' managemental conditions in and around Madhepura (Bihar).

SEASON OF CALVING :

Jadhav et al. (1991) reported significant ($P<0.01$) effect of season of calving on CI and observed that autumn, rainy and winter calvers had significantly ($P<0.01$) lower days of calving interval than summer and spring calvers in 1st lactation of various Holstein x Sahiwal grades.

Yadav et al. (1992) observed that season of calving did not influence significantly CI in Sahiwal cows.

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

Singh et al. (2000) observed that season of calving did not play significant role on CI in seven genetic groups of crossbred cows involving HS, BS and Jersey with Hariana.

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

Akhter et al. (2003) observed significant ($P<0.05$) influence 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) found significant (P<0.01) effect of season of calving on CI in Desi, HFX and Jersey crossbred cows maintained under farmers' managemental conditions 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.

Kumar (2006) found 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 reported 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.

Prabhakar (2007) reported non-significant effect of season of calving on CI in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Madhepura (Bihar).

LACTATION ORDER :

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

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

Singh et al. (2000) reported significant (P<0.05) decline in CI (days) with the increase of parity of lactation in crossbred cows involving HF, BS and Jersey with Hariana.

Priya Raj (2002) reported significant (P<0.05) effect of sequence of calving on CI (days) in crossbred cows in private dairy units maintained under farmers' managemental conditions in and around Patna (Bihar).

However, she could not find any definite trend for the effect of sequence of lactation on this trait.

Kumar[1] (2004) observed that parity of lactation had significant ($P<0.01$) effect on CI (days) in Desi and crossbred cows maintained under farmers' managemental conditions in and around Darbhanga (Bihar). However, he also could not find any definite trend.

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

Sharan (2005) reported that sequence of lactation did not play significant role on CI (days) in Hariana and its crosses.

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

Prabhakar (2007) reported significant ($P<0.05$) effect of sequence of lactation in Desi, HFX and JX cows maintained under farmers' managemental conditions. He, however, observed that the average CI increased in 3rd and onwards lactations from 1st and 2nd.

FARMING SYSTEM :

Kumar[1] (2004) observed that farming system had no significant role on CI (days) in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Darbhanga (Bihar).

Kumar (2005) reported that system of farming had significant ($P<0.01$) effect on CI (days). He observed that cows maintained 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) found that the Desi, HFX and JX cows maintained under farmers' managemental conditions 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.

Prabhakar (2007) reported non-significant effect of system of farming on CI days in Desi and crossbred cows of HF x Desi and Jersey x Desi maintained under farmers' managemental conditions in and around Madhepura (Bihar).

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)
HF x Sahiwal	6.10 ± 0.12	Jadhav et al. (1991)
Hariana	3.49 ± 0.04	Yadav and Rathi

		(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)
Desi HFX JX	2.525 ± 0.032 5.725 ± 0.054 4.866 ± 0.051	Prabhakar (2007)

EFFECT OF GENETIC GROUP :

Jadhav et al. (1991) conducted research to study 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 observed significant ($P<0.05$) effect of genetic group on it. They reported 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) reported significant ($P<0.05$) effect of genetic group of cattle on MY / day CI maintained under farmers' managemental conditions and located in and around Ranchi (Jharkhand). They observed 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) reported significant (P<0.05) effect of genetic group on MY / day CI in 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) observed that genetic group had significant (P<0.01) role on MY/day CI. She found significantly (P<0.01) higher MY / day CI in HF crossbred cows than Jersey crossbreds in private dairy units maintained under farmers' managemental conditions in and around Patna (Bihar).

Akhter et al. (2003) conducted research to study 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 it.

Kumar[1] (2004) reported that HFX and JX had significantly (P<0.01) more than double MY / day CI than Desi cows maintained under farmers' managemental conditions in and around Darbhanga (Bihar). He further reported that HFX had higher MY / day CI than JX.

Kumar (2005) also reported that HFX and JX cows with Hariana had significantly (P<0.01) more than double MY / day CI than Desi cows maintained in private dairy units under farmers' managemental conditions in and around Patna (Bihar).

Sharan (2005) reported significant (P<0.05) effect of genetic group on MY / day CI in Hariana and its crosses with HF. 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) observed significant (P<0.05) effect of genetic group on MY / day CI in Desi, HFX and JX cows maintained under farmers' managemental conditions 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 had also significantly (P<0.05) 2.93 kg higher MY / day CI than Desi cows.

Prabhakar (2007) reported significant (P<0.01) effect of MY/day CI in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Madhepura (Bihar). He observed 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, JX had also significantly (P<0.05) 2.341kg higher MY/day CI than Desi cows. He opined that HFX had more than double and JX had nearly double MY/day CI than Desi cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

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

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

Priya Raj (2002) reported non-significant effect of location of herd on MY / day CI in HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar).

Kumar[1] (2004) observed that different zones in and around Darbhanga (Bihar) had no significant effect on MY / day CI in Desi and crossbred cows maintained under farmers' managemental conditions.

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

Kumar (2006) reported that location of herd did not influence significantly MY / day CI in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) observed non-significant effect of location of herd on MY/day CI in Desi, HFX and JX cows maintained under farmers' managemental conditions.

HERD SIZE :

Shrivastava and Singh (2000) observed 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 maintained in un-organised farm located in and around Ranchi (Jharkhand).

Priya Raj (2002) reported that the size of herd had no significant effect on MY / day CI in HFX and JX cows maintained under farmers' managemental conditions located in and around Patna (Bihar).

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

Kumar (2005) observed that the herd size had no significant influence on MY / day CI in Desi, HFX and JX cows maintained under farmers' managemental conditions 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 conditions in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) found that the size of herd had no significant effect on MY/day CI in Desi and Jersey x Desi cows maintained under farmers' managemental conditions.

SEASON OF CALVING :

Jadhav et al. (1991) reported significant ($P<0.01$) effect of season of calving 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) could not find significant effect of season of calving on MY / day CI in Sahiwal cows. However, they could observe the highest MY / day CI by winter calvers followed by summer and rainy calvers.

Yadav and Rathi (1992) reported that season of calving did not influence significantly the 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

maintained under farmers' managemental conditions in private dairy units located in and around Ranchi (Jharkhand).

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

Priya Raj (2002) reported that season of calving did not play significant role on MY / day CI in HFX and JX cows under farmers' managemental conditions in private dairy units located in and around Patna (Bihar).

Akhter et al. (2003) could find 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) reported significant ($P<0.01$) effect of season of calving on MY / day CI in Desi and crossbred cows maintained under farmers' managemental conditions in private dairy units located in and around Darbhanga (Bihar).

Kumar (2005) reported that season of calving did not play significant role 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 had significant ($P<0.05$) effect on MY / day CI in Desi, HFX and JX cows maintained in the private dairy units under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar). He reported 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.

Prabhakar (2007) observed non-significant effect of season of calving on MY/day CI in HFX, JX and Desi cows maintained under farmers' managemental conditions in and around Madhepura (Bihar).

LACTATION ORDER :

Vij et al. (1992) reported significant (P<0.01) effect of sequence of lactation on MY / day CI in Tharparkar cows. However, they could not find any definite trend for its effect on MY/day CI..

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

Yadav et al. (1992) observed that the MY/day of CI increased significantly (P<0.01) up to 3rd lactation in Sahiwal cows.

Shrivastava and Singh (2000) reported that sequence of lactation played significant (P<0.05) role on MY / day CI in three genetic grades of Holstein Friesian crosses with Zebu maintained under farmers' managemental conditions in private dairy units located in and around Ranchi (Jharkhand). They observed that the MY / day CI increased significantly (P<0.05) up to 3rd lactation.

Singh et al. (2000) reported significant (P<0.01) effect of parity 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 3rd lactation. However, the mean MY / day CI of 2nd and 3rd lactations did not differ significantly.

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

located in and around Patna (Bihar). She could find that MY / day CI increased up to 3rd lactation after which it tended to decline.

Kumar[1] (2004) observed significant (P<0.01) effect of parity of lactation on MY / day CI in cattle maintained under farmers' managemental conditions in private dairy units located in and around Darbhanga (Bihar). He noted that the MY / day CI increased up to 3rd lactation after which it declined.

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

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) studied the effect of sequence of lactation on MY / day CI in Desi, HFX and JX cows under farmers' managemental conditions He reported that although there was no any definite trend, yet the MY / day CI significantly (P<0.05) declined after 3rd & 4th lactations.

Prabhakar (2007) reported that season of calving had significant (P<0.01) effect on MY/day CI in HFX, JX and Desi cows maintained under farmers' managemental conditions in and around Madhepura (Bihar). The MY/day CI increased gradually up to 3rd sequence of lactation where it attained its maximum value after which it declined gradually.

FARMING SYSTEM :

Kumar[1] (2004) reported that farming system had no significant influence on MY / day CI in cows maintained under farmers' managemental conditions in private dairy units located in and around Darbhanga (Bihar).

Kumar (2005) reported non-significant influence of farming system on MY / day CI in Desi, HFX and JX cows maintained in the private dairy units located in and around Patna (Bihar). However, he could find 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.

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

Prabhakar (2007) reported that MY/day CI of HFX, JX and Desi 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.

DRY PERIOD :

The average dry periods as mentioned by various investigators are summarized 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	228.0±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)
Desi HFX JX	143.289 ± 0.682 115.084 ± 1.155 117.868 ± 1.093	Prabhakar (2007)

EFFECT OF GENETIC GROUP :

Priya Raj (2002) studied the effect of genetic group on dry period in HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar). She could not find significant effect of genetic group on it

Akhter et al. (2003) reported significant ($P<0.05$) 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.

Kumar[1] (2004) observed the effect of genetic group on dry period to be significant ($P<0.01$) in Desi, HFX and JX cows maintained under farmer's managemental conditions 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) reported significant (P<0.01) effect of genetic group on dry period in Hariana and its crosses with HF and Jersey. He found 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) observed 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) found significant (P<0.01) effect of genetic group on dry period days in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar). He observed the minimum dry period (72.85 days) 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 were found to be non-significant.

Prabhakar (2007) reported significant (P<0.01) effect of genetic group on dry period in Desi, HFX and JX cows under farmers' managemental conditions. He observed that HF crossbred and Jersey crossbred cows had significantly (P<0.05) 28.205 days and 25.421 days shorter dry periods than Desi cows. Besides, HFX cows had also 2.784 days shorter dry periods than JX cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Priya Raj (2002) conducted research to study the effect of different zones on dry period in HFX and JX cows maintained in the private dairy units located in and around Patna (Bihar). She reported non-significant effect of zones on dry period.

Kumar[1] (2004) reported that different zones had no significant effect on dry period in Desi, crossbred cows and graded buffaloes maintained under farmers' managemental conditions.

Kumar (2005) observed non-significant effect of different locations on dry period in Desi and crossbred cows maintained under farmers' managemental conditions in and around Patna (Bihar).

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 under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) observed non-significant effect of location of herd on dry period in Desi, HF crossbred and Jersey crossbred cows under farmers' managemental conditions.

HERD SIZE :

Priya Raj (2002) observed non-significant influence of herd size on dry period in HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar).

Kumar[1](2004) could not find significant effect of herd size on dry period in Desi and crossbred cows maintained under farmers' managemental conditions.

Kumar (2005) observed that the size of the herd had non-significant influence on dry period in Desi and crossbred cows of HF and Jersey with Desi maintained under farmers' managemental conditions in and around Patna (Bihar).

Kumar(2006) observed that the size of the herd had no significant influence on dry period (days) in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) reported that herd size did not play significant role on dry period in Desi, HFX and JX cows maintained under farmers' managemental conditions.

SEASON OF CALVING :

Vij et al. (1992) reported significant ($P<0.05$) effect of season of calving on dry period in Tharparkar cows. They observed that December-February calvers had shorter dry period as compared to other seasons of calving.

Singh et al.(1993) reported that the season of calving had no significant influence on the 1st dry period in Sahiwal and its crosses with Jersey and Red Dane.

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

Priya Raj (2002) observed that month of calving had no significant effect on dry period in HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar).

Akhter et al. (2003) reported significant ($P<0.05$) effect of season of calving on 1st dry period in crosses involving three exotic breeds viz. HF, J and RD with three Zebu breeds viz. Sahiwal, Red Sindhi and Hariana. They

observed that rainy calvers had the shortest dry period followed by spring, winter and summer.

Kumar[1] (2004) observed non-significant effect of season of calving on dry period in Desi and crossbred cows maintained under farmers' managemental conditions in and around Darbhanga (Bihar).

Kumar[2] (2004) reported 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 had no significant effect on dry period in Desi, HFX and JX crossbred cows in private dairy units located 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 maintained under farmers' managemental conditions in and 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.

Prabhakar (2007) could not find significant effect of season of calving on dry period in Desi, HFX and JX cows maintained under farmers' managemental conditions.

Raja and Narula (2008) reported non-significant effect of season of calving on 1st dry period in Sahiwal cows.

LACTATION ORDER :

Vij et al. (1992) observed significant ($P<0.01$) effect of sequence of lactation on dry period in Tharparkar cows. They reported that the dry period decreased after 2nd lactation and had an increasing tendency in 4th and 5th lactations.

Priya Raj (2002) observed significant ($P<0.05$) effect of parity of lactation on the dry period in crossbred cows of HF and Jersey with Zebu maintained under farmers' managemental conditions in and around Patna (Bihar).

Kumar[1] (2004) reported that parity of lactation had no significant effect on dry period in Desi and crossbred cows maintained under farmers' managemental conditions.

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

Kumar (2005) observed that parity of lactation had no significant effect on dry period in Desi, HFX and JX cows maintained under farmers' managemental conditions.

Kumar(2006) studied the effect of the parity of lactation on dry period in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district of (Bihar). He reported 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.

Prabhakar (2007) observed significant ($P<0.01$) effect of lactation order on dry period in Desi, HFX and JX cows. He opined that there was gradual decline in dry period days up to 3rd sequence of lactation after which it significantly increased.

FARMING SYSTEM :

Kumar[1] (2004) found non-significant effect of farming system on dry period in Desi and crossbred cows maintained under farmers' managemental conditions in and around Darbhanga (Bihar).

Kumar (2005) observed significant (P<0.01) influence of farming system on dry period. He found 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) observed that Desi, HFX and JX 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.

Prabhakar (2007) reported that Desi, HFX and JX 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 under farmers' managemental conditions.

NET COST :

GENETIC GROUP :

Priya Raj (2002) found the average net cost of per kg milk production of HF crossbred cows to be significantly (P<0.05) lower than Jersey crossbred cows maintained in the private dairy units located in and around Patna (Bihar).

Kumar[1] (2004) found significant (P<0.01) effect of genetic group on net cost of milk production. He observed 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) reported significant (P<0.01) effect of genotypes on net cost of per kg of milk production and found that HF crossbreds had the lowest cost of per kg milk production. He further observed that the average net cost per kg of milk produced of 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 noted 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) observed significant (P<0.01) effect of genetic group on net cost per kg of milk production in the dairy units maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar). He found 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 suggesting HF crossbreds to be the most economical followed by Jersey crossbreds and Desi cows.

Prabhakar (2007) studied the effect of genetic group on net cost of per kg milk production in Desi, HFX and JX cows under farmers' managemental conditions. He observed that HF crossbred cows had the lowest net cost per kg of milk production followed by Jersey crossbreds and Desi cows. He found that 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, he also observed that JX cows had also significantly (P<0.05) lower net cost per kg of milk production than Desi cows.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

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

Priya Raj (2002) reported that location of herd did not play significant role on net cost of per kg milk production in cows maintained in Khatals in and around 15 kms of Patna (Bihar).

Kumar[1] (2004) found significant ($P<0.01$) effect of zones on net cost of milk production in milch cows maintained under farmers' managemental conditions in and around Darbhanga (Bihar).

Kumar (2005) found that the location of herd played significant ($P<0.01$) role 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) reported that location of herd had significant ($P<0.05$) effect on average net cost per kg of milk production of Desi, HFX and JX cows maintained under farmers' managemental conditions.

Prabhakar (2007) reported non-significant effect of location of herd on net cost per kg of milk production in Desi, HF crossbreed and Jersey crossbred cows with Desi under farmers' managemental conditions.

HERD SIZE :

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

Priya Raj (2002) reported 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) observed that herd size had significant (P<0.01) effect on net cost per kg of milk production in Desi, HFX and JX cows maintained under farmers' managemental conditions 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) reported significant (P<0.01) effect of herd size on net cost per kg of milk production in Desi, HFX and JX cows maintained under farmers' managemental conditions. He found the average net cost per kg of milk production in the size of 7 & above milch cows to be significantly (P<0.01) Re. 0.48 lower than the herd size of 3-6 cows.

Kumar (2006) observed that the herd size played significant (P<0.01) effect on net cost per kg of milk production. He could find 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.

Prabhakar (2007) observed that the average net cost per kg of milk production of herd size 8 & above was significantly (P<0.05) lower by Re. 0.238 and Re. 0.213 than the herd sizes of 3-4 and 5-7 respectively in the cows maintained under farmers' managemental conditions.

SEASON OF CALVING :

Priya Raj (2002) observed that the season of calving had non-significant effect on net cost of per kg milk production in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Patna (Bihar).

Kumar[1] (2004) observed that season of calving had significant (P<0.01) role on net cost per kg of milk production in Desi, HFX and JX cows under farmers' managemental conditions in and around Darbhanga (Bihar).

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

Kumar (2006) observed significant (P<0.01) effect of net cost per kg of milk production in Desi, HFX and JX cows maintained under farmers' managemental conditions. He found that winter and rainy calvers had significantly (P<0.05) Re. 0.74 and Re. 0.45 lower net cost per kg of milk production than summer calvers.

Prabhakar (2007) reported that season of calving had non-significant effect on net cost per kg of milk production in Desi and crossbred cows of HF and Jersey with Desi under farmers' managemental conditions. He observed that the average net cost per kg of milk ranged from Rs. 9.187 to Rs. 9.298 in different seasons.

LACTATION ORDER:

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

Kumar[1] (2004) observed that the net cost of per kg milk production during 3rd lactation was significantly (P<0.05) lower than all the sequences up to 5th parity in milch cows maintained under farmers' managemental conditions.

Kumar (2005) reported significant (P<0.05) effect of sequence of lactation on the net cost per kg of milk production in Desi and crossbred cows maintained under farmers' managemental conditions in and around Patna (Bihar). He found 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 had no significant effect on net cost per kg of milk production. 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 there by it increased in subsequent lactations.

Prabhakar (2007) observed the lowest net cost per kg of milk production in 3rd sequence of lactation in Desi and crossbred cows of HF and Jersey with Desi maintained under farmers' managemental conditions. However, he could not find significant differences in average net cost per kg of milk production of 1st 2nd and 4th lactations.

FARMING SYSTEM:

Kumar[1] (2004) observed that the cows 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 conditions.

Kumar (2005) observed non-significant effect of farming system on net cost/kg milk production under farmers' managemental conditions.

Kumar (2006) reported that the system of farming had no significant effect on net cost per kg of milk production in Desi, HFX and JX cows maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar).

Prabhakar (2007) reported significantly ($P<0.01$) Re. 0.515 lower average net cost per kg of milk production in Desi, HFX and JX cows maintained in the dairy units integrated with agriculture than those maintaining dairying alone under farmers' managemental conditions.

ECONOMICS OF MILK PRODUCTION :

Singh et al. (1986[a]) opined HF crossbreds to be the "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 could observe the Jersey crossbred cows to be more economical milk producer, more adaptable, more resistant to stress conditions and better performance of male calves.

Kalra et al. (1995) found 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 noted 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) reported that among the various cost items of milk production, feed cost shared highest followed by labour cost, interest of fixed assets, depreciation of animal and veterinary and miscellaneous

expenditure in different breeds of cattle and buffalo of Gopalganj district in Bihar.

Chanadra and Agarwal (2000) observed that among the variable cost items, feeds and fodder shared 69.8% of the gross cost of maintenance in crossbred cows. They found the labour cost to be 21,5% in it.

Priya Raj (2002) observed that feeds and fodders contributed 63.4% and 65.41% in HFX and JX cows respectively maintained under farmers' managemental conditions.

Kumar[1] (2004) observed that the feed cost contributed maximum amount of variable cost in Desi, HFX and JX cows. He found 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 maintained under farmers' managemental conditions.

Kumar (2005) observed that among the variable cost items, feed cost contributed 69.95%, 71.70% and 69.88% in Desi, HFX and JX cows respectively maintained under farmers' managemental conditions. The respective percentage of labour cost were noted to be 12.79, 14.89 and 17.19.

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

Prabhakar (2007) reported that the feed cost contributed 70.817%, 72.70% and 70.929% of gross cost per kg of milk production in Desi, HFX and JX cows respectively maintained under farmers' managemental conditions in Madhepura district of Bihar. He further observed the corresponding percentages of labour cost to be 12.60, 14.645 and 16.108. He noted the overall feed cost, labour cost, depreciation, veterinary and A.I. cost, interest on fixed capital and miscellaneous cost to be 71.425%, 14.383%, 4.442%, 2.162%, 4.805% and 2.588% respectively.

Bhowmik and Sirohi (2008) conducted an experiment to workout the cost and returns on milk production in rural area of South Tripura to examine the relative economics of crossbred and local cows. They reported the average productivity of a crossbred and local cows to be Rs. 2.97 / litres /day and 1.04 literes /day respectively. They observed that the concentrate input accounted for 50-60% of the net cost and the average cost of milk production was Rs. 9.40/litres and 19.26/litres for crossbred and local cows respectively. They opined that the net return was positive from crossbred and negative from local cows. They conducted that the dairy development efforts in the region should focus on promoting crossbreding as it provided a handsome profit margin to the farmers.

CONSTARINS IN LIVESTOCK FARMING:

Rajendran and Prabhaharan (1993) observed five main constraints which ranked in order were observed to be higher incidence of repeat breeding, 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) opined the urgent need of employing more extension efforts for following proper artificial insemination schedule by the dairy owners.

Priya Raj (2002) observed the main constraints perceived by dairy owners in and around Patna 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) presented the main constraints in dairy sectors perceived by the respondents under four categories viz. technical, economic, organizational and social. They found the major technical constraints to be repeat breeding of cows, low conception rate through A.I., calf mortality and poor knowledge of heat detection whereas they noted the economic constrains to be lack of credit facilities, high cost of veterinary services and non-availability of green fodder. They observed the major organizational constraints to be distant location of A.I. centre, lack of motivation by extension workers and non-availability of A.I. facility and the main social constraints perceived by the dairy farmers to be illiteracy, lack of support from elders and social dogma.

Kumar [1] (2004) observed ten major constraints perceived by the dairy farmers' in Desi and crossbred cows of HF and Jersey with Desi maintained under farmers' managemental conditions. He ranked them as 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) noted the major constraints perceived by the dairy farmers in rearing Desi, HFX and JX cows maintained under farmers' managemental conditions. 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) observed eleven major constraints perceived by the owners of dairy units maintained under farmers' managemental conditions in and around Biharsharif of Nalanda district (Bihar). These constraints were observed in rearing Desi, HFX and JX cows 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, non-availability of green fodders throughout the year, lack of finance/credit facilities, uneconomical crossbred male calves and non-remunerative price of milk.

Prabhakar (2007) reported eleven major constraints perceived by the dairy owners in private dairy units maintained under farmers' managemental conditions in and around Madhepura (Bihar). These constraints ranked in

order as high cost of feed, 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 fodders throughout the year, uneconomical crossbred male calves, lack of credit facility and non-remunerative price of milk.

MATERIALS AND METHODS

MATERIALS AND METHODS

Source of Data :

The research under study was carried out on Desi and HF crossbred and Jersey crossbred cows maintained in private dairy units located in a radius of about 20 kms in and around Jehanabad (Bihar).

Area of Experimentation :

The whole area under investigation was divided into four distinct zones/Blocks consisting of following villages /Mohalla. :

Table - 9 : Location-wise villages of area of experimentation.

Sl. No.	Zone No.	Zone	Villages
1	I	Jehanabad	Malahchack, Panchmahla, Lok Nagar, Kutamon chack
2	II	Ghosi	Dehuni, Gopalganj, Mirabigha, Bharthu, Gorsar, Jhamanabigha
3	III	Kako	Kako, Maniyama, Dersaiya, Mahmadpur
4	IV	Modanganj	Bandhuganj, Peuta, Karhara, Mahamdpur, Baina, Gandhar

Primary Survey :

The primary survey was conducted in the private dairy units popularly known as 'Khatals' as well as animals maintained by the dairy farmers' at their doors, located in a radius of about 20 kms in and around Jehanabad. '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 investigation. A total of 1129 cows consisting Desi, HFX and JX cows were enumerated from 220 dairy units located in and around Jehanabad (Bihar) which are tabulated below :

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

Location of the Zones	Dairy units enumerated	Genetic groups			
		Desi	HFX	J X	Total
I	48	131	130	98	359
II	54	122	88	66	276
III	57	99	73	59	231
IV	61	123	78	62	263
Total	**220**	**475**	**369**	**285**	**1129**

General managerial practices of dairy units :

In each Khatals the managerial practices were different. The cows, in general, were stallfed with individual feeding. Cows were provided the concentrates on the basis of their physical and physiological status such as size of the body, milk production, order of lactations, dry period , body weight etc.

Apart from few exceptions, animals were fed home made concentrates. The most common items of dry fodder consisted of wheat bhoosa and choffed paddy. Seasonal cultivated and un-cultivated grasses were the chief source of green fodder. There was general practice to add mineral mixture, vitamins and common salt to balance the ration. Most of the dairy units were not following the scientific schedule of vaccination. However, the farmers used to take prophylactic and curative measures against various diseases. Besides, A.I. was also in common practice for breeding the cows in most of the dairy units.

The housing facilities maintained in the dairy units were not scientific. The cows were maintained in four types of houses such as

Kachcha, ½ Kachcha and ¾ pucca and also full pucca houses. The different types of houses are categorised as below.

Type A - Full kachcha house

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

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

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

Respondent Units :

Out of 220 enumerated units, only 198 units provided relevant informations which were defined as 'respondent units'. Data were obtained from them and considered for further investigation. These respondent units consisted of 398 Desi, 301 HFX and 243 JX cows. The location-wise distribution of the respondent units along with cows of different genetic groups are tabulated as follow:

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

Location o the Zones	Respondent dairy units	Crossbred cows			
		Desi	HFX	J X	Total
I	46	117	119	90	326
II	52	99	70	55	224
III	48	88	53	48	189
IV	52	94	59	50	203
Total	**198**	**398**	**301**	**243**	**942**

Sampling of respondent units :

There were total 198 units of which 50% i.e. 99 dairy units consisting of 642 cows of different genetic groups were randomly selected utilizing procedures of "stratified random sampling with proportional

allocation" (Snedecor and Cochran, 1967). The location-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 in table-12.

A total of 300 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 : Location-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					
No. of cows studied					
Desi	59	41	32	31	163
HFX	102	63	47	46	258
JX	85	49	42	45	221
Total	**246**	**153**	**121**	**122**	**642**
Discarded Cows					
Desi	58	58	56	63	235
HFX	17	07	06	13	43
JX	05	06	06	05	22
Total (B)	**80**	**71**	**68**	**81**	**300**

Collection of data :

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

The information consisting of location, herd size, farming system, genetic group and measures of production, reproduction and economic efficiencies were noted. These consisted of the followings :

Information of the unit :

(a) Zone / location

(b) Herd-constitution

(c) 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) (LMY)

(b) Lactation length (days) (LL)

(c) Peak yield (kg) (PY)

(d) Days to attain peak yield (days) (DAPY)

(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) (DP)

(b) Calving interval (days) (CI)

(D) Measure of economic efficiency

(a) Cost of milk production

The distribution of Desi, and crossbred cows with the details of herd size, season of calving, farming system and sequence of lactation has been mentioned in table-13.

The selected respondent units were given the schedule and questionnaires for recording the information as per the objective of the research. 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 noted and also included in this study. They also provided some relevant information apart from the objectives of this study which were recorded for future reference and guidance.

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 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 Jehanabad (Bihar)

Genetic group	No. of animal	Total
Desi	163	642
HFX	258	
JX	221	
Non-Genetic group		
Location /Zone		
I	246	642
II	153	
III	121	
IV	122	
Herd size		
3 - 4	150	642
5 - 7	105	
8 & above	387	
Lactation order		
1st	138	642
2nd	172	
3rd	188	
4th	117	
5th & above	27	
Season of Calving		
Winter	146	642
Summer	229	
Rainy	267	
Farming system		
Dairying alone	47	642
Agriculture + Dairying	595	

Cost of milk production :

The measure of cost of milk production of a cow was considered as the "net cost of maintenance of a cows for each kg of milk she produced in an inter-calving period". Therefore, 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 different expenditure items on maintenance of a cow were categorized mainly 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 Jehanabad could be derived on the basis of exact purchase cost of 100 cows, their milk yield and sequence of lactation 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 2000.00
2	Milk yield (kg) x 1800.00
3	Milk yield (kg) x 1500.00
4	Milk yield (kg) x 1300.00
5 & above	Milk yield (kg) x 1000.00

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 Jehanabad (Bihar). The following approximate rates were utilized to estimate the cost of houses built up in and around Jehanabad (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 idea behind fixation of housing cost was to provide 40 sft. covered area to each cow. The construction cost of trough etc. varied depending upon 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 estimated to be for 25 yrs. Depreciation on housing

was estimated as 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 :

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

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 of all the 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 calculated 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 keeping in view that utensils, equipments, machineries etc. of a Khatal were equally used for each animal at that Khatal irrespective of its level of milk production. Thus, this cost item was considered as fixed for each 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 calculated out @ 8% per annum.

Variable cost item :

(a) Cost of feeds and fodders: The average quantity of fodder fed to each 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. The expenditure of concentrates was calculated as the rates of purchase of concentrate ration or its ingredient along with its transportation cost. The seasonal variation in the market rates of different feeds and fodders were also considered. In this way, the average daily expenditure for feed and fodders was worked out for each cow under investigation.

(b) Labour cost : The 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.

(c) Cost of A.I. and Veterinary aids : Cost of items for A.I. and veterinary aids consisted of cost of medicines, semen, vaccines, and other sanitary items along with 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 investigation.

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

The miscellaneous cost 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 included expenditure on all cost components viz. depreciation on animal, building/shed, equipment, farm machinery, utensils etc, interest on fixed capital, cost of feed and fodders, labour cost, veterinary aids cost 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 included the 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, keeping in viewthat 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 Jehanabad (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 :

Net cost of maintenance 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 noted 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, season of calving , sequence of lactation and farming system to study 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 : Jehanabad

Zone II : Ghoshi

Zone III : Kako

Zone IV : Modanganj

(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) Season of calving :

The year was classified into 3 seasons as mentioned below :

(i) Winter : November - February

(ii) Summer : March - June

(iii) Rainy : July - October

(5) Lactation parity :

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

(i) 1st Parity

(ii) 2nd Parity

(iii) 3rd Parity

(iv) 4th parity

(v) 5th and above parity

(6) Farming system :

The dairy units were classified according to the system of farming adopted by the farmers which included:

(i) Only animal husbandry

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

Statistical Methods :

Research data obtained in the study were statistically analyzed 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 ..... 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.

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

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 ($i = 1, 2, 3, \ldots\ldots\ldots\ldots K$ and $j = 1, 2, 3, \ldots\ldots\ldots\ldots n_i$), 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 :

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

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) **through Computer in Deptt. of 'Livestock Economics and Statistics' at Indian Veterinary Research Institute, Izzatnagar, Bareilly (U.P.)** to study the effect of genetic and various non-genetic factors on milk production efficiency traits. The following mathematical model was used :

$Y_{ijklmno} = \mu + G_i + HL_j + HS_k + L_l + S_m + Z_n + e_{ijklmno}$

where $Y_{ijklmno}$ is the value of o^{th} individual under i^{th} genetic group, j^{th} location, k^{th} herd size, l^{th} lactation order, m^{th} season of calving and n^{th} farming system

μ = Overall general mean

G_i = The effect i^{th} genetic group (i = 1, 2, 3)

HL_j = The effect of j^{th} location of herd (j = 1, 2, 3, 4)

Hs_k = The effect of k^{th} herd size (k = 1, 2, 3)

L_l = The effect of l^{th} lactation order (l=1, 2, 3, 4, 5)

S_m = The effect of m^{th} season of calving (m = 1, 2, 3)

Z_n = The effect of n^{th} farming system (n = 1, 2)

$e_{ijklmno}$ = the random error which is distributed normally and independently with mean o and variance σ^2_e.

Duncans' Multiple Range (DMR) test as modified by Kramer, (1957) was used for pair-wise comparison of the least squares means at 5% or 1% levels of probability.

Constraints in dairy farming :

The important technological and managemental problems as perceived by the dairy farmers in maintaining the dairy units in and around Jehanabad (Bihar) was recorded. Garett's ranking technique was used to rank the problems. The order of merit given by the respondents were noted and 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.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

LACTATION MILK YIELD (LMY) :

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

Average LMY:

Average lactation milk yield was observed to be 1009.16 kg, 2410.68 kg and 1974.67 kg in Desi, HFX and JX cows respectively in this study.

Literature revealed the ranges for Desi to be from 693.2 kg (Parmar et al., 1986) to 1935.61 kg (Vij et al., 1992), for HFX from 1204.51 kg (Sharan, 2005) to 3655.1 kg (Singh et al., 1986[a]) and for JX from 1256.8 kg (Thakur et al., 1999) to 2681.11 kg (Patel and Trivedi, 1989) (Table 1). The findings of the present study fell in the above ranges mentioned in the literature. Differences in the genetic group of indigenous cows, levels of exotic inheritance of HF and Jersey, managemental and environmental differences might be attributed to the variations in the mean LMY of the three genetic groups.

Effect of Genotypes :

Least squares analysis of variance (Table-16) reflected highly significant ($P<0.01$) effect of genotypes on LMY. The highest LMY (2410.68 kg) was observed to be in HFX followed by JX (1974.67 kg) and

Desi (1009.16 kg). HFX cows had significantly (P<0.01) 1401.52 kg and 436.01 kg higher LMY than Desi and JX cows respectively. Besides, JX cows had also 965.51 kg higher LMY than Desi cows maintained in the Jehanabad district of Bihar. A critical analysis of the findings revealed that HFX had nearly two and a half times and JX cows had also nearly double LMY than Desi cows. These findings suggested that both HF and Jersey are well adapted in the agro-climatic environment of Jehanabad district in Bihar and performed well in this environment.

Raj Kumar (1985) reported almost double higher LMY in JX, Kumar[1] (2004) obtained highest LMY in ½ HF ½ H genetic group followed by ½ J ½ H, Kumar[2] (2004) observed more than double LMY in ½ HF ½ H genetic group than Hariana, Kumar (2005) observed nearly three times higher LMY in HFX and JX cows than Desi, Sharan (2005) obtained more than double LMY in ½ HF ½ H genetic group than Hariana and Kumar (2006) and Prabhakar (2007) observed more than double LMY in HFX and JX cows than desi under farmers' managemental conditions.

The findings of all the above authors are similar to the results obtained in the present study. Besides, significant (P<0.01) effect of genetic group on LMY have also been reported by various authors (Panda and Sadhu, 1983; Hayatnagarkar et al., 1990; Jadhav et al., 1991; Singh et al., 1993; Thakur et al., 1999; Priya Raj, 2002; Akhter et al., 2003; Bhaduria

and Katpatal, 2003 and Hussain et al., 2008) which are in close agreement with the findings of the present study.

It is worth mentioning that although HFX cows had more LMY than JX cows, yet many of the dairy farmers of Jehanabad district of Bihar, during questionnaires, preferred JX cows over HFX cows because of higher fat percentage in the milk of JX cows, more docile in nature of JX, more use of Jersey crossbred male calves and comparatively more resistant to diseases of JX.

EFFECT OF NON-GENETIC FACTORS :

Location of herd (Zones) :

Lactation milk yield in different locations ranged from 1790.35 kg in zone II to 1805.31 kg in zone I. Least squares analysis of variance (table-16) presented non-significant effect of locations (zones) on LMY. Priya Raj (2002) in HFX and JX cows, Bhadauria and katpatal (2003) in HF x Sahiwal crosses and Kumar[1] (2004) in HFX, JX and Desi cows observed non-significant effect of location of herd on LMY under farmers' managemental conditions which are in conformity with the findings of the present study. It is to be mentioned that all the four zones under study were located in a radius of about 20 kms. only in the district of Jehanabad having similar agro-climatic environment, feeding schedule and managemental practices which might have reflected into similar and non significant effect

of location on LMY. However, contrary to the findings of the present study, Singh et al. (1986[b]), Hayatnagarkar et al. (1990), Jadhav et al. (1990), Kumar (2005) and Prabhakar (2007) observed significant effect of location on LMY which might be attributed to the differences in the agro-climatic regions of different zones and variations in feeding schedules and managemental practices.

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.	M.S.S.	
		Lactation Milk yield	Lactation length
Genetic group	2	95822860.0**	5445.385**
Location of herd	3	6507.816^{NS}	222.3635^{NS}
Herd size	2	27625.98^{NS}	360.1665^{NS}
Lactation order	4	36615.60^{NS}	403.4417^{NS}
Season of calving	2	11614.14^{NS}	775.4612^{NS}
Farming system	1	248.9412^{NS}	1.605080^{NS}
Error	627	20554.31	304.5614

**** Significant at (P<0.01); NS – Non-significant**

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
Overall mean (μ)	1798.17±12.25	333.12±1.49
Genetic factors		
Desi	1009.16[a]±15.52	335.68[a]±1.89
HF crossbred	2410.68[b]±14.37	336.37[a]±1.75
Jersey crossbred	1974.67[c]±14.43	327.33[b]±1.76
Non-genetic factors		
Location of herd (zones)		
I	1805.31±17.14	331.34±2.09
II	1790.35±14.51	334.11±1.77
III	1794.39±17.19	333.01±2.09
IV	1802.61±17.04	334.04±2.08
Herd size		
3 - 4	1803.66±16.75	331.19±2.04
5 - 7	1808.79±16.58	334.32±2.02
8 & above	1782.05±14.85	333.86±1.81
Season of calving		
Winter	1788.47±15.97	330.69±1.94
Summer	1802.36±14.44	333.90±1.76
Rainy	1803.67±14.08	334.78±1.71
Lactation order		
1st	1781.40±15.82	331.85±1.93
2nd	1819.89±14.99	330.61±1.82
3rd	1785.75±1419	331.90±1.73
4th	1800.09±16.70	332.30±2.03
5th & above	1803.73±29.55	338.96±3.60
Farming system		
Dairying alone	1796.89±22.28	333.02±2.71
Agriculture + Dairying	1799.44±8.52	333.23±1.04

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

Herd size :

Table -16 of least squares analysis of variance presented that the size of herd did not influence LMY in this study. The mean LMY ranged from 1782.05 kg in 8 & above herd size to 1808.79 kg in the size of 5-7. Priya Raj (2002) in HFX and JX cows and Prabhakar (2007) in HFX, JX and Desi cows under farmers' managemental conditions reported non-significant effect of herd size on LMY which are in close agreement with the findings of the present study. However, Shrivastava et al. (1998), Kumar[1] (2004) and Kumar (2005) observed significant effect of herd size on LMY.

SEASON OF CALVING :

Least squares analysis of variance (Table -16) revealed that season of calving did not play significant role on LMY. Jadhav et al. (1991) , Yadav and Rathi (1992), Singh et al. (1993), Raheja (1997), Thakur et al. (1999), Singh et al., (2000), Shiv Prasad (2003), Bhadauria and Katpatal (2003), Kumar[2] (2004), Prabhakar (2007), Singh and Singh (2008) and Thorat et al. (2008) reported non-significant effect of season of calving on LMY in various indigenous and their crosses with exotic breeds like HF, Jersey and Red Dane. The findings of the present research are similar to the results obtained by the above mentioned authors. Non-significant effect of season of calving obtained in this study might be due to uniform management of lactating animals under same animal husbandry and feeding practices. However, Kumar[1] (2004), Kumar (2005), Sharan (2005) and Kumar (2006),

contrary to the findings of the present study, observed significantly ($P<0.05$) lower LMY during summer seasons which might be, possibly, due to higher environmental temperature and scarcity of green forage.

LACTATION ORDER :

Least squares analysis of variance (Table-16) presented non-significant effect of lactation order on LMY. Kumar[2] (2004) in Hariana and its crosses with HF and Kumar (2006) in Desi, HFX and JX cows reported non-significant effect of parity of lactation on LMY under farmers' managemental conditions. The findings of the present study are in conformity with the findings of the above mentioned authors. However, Raj Kumar (1985), Priya Raj (2002), Shiv Prasad (2003), Kulkarni et al. (2003) and Prabhakar (2007) observed significant ($P<0.05$) effect of sequence of lactation on LMY.

FARMING SYSTEM :

As revealed through least squares analysis of variance (Table-16), the system of farming did not play significant role on LMY. Kumar[1] (2004) also reported non-significant effect of farming system on LMY in Desi and crossbred cattle maintained under farmers' managemental conditions in Darbhanga district of Bihar. The findings of the present study are similar to the results reported by Kumar[1] (2004). Non-significant effect of farming system on LMY is suggestive of the fact that dairy farmers of Jehanabad

district without having integration with agriculture could manage to provide similar feeding schedule and managemental practices to their dairy animals as provided by those having integration with agriculture. However, Kumar (2005), Kumar (2006), and Prabhakar (2007) reported that cows maintained in the dairy units integrated with agriculture had higher LMY than those maintained in the units involving dairying alone which might be due to quality and timely green fodder production by the farmers' for their lactating cows.

LACTATION LENGTH (LL) :

Least squares means of Lactation length in Desi, HFX and JX cows were obtained as 335.68±1.89 days, 336.37±1.75days and 327.33±1.76days respectively (Table-17). Literature revealed the ranges of lactation length days to be from 262.585 (Prabhakar, 2007) to 385.3 days. (Parmar et al., 1986) for indigenous cows, from 247.87 days (Bhattacharya et al., 2002) to 432.7 days (Parmar et al., 1986) for HFX and from 306.08days (Singh et al., 1993) to 462.69 days (Kumar[2] 2004) for JX cows. The findings of the present study for all the three genetic groups fell in the ranges mentioned above. However, the findings of this study is very close to the mean lactation lengths reported by Pundir and Raheja (1997) for Desi cows, Kumar[2] (2004) for HFX and Chopra (1990) for JX cows who reported these values to be 334.44 days, 334.85 days and 328.3days respectively. Variations in mean LL days might be attributed to the differences in breeds

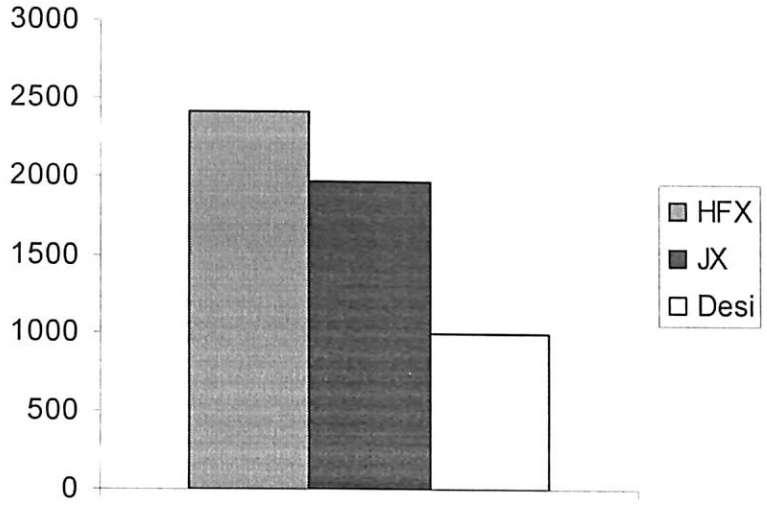

Figure 1: Lactation milk yield (kg) in HFX, JX and Desi cows under farmers' managemental conditions in Jehanabad district of Bihar

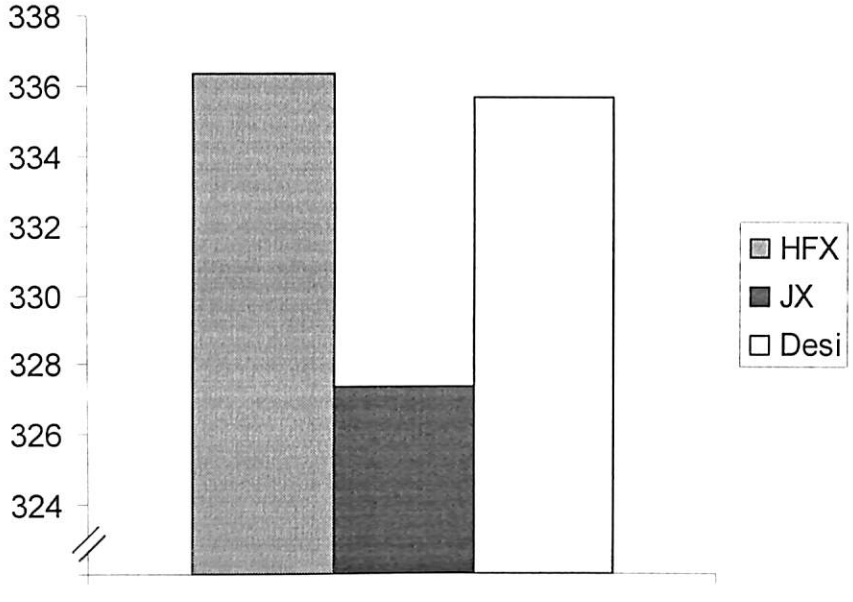

Figure 2: Lactation length (days) in HFX, JX and Desi cows under farmers' managemental conditions in Jehanabad district of Bihar

of indigenous cows, levels of exotic inheritance of HF and Jersey along with managemental and environmental differences.

EFFECT OF GENETIC FACTORS :

Least squares analysis of variance (Table-16) presented highly significant ($P<0.01$) effect of genetic group on LL (days). HF crossbreds had the highest (336.37 days) LL days followed by Desi and JX cows. Duncan's Multiple Range Test revealed that the mean LL days of Desi and HFX did not differ significantly although HF crossbreds had 0.69 days longer LL days than Desi cows. But both Desi and HFX had significantly ($P<0.01$) 8.35 days and 9.04 days longer LL than JX cows. Significant ($P<0.01$) effect of genetic groups on LL days have also been reported by Thakur et al.(1999), Sharan (2005), Kumar (2006) and Prabhakar (2007). Kumar (2006) reported longer LL days of Desi cows than JX cows and Prabhakar (2007) observed longest LL days to be in HFX cows. The findings of the present study are in conformity with the findings of both the authors mentioned above. However, contrary to the findings of the present study, Kumar et al. (2007) observed non-significant influence of genetic group on LL days.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Least squares analysis of variance (Table-16) reflected non-significant effect of location of herd /zones on LL days. The mean LL days ranged from 331.34 days in zone-I to 334.11 days in zone-II. Priya Raj (2002), Kumar[1] (2004), Kumar (2006) and Kumar et al. (2007) reported non-significant effect of location of herd on LL days in Desi, HFX and JX lactating cows under farmers' managemental conditions in different districts of Bihar which are in conformity with the findings of the present study. However, Jadhav et al. (1991) and Prabhakar (2007) observed significant ($P<0.05$) effect of location of herd on LL days. Since all the four zones are located in and around 20 kms. of Jehanabad district, therefore similar managemental and environmental practices adopted therein might be responsible for non-significant effect of location on LL days.

HERD SIZE :

Least squares analysis of variance (Table-16) revealed non-significant effect of herd size on LL days. The mean LL days ranged from 331.19 days in the herd of 3-4 cows to 334.32 days in herd size of 5-7 cows. Priya Raj (2002), Kumar[1] (2004), Kumar et al. (2007) and Prabhakar (2007) in Desi, HFX and Jersey cows maintained under farmers' managemental conditions in different districts of Bihar also reported non-significant effect of herd size

on LL (days) which are similar to the finding of the present study. However, Kumar (2006) reported significantly ($P<0.05$) longer LL days in herd sizes of 7-8 and 9 & above than 5-6 herd size.

SEASON OF CALVING :

Table-16 presented non-significant effect of season of calving on LL days in this study. The mean days of lactation length varied from 330.69 days in winter to 334.78 days in rainy seasons of calving. Yadav et al. (1992), Jadhav and Rathi (1992), Singh et al. (1993), Shettar and Govindaiah (1999), Thakur et al. (1999), Singh et al. (2000), Akhtar et al. (2003), Kumar[1] (2004), Kumar[2] (2004) and Sharan (2005) in indigenous and crossbred cows observed non-significant effect of season of calving on LL days which are in agreement with the findings of the present study. Similar feeding schedules and managemental practices throughout the year might have resulted into the similar effects of season of calving on LL days. However, Jadhav et al. (1991), Priya Raj (2002), Kumar (2006), Kumar et al. (2007) and Prabhakar (2007) reported significant ($P<0.05$) effect of season of calving on LL days. .

LACTATION ORDER :

Least squares analysis of variance (Table-16) presented non-significant effect of sequence of lactation on LL days. Kumar[2] (2004), Sharan (2005) and Kumar et al. (2007) observed that sequence of lactations

did not play significant role on LL days in Desi, HFX and JX cows under farmers' managemental conditions in different districts of Bihar which are in conformity with the findings of the present study. However, Priya Raj (2002). Kumar (2004) and Kumar (2006) reported significant ($P<0.05$) effect of lactation order on LL days. Kumar (2006) observed irregular trend in LL days whereas Prabhakar (2007) obtained the tendency of LL days to decline in 4th and 5th & above lactations.

FARMING SYSTEM :

Least squares analysis of variance (Table-16) revealed non-significant effect of farming system on LL days. Kumar[1] (2004) observed that farming system did not play significant role on LL days in various genetic groups of cows under farmers' managemental conditions in and around Darbhanga (Bihar) which is in agreement with the findings of the present study. This might be, possibly, due to the reason that dairy farmers of Jehanabad district without having integration with agriculture might have managed similar feeding and managemental practices to their lactating cows. However, Kumar (2006), Kumar et al. (2007) and Prabhakar (2007) reported significantly ($P<0.05$) longer LL days of cows maintained in the dairy units integrated with agriculture farming than those which maintained dairying alone.

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.	M.S.S.	
		Peak yield	DAPY
Genetic group	2	1702.324**	1372.761**
Location of herd	3	7.858137^{NS}	13.13717^{NS}
Herd size	2	0.9001980^{NS}	35.36460^{NS}
Lactation order	4	25.62924**	47.18052^{NS}
Season of calving	2	0.4221370^{NS}	100.8765^{NS}
Farming system	1	2.764880^{NS}	0.02229009^{NS}
Error	627	6.232718	43.63716

** Significant at (P<0.01); NS – Non-significant

PEAK YIELD :

Average Value :

Least squares means of peak yield in Desi, HFX and JX cows were obtained as 5.76 kg, 11.68 kg and 9.24 kg respectively (Table-19). Literature revealed the ranges of peak yield to be from 4.21 kg (Kumar, 2005) to 9.22 kg (Jadhav et al., 1992) for indigenous cows, from 5.32 kg (Kumar[2] 2004) to 16.19 kg (Shiv Prasad, 2003) for HFX cows and from 7.96 kg (Kumar, 2005) to 13.27 kg (Singh et al., 1993) for JX cows. The findings of the present study in all the three genetic groups of cows fell in the ranges mentioned above. Variations in peak yield in different genetic groups might be attributed to differences in indigenous breeds, levels of exotic inheritance of HF and Jersey as well as managemental and environmental fluctuations.

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
Overall mean (μ)	8.89±0.21	49.42±0.56
Genetic factors		
Desi	5.76^{a}±0.27	51.12^{a}±0.72
HF crossbred	11.68^{b}±0.25	46.57^{b}±0.66
Jersey crossbred	9.24^{c}±0.25	50.57^{a}±0.67
Non-genetic factors		
Location of herd (zones)		
I	8.68±0.30	49.30±0.79
II	8.67±0.25	49.85±0.67
III	9.06±0.30	49.41±0.79
IV	9.17±0.30	49.13±0.79
Herd size		
3 - 4	8.99±0.29	49.93±0.77
5 - 7	8.81±0.29	49.39±0.76
8 & above	8.89±0.26	48.94±0.68
Season of calving		
Winter	8.95±0.28	50.12±0.71
Summer	8.88±0.25	49.49±0.67
Rainy	8.85±0.25	48.66±0.65
Lactation order		
1^{st}	8.72^{a}±0.28	49.07±0.73
2^{nd}	8.68^{a}±0.26	49.05±0.69
3^{rd}	8.26^{a}±0.25	48.50±0.65
4^{th}	8.50^{a}±0.29	49.21±0.77
5^{th} & above	10.31^{b}±0.52	51.28±1.36
Farming system		
Dairying alone	8.76±0.39	49.41±1.03
Agriculture + Dairying	9.03±0.15	49.43±0.39

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

EFFECT OF GENETIC FACTORS :

Least squares analysis of variance (Table-18), revealed highly significant ($P<0.01$) effect of genotypes on peak yield. The highest peak yield (11.68 kg) was observed to be in HF crossbred cows which was significantly ($P<0.01$) higher by 5.92 kg and 2.44 kg than Desi and JX cows. JX cows had also significantly ($P<0.01$) 3.48 kg higher PY than Desi cows. Significant effects of genotypes on PY have also been reported by Jadhav et al. (1991), Nayak and Raheja (1996) and Dutt and Bhushan (2001). Besides, Priya Raj (2002) reported significantly ($P<0.01$) higher PY in HFX cows than JX cows. Apart from these Kumar (2005), Kumar (2006) and Prabhakar (2007) obtained highest peak yield to be in HFX cows followed by JX and Desi cows under farmers' managemental conditions in different districts of Bihar. The findings of the present study conducted in the district of Jehanabad of Bihar are in agreement with the results obtained by the above mentioned authors.

EFFECT OF NON-GENETIC FACTORS :

LOCATION /ZONES :

Least squares analysis of variance (Table-18) presented non-significant effect of location /zones on PY. Priya Raj (2002), Kumar[1] (2004), Kumar (2005) and Prabhakar (2007) found non-significant effect of location on PY under farmers' managemental conditions in different

districts of Bihar. The results obtained in the present study are very similar to the findings of the above mentioned authors. Since the present study was conducted in a radius of 20 kms only in and around Jehanabad consisting of all the four zones, there might not be much variations in agro-climatic, managemental and other environmental factors.

HERD SIZE :

Table-18 of least squares analysis of variance presented non-significant effect of herd size on PY. Kumar[1] (2004), Kumar (2005) and Prabhakar (2007) observed that the size of herd did not influence PY significantly under farmers' managemental conditions in Dharbhanga, Patna and Madhepura districts of Bihar respectively. The findings of the present study conducted in Jehanabad district of Bihar are in agreement with the findings of above mentioned authors who conducted research in different other districts. However, Kumar (2006) reported that the cows maintained in herd size of 9 & above had significantly ($P<0.05$) higher PY than those maintained in the herd sizes of 3-4 and 5-6.

SEASON OF CALVING :

Least squares analysis of variance (Table-18) presented non-significant effect of season of calving on peak yield. However, it was observed to be the highest during winter season. Non-significant effect of season of calving on peak yield have also been reported by Singh et al.

(1993) in Sahiwal and its crossbreds with Jersey and Red Dane, Singh et al. (2000) in different exotic crosses with Hariana, Dutt and Bhusan (2001) in half breds of exotic crosses with Hariana, Kumar[2] (2004) in Hariana and its crosses with HF and Jersey and Kumar (2005) in Desi. HFX and JX cows maintained under farmers' managemental conditions, Das et al. (2006) in Jersey and Red Dane cows and Prabhakar (2007) in Desi, HFX and JX cows maintained under farmers' managemengal conditions in Madhepura district of Bihar. The findings of the above authors in general and Kumar (2005) and Prabhakar (2007) in particular are in conformity with the findings of the present study. It is worth mentioning that Kumar (2005) and Prabhakar (2007) also conducted their research under farmers' managemental conditions in different districts of Bihar.

LACTATION ORDER :

Least squares analysis of variance (Table-18) presented significant ($P<0.05$) effect of parity of lactation on PY. Yadav and Rathi (1992), Zaman et al. ((1998), Priya Raj (2002) and Prabhakar (2007) also observed significant ($P<0.05$) effect of parity of lactation on PY. However, Duncan's multiple Range Test reflected that the mean PY from 1st to 4th sequences of lactations did not differ significantly. Non-significant effect of parity on PY up to 4th lactations have also been reported by Jadhav et al. (1992) in Sahiwal cows, Bhattacharya et al. (1999) in Hariana cows, Kumar[2] (2004) in different genetic groups of Hariana and its crosses with HF and Jersey,

Kumar (2005) and Kumar (2006) in Desi, HFX and JX cows maintained in the unorganized dairy units in different districts of Bihar.

FARMING SYSTEM :

The system of farming did not play significant role on PY. Kumar[1](2004) reported non-significant effect of farming system under farmers' managemental conditions in and around Darbhanga (Bihar) which is in agreement with the findings of the present study. However, Kumar (2005), Kumar (2006) and Prabhakar (2007) obtained significantly ($P<0.05$) higher PY of cows maintained in dairy units integrated with agriculture. Although non-significant in present study, the cows maintained in dairy units integrated with agriculture had 0.27 kg higher PY than those maintained in dairying alone, a similar trend obtained by the above authors.

DAYS TO ATTAIN PEAK YIELD (DAPY) :

Average values of DAPY:

The least squares means of DAPY (depicted in Table-19) of Desi, HFX and JX cows were obtained as 51.12±0.72 days, 46.57±0.66 days and 50.57±0.67 days respectively. Literature revealed that the ranges of DAPY varied from 39.12 days (Prabhakar, 2007) to 59.94 days (Kumar, 2005) for Desi cows, from 26.80 days (Kumar[2] 2004) to 54.25 days (Rathi, 1975) for HFX cows and from 35.35 days (Kumar[2], 2004) to 56.60 days (Singh et al. 2004) for JX cows. The findings of the present study fell in the ranges

mentioned above. Variations in DAPY might be attributed to variations in breeds of indigenous cows, exotic breeds used for crossbreeding, levels of exotic inheritance in cross bred cows and managemental and environmental factors.

EFFECT OF GENETIC FACTOR :

Least squares analysis of variance (Table-18) presented highly significant ($P<0.01$) effect of genotype on DAPY (days). The shortest DAPY (46.57) was observed to be in HF cross bred cows, whereas the longest DAPY (51.12) was found to be in Desi cows. An appraisal of (Table -19) disclosed that HF crossbred cows had significantly 4.55 days and 4.00 days lower DAPY than Desi and Jersey crossbred cows respectively. Although JX cows had 0.55 days shorter DAPY than Desi cows, yet the mean DAPY of Desi and JX cows did not differ significantly. Kumar (2005) and Kumar (2006) reported significantly ($P<0.05$) lower DAPY in HF crossbred cows than JX and Desi cows under farmers' managemental conditions in Patna and Nalanda districts of Bihar respectively which are in conformity with the findings of the present study conducted in Jehanabad district of Bihar. Besides, Prabhakar (2007) observed significantly lower DAPY in HFX than JX cows in Madhepura district of Bihar which is in agreement with the findings of the present study. Apart from these, Kumar[1] (2004), Kumar[2] (2004) and Singh et al. (2004) observed significant ($P<0.05$) effect of genotypes on DAPY in dairy cows, a similar trend obtained in the

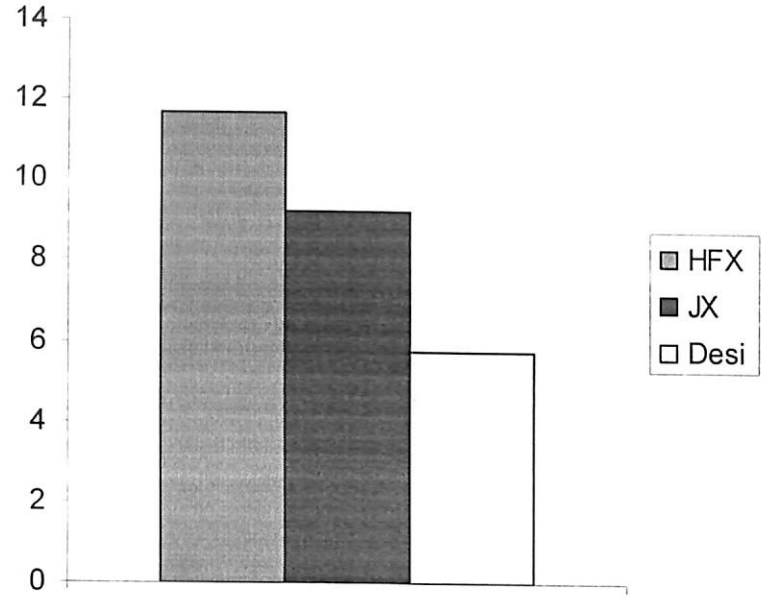

Figure 3: Peak yield (kg) in HFX, JX and Desi cows under farmers' managemental conditions in Jehanabad district of Bihar

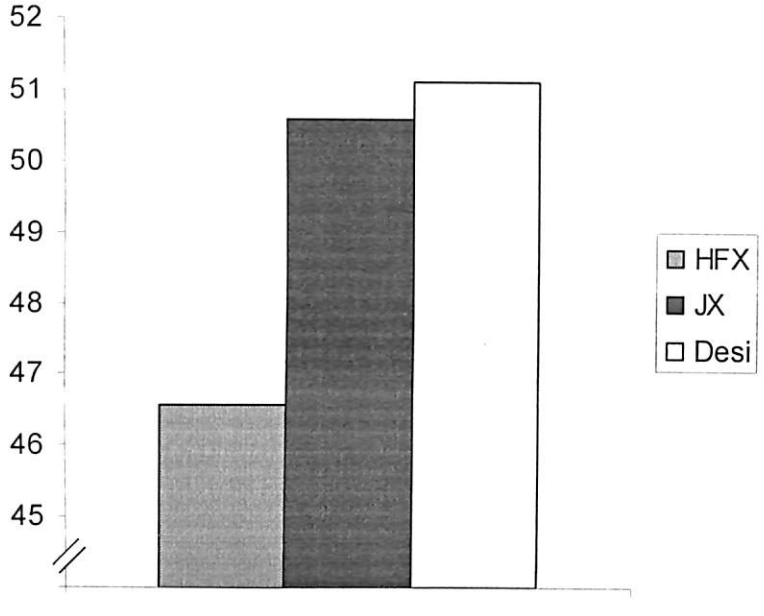

Figure 4: Days to attain peak yield (days) in HFX, JX and Desi cows under farmers' managemental conditions in Jehanabad district of Bihar

present study. However, contrary to the findings of the present study, Singh et al. (1993) could not find significant effect of genetic group on DAPY.

EFFECT OF NON-GENETIC FACTORS :

LOCATION/ZONES OF HERD :

Least squares analysis of variance as depicted in Table-18, presented non-significant effect of location of herd on DAPY in the district of Jehanabad. The DAPY ranged from 49.13 days in Modanganj block to 49.85 days in Ghosi Block. Kumar[1] (2004) and Prabhakar (2007) reported non-significant effect of location of herd on DAPY in Desi, HFX and Jersey cows maintained in private dairy units under farmers' managemental conditions in Darbhanga and Madhepura districts of Bihar respectively. The results obtained in the present study are in agreement with the findings of the above authors. It is worth mentioning here that all the four zones in this study were located in a radius of about 20 kms. only around Jehanabad having similar agro-climatic conditions. Besides, similar feeding schedules and managemental conditions in all the zones might be responsible for similar effect in different zones. However, contrary to the findings of the present study, Kumar (2005) and Kumar (2006) observed significant effect of location of herd on DAPY who claimed the differences to be due to variations in feeding and managemetal practices.

HERD SIZE :

Table -18 presented that the size of the herd did not influence DAPY in the district of Jehanabad (Bihar). DAPY varied from 48.94 days in the size of 8 & above to 49.93 days in 3-4 herd size. All the four authors namely Kumar (2004), Kumar (2005), Kumar (2006) and Prabhakar (2007) who conducted their studies in Desi, HFX and JX cows maintained under farmers' managemental conditions in Darbhanga, Patna, Nalanda and Madhepura districts of Bihar respectively reported non-significant effect of herd size on DAPY. The findings of the present study are in conformity with the results obtained by the above mentioned authors.

SEASON OF CALVING :

Least squares analysis of variance (Table-18) presented non-significant effect of season of calving on DAPY. The DAPY (Table -19) ranged from 48.66 days during rainy to 50.12 days during winter calvings. Singh et al. (1993), Das et al. (2006) and Prabhakar (2007) reported non-significant effect of season of calving on DAPY. The results obtained in the present study are in agreement with the findings of the above authors. Besides, the lower DAPY obtained during rainy season of calving had a similar trend reported by Kumar (2005) and Kumar (2006). However, Singh et al. (2004), Kumar[1] (2004) and Kumar (2006) observed significant ($P<0.05$) effect of season of calving on DAPY.

LACTATION ORDER :

The sequence of lactation (Table-18) did not play significant role on DAPY. However, it ranged from 48.50 days in 3rd lactation to 51.28 days in 5th and above lactations. Although non-significant, yet the trend appeared to be clear. The DAPYs ranged from 48.50 days to 49.21 days from 1st to 4th lactations but after 4th sequence of lactation there had been sudden rise to 51.28 days in 5th & above lactations suggesting lower performance with the increase in lactation order. Non-significant effects of lactation order on DAPY have also been reported by Zaman et al. (1998) and Kumar[2] (2004). Increase in DAPY in 5th and above lactations have also been reported by Kumar (2005) and Kumar (2006), a similar trend obtained in this study.

FARMING SYSTEM :

Least squares analysis of variance (Table-18) presented non-significant effect of system of farming on DAPY in the district of Jehanabad (Bihar). All the four authors namely Kumar[1] (2004), Kumar (2005), Kumar (2006) and Prabhakar (2007) who conducted their research in Darbhanga, Patna, Nalanda and Madhepura districts of Bihar respectively under farmers' managemental conditions reported non-significant effect of farming system on DAPY which are in conformity with the findings of the present study. It appeared that the farmers of Jehanabad district maintaining dairying alone would have provided similar feeding and managemental schedule as that of farmers maintaining dairy units integrated with agriculture.

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

AVERAGE VALUES OF MY/day LL :

The least squares means of milk yield per day of lactation length (MY/day LL) of Desi, HFX and JX cows were obtained as 3.40 kg, 8.05 kg and 6.61 kg respectively in the district of Jehanabad (Table-21). Literature revealed that the average MY/day LL ranged from 2.64 kg (Sharan, 2005) to 6.54 kg (Vij et al., 1992) for Desi cows, from 2.82 kg (Kumar[2], 2004) to 9.09 kg (Shrivastava and Singh, 2000) for HFX and from 5.03 kg (Kumar[2], 2004) to 7.11 kg (Singh et al., 1993) for JX cows. The findings of the present research fell in the ranges mentioned above. Variations in the Desi/Indigenous breeds of cows, levels of inheritance of HF and Jersey into Desi/indigenous breeds and managemental and environmental factors might be responsible to cause such differences.

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.	M.S.S.	
		MY Day /LL	Calving Interval
Genetic group	2	1051.534**	78234.33**
Location of herd	3	0.08882620^{NS}	134.8440^{NS}
Herd size	2	0.1374151^{NS}	2385.928**
Lactation order	4	0.5907753^{NS}	273.9660^{NS}
Season of claving	2	0.2583241^{NS}	405.2451^{NS}
Farming system	1	0.0003147968^{NS}	119.6849^{NS}
Error	627	0.2705280	405.7927

** Significant at (P<0.01); NS – Non-significant

EFFECT OF GENETIC FACTOR :

Least squares analysis of variance as depicted in Table-20, revealed highly significant ($P<0.01$) effect of genotypes on MY/day LL. An appraisal of least squares means (Table-21) presented that HFX had the highest MY/day LL followed by JX and Desi cows. HFX had 4.65 kg and 1.44 kg significantly ($P<0.01$) higher MY/day LL than Desi and JX cows respectively. Besides, JX cows had also 3.21 kg significantly ($P<0.01$) higher MY/day LL than Desi cows. A critical analysis of the least squares means (Table-21) revealed that HFX had more than double and JX had also nearly double MY/day LL than Desi cows. It is worth mentioning here that in the present study HFX had more than double and JX had also nearly double lactation milk yield (LMY) than Desi cows. These findings again reflected that both HF and Jersey are well adapted in the agro-climatic environment of Jehanabad district. Significant effect of genotypes on MY/day LL have also been reported by Hayatnagarkar et al.(1990), Jadhav et al. (1991), 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), Kumar (2006) and Prabhakar (2007) which are in agreement with the findings of the present study. Besides, Kumar[1] (2004), Kumar[2] (2004), Kumar (2005), Sharan (2005), Kumar (2006) and Prabhakar (2007) also reported that HFX had more than double and JX had nearly double MY/day LL than Desi cows under farmers' managemental conditions in different districts of Bihar. The

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
Overall mean (μ)	6.02±0.04	438.14±1.72
Genetic factors		
Desi	3.40^{a}±0.06	461.67^{a}±2.18
HF crossbred	8.05^{b}±0.05	422.33^{b}±2.02
Jersey crossbred	6.61^{c}±0.05	430.41^{c}±2.03
Non-genetic factors		
Location of herd (zones)		
I	6.04±0.06	438.45±2.41
II	5.97±0.05	438.18±2.04
III	6.03±0.06	439.21±2.42
IV	6.02±0.06	436.71±2.40
Herd size		
3 - 4	6.04±0.06	442.72^{a}±2.35
5 - 7	6.04±0.06	437.02^{b} ±2.33
8 & above	5.98±0.05	434.68^{b} ±2.09
Season of calving		
Winter	5.97±0.06	437.31±2.44
Summer	6.04±0.05	437.41±2.03
Rainy	6.04±0.05	439.70±1.98
Lactation order		
1^{st}	5.96±0.06	436.94±2.22
2^{nd}	6.10±0.05	438.57±2.11
3^{rd}	5.95±0.05	435.91±1.99
4^{th}	6.01±0.06	437.97±2.34
5^{th} & above	6.08±0.11	441.28±4.15
Farming system		
Dairying alone	6.02±0.08	437.25±3.13
Agriculture + Dairying	6.02±0.03	439.02±1.20

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

above authors also reported that HFX had also significantly ($P<0.01$) higher MY/day LL than JX cows. The findings of the present study are in conformity with the findings of all the above mentioned authors. These findings suggested that crossbreeding of indigenous/Desi cows with HF and Jersey exotic inheritance would be helpful in rapid increase of milk yield in Jehanabad district of Bihar and also in narrowing the gap between availability and requirement of milk yield.

EFFECT OF NON-GENETIC FACTORS :

LOCATION/ZONES OF HERD :

Least squares analysis of variance (Table-20) suggested that location of herd/zones did not play significant role on MY/day LL in this study. Least squares means of MY/day LL varied from 5.97 kg to 6.04 kg in different zones of Jehanabad district of Bihar. Priya Raj (2002), Kumar[1] (2004), Kumar (2006) and Prabhakar (2007) reported non-significant effect of locations on MY/day LL under farmers' managemental conditions in different districts of Bihar. The findings of the present study are in very close agreement with the findings of the above mentioned authors and also give strength to their findings. Similar managemental and environmental practices along with uniform feeding schedule in and around 20 kms of Jehanabad might be attributed to such similar results. However, Shrivastava and Singh (2000) and Kumar (2005) observed significant ($P<0.05$) effect of location of herd on MY/day LL.

HERD SIZE :

As depicted in (Table-20), least squares analysis of variance could not find significant effect of herd size on MY/day LL. MY/day LL ranged from 5.98 kg in 8 & above herd size to 6.04 kg in both 3-4 and 5-7 herd sizes. Priya Raj (2002), Kumar (2005) and Kumar (2006) reported non-significant effect of herd size on MY/day LL in HFX, JX and Desi cows in unorganized farms under farmers' managemental conditions in different districts of Bihar . The findings of the present study are in close agreement with the results obtained by the above authors. However, Shrivastava and Singh (2000), Kumar[1] (2004) and Prabhakar (2007) reported that lower herd size had higher MY/day LL.

SEASON OF CALVING :

Least squares analysis of variance (Table-20) indicated that season of calving did not exert significant effect on MY/day LL. Yadav and Rathi (1992) in Hariana cows, Yadav et al. (1992) in Sahiwal cows, Thakur et al. (1999) in Jersey and its crosses with four indigenous breeds of cows, Shrivastava and Singh (2000) in Friesian x zebu crossbreeds observed non-significant effect of season of calving on MY/day LL. Besides, Priya Raj (2002), Kumar (2005), Kumar (2006) and Prabhakar (2007) reported non-significant effect of season of calving on MY/day LL in unorganized farms under farmers' managemental conditions in different districts of Bihar. The findings of the present study are in close agreement with the findings of the above authors. Uniform managemental and environmental practices might

be responsible for similar effect of season of calving on MY/day LL. However, Kumar[1] (2004) reported significantly (P<0.01) higher MY/day LL during winter seasons which might be, possibly, due to favorable climate and ad lib availability of greens and dry fodder.

LACTATION ORDER :

The least squares analysis of variance, depicted in Table-20, presented non-significant effect of sequence of lactation of MY/day LL with irregular trend. Kumar[2] (2004) in Hariana and its different grades with HF and Jersey and Kumar (2006) in Desi, HFX and JX cows in unorganized farms under farmers' managemental conditions reported non-significant effect of parity of lactation on MY/day LL. The findings of the present study are in conformity with the findings of the above authors. However, Shrivastava and Singh (2000) Priya Raj (2002), Kumar[1] (2004) and Prabhakar (2007) reported significant (P<0.01) effect of season of calving on MY/day LL. They reported significant (P<0.05) decline in MY/day LL after 3^{rd} /4^{th} lactations.

FARMING SYSTEM :

As depicted in (Table-20) least squares analysis of variance revealed non-significant effect of farming system on MY/day LL. Kumar[1] (2004) and Kumar (2006) in Desi, HFX and JX cows maintained under farmers' managemental conditions in Darbhanga and Nalanda districts of Bihar respectively reported non-significant effect of farming system on MY/day LL. The findings of the present study conducted in the district of Jehanabad

are in agreement with the findings of the above mentioned authors. Non-significant effect of farming system on MY/day/LL might indicate that the farmer of Jehanabad district without having integration with agriculture were able to manage similar feeding schedule and managemental practices to their lactating cows as provided by those having integration with agriculture. However, Kumar (2005) and Prabhakar (2007) reported significantly ($P<0.05$) higher values of MY/day LL in dairy units integrated with agriculture than those having dairying alone which might be, possibly, due to the availability of more green fodders to the lactating cows.

CALVING INTERVAL (CI) :

Calving interval is one of the important economic indicators and it plays significant role in the economics of dairy enterprises. Besides, it reflects on healthy reproductive status of the cows.

AVERAGE CALVING INTERVAL :

Least squares means of calving interval (days) of Desi, HFX and JX cows were obtained as 461.67 days, 422.33 days and 430.41 days respectively in this study. Literature revealed the ranges of calving interval days to be from 416.57 (Yadav and Rathi 1992) to 570.70 (Sharan 2005) for indigenous cows, from 378.7 (Akhter et al. 2003) to 538.97 (Sharan 2005) for HFX cows and from 396.87 (Akhter et al. 2003) to 451.70 (Chaudhari et al. 1995) for JX cows. The findings of the present study for all the three genotypes fell in the ranges mentioned above. Variations in genetic architecture and reproductive status of the cows and in managemental, environmental and nutritional factors might be attributed to the differences in CI (days).

EFFECT OF GENETIC FACTORS :

Least squares analysis of variance, as depicted in Table-20, presented highly significant ($P<0.01$) effect of genotypes on CI (days). It was observed that HF crossbred cows had the lowest CI (422.33 days) followed by Jersey crossbred cows (430.41 days) and Desi (461.67 days) (Table-21). An appraisal of the Table-21 indicated that HF crossbred cows had significantly ($P<0.05$) 39.34 days and 8.08 days lower CI than Desi and JX cows respectively. Besides, JX cows had also significantly ($P<0.05$) 31.26 days lower CI than Desi cows. These findings indicated that both crossbred cows were superior to Desi cows with respect to calving interval.

Jadhav et al. (1991), Singh et al. (2000), Priya Raj (2002), Kumar (2005), Sharan (2005), Kumar (2006) and Prabhakar (2007) reported significant ($P<0.05$) effect of genetic groups on CI days which are in conformity with the findings of the present study. Besides, Kumar (2005) and Kumar (2006) observed lowest CI days in HFX followed JX and Desi cows maintained under farmers' managemental conditions. The findings of the present study conducted under farmers' managemental conditions in Jehanabad district of Bihar are in very close agreement with the findings of the above authors.

EFFECT OF NON-GENETIC FACTOR :

LOCATION/ZONES OF HERD :

Least squares analysis of variance (Table-20) revealed non-significant effect of location of herd on calving interval days which varied from 436.71 days in zone-IV to 439.21 days in zone-III. Non-significant effect of location might be attributed to similar managemental and environmental factors provided to the lactating cows. It is worth mentioning that all the

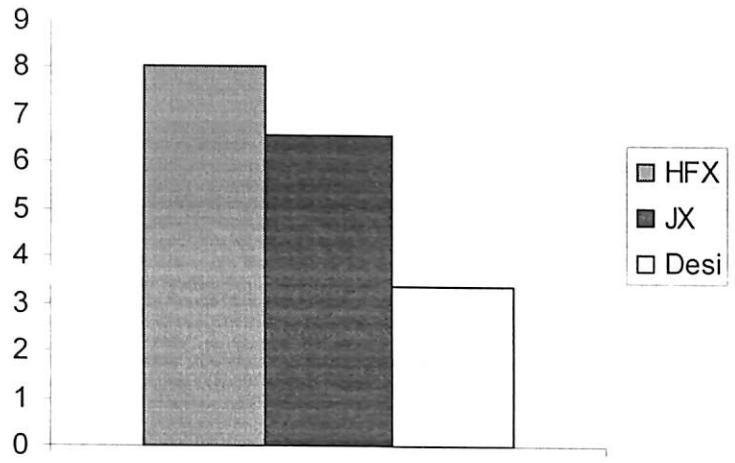

Figure 5: MY/day LL (kg) in HFX, JX and Desi cows under farmers' managemental conditions in Jehanabad district of Bihar

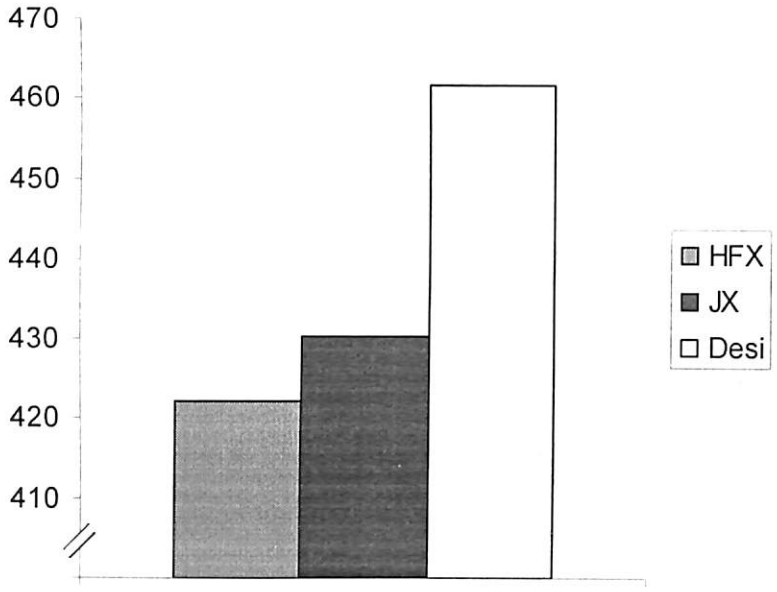

Figure 6: Calving interval (days) in HFX, JX and Desi cows under farmers' managemental conditions in Jehanabad district of Bihar

zones were located in a radius of about 20 kms. in and around Jehanabad having similar agroclimatic environment. 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 maintained under farmers' managemental conditions in different districts of Bihar reported that location of herd did not influence calving interval significantly which are in conformity with the findings of the present study. However, Kumar (2006) and Prabhakar (2007) observed significant ($P<0.05$) effect of location on CI.

HERD SIZE :

Least squares analysis of variance (Table -20) presented significant ($P<0.01$) effect of herd size on CI. An appraisal of least squares means (Table-21) revealed that the herd size of 8 & above had significantly ($P<0.01$) 8.04 days lower calving interval than the herd size of 3-4. Besides, the herd size of 5-7 had also significantly ($P<0.01$) 5.70 days lower CI than herd size of 3-4. Herd size of 8 & above had also 2.34 days lower CI than 5-7 herd size, however, it did not differ significantly. A critical analysis of the least squares means revealed clear cut trend. Higher the herd size lower was the calving interval days i.e. the calving interval days decreased significantly with the increase of size of herd. Kumar (2006) reported significant ($P<0.01$) effect of herd size on CI days in Desi, HFX and JX cows maintained under farmers' managemental conditions in Nalanda district of Bihar which is in close agreement with the finding of the present study. However, Kumar (2005) and Prabhakar (2007) reported non-significant effect of herd size on CI.

SEASON OF CALVING :

Least squares analysis of variance, as presented in Table -20, revealed non-significant effect of season of calving on CI which ranged from 437.31

days in winter to 439.70 in rainy calvers (Table-21). Yadav et al. (1992) in Sahiwal cows, Yadav and Rathi (1992) in Hariana cows, Singh et al. (2000) in seven genetic groups of crossbred cows, Priya Raj in crossbred cows of HF and Jersey with local cows under farmers' managemental conditions and Prabhakar (2007) in Desi, HFX and JX cows maintained under farmers' managemental conditions reported non-significant effect of season of calving on CI which are in conformity with the findings of the present study. However, Akhter et al (2003), Kumar (2005) and Kumar (2006) observed significant effect of season of calving on CI.

LACTATION ORDER :

As depicted in table-20, lactation order did not play significant role on CI. Besides, the trend observed was also very irregular. It increased in 2nd lactation from 1st, decreased in 3rd lactation from 2nd, again increased in 4th lactation from 3rd and again increased in 5th and above lactations from 4th. However, an appraisal of the least squares means of CI (Table -21) had one clear cut finding that it was lowest in 3rd lactations and highest in 5th & above lactations. Sharan (2005) also reported nun-significant effect of sequence of lactation on CI (days) which are in close agreement with the findings of the present study. However, Priya Raj (2002), Kumar[1] (2004) and Kumar (2005) reported significant ($P<0.05$) effect of lactation order on CI days but without any definite trend.

FARMING SYSTEM :

Least squares analysis of variance as depicted in Table-20 presented that system of farming did not play any significant role on CI days. Kuamr[1] (2004) and Prabhakar (2007) in Desi, HFX and JX cows maintained under

farmers' managemental conditions in Dharbhanga and Madhepura districts of Bihar respectively reported non-significant effect of farming system on CI days which are quite similar to the results and trend obtained in this study. However, Kumar (2005) and Kumar (2006) observed significant ($P<0.05$) effect of farming system on CI days.

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

The over all mean (μ) for MY/day of CI was observed to be 4.60±0.06 kg. Least squares means MY/day CI in Desi, HFX and JX cows were observed to be 2.46±0.08 kg, 6.35±0.07 kg and 5.00±0.07 kg respectively.

Literature revealed the ranges of MY/day CI to be 1.65 kg (Sharan, 2005) to 4.90 kg (Vij et al. (1992) for Desi cows, from 2.95 kg (Sharan, 2005) to 9.4 kg (Singh et al., 1996) for HFX and from 4.53 kg (Hayatnagarkar et al., 1990) to 6.5 kg (Akhter et al., 2003) for Jersey crossbred cows. The average values obtained in the present study fell in the ranges as mentioned in the literature for all the three types of genotypes of cows. Variations in MY/day CI of the cows of different genetic architecture might be attributed to the differences in breeds of indigenous cows, levels of exotic inheritance of different breeds among indigenous crossbreds cows and managemental and environmental factors.

EFFECT OF GENETICS GROUPS :

Least squares analysis of variance (Table 22) presented highly significant ($P<0.01$) effect of genotypes on MY/day CI. A critical analysis of least squares means (Table 23) revealed that the highest (6.35 kg) MY/day CI was observed to be in HF crossbred cows followed by Jersey crossbred cows (5.00 kg) and Desi cows (2.46 kg). HFX had significantly ($P<0.01$) 3.89 kg and 1.35 kg higher MY/day CI than Desi and JX cows respectively. Besides, Jersey crossbred cows had also significantly ($P<0.01$) 2.54 kg higher MY/day CI than Desi cows. An appraisal of least squares means revealed that HF crossbred cows had significantly ($P<0.01$) more than two and a half times and Jersey crossbred cows had more than double MY/day CI than Desi cows. It is to be pointed out here that HF crossbred cows had also nearly 2 ½ times more and Jersey crossbred cows had nearly double LMY and MY/day LL than Desi cows obtained in this investigations.

The findings obtained in this study again reflected that both HF and Jersey exotic inheritance are well adapted in the agro-climatic region of Jehanabad districts of Bihar with respect to milk production. Besides, HF crossbred cows again proved itself to be superior to Jersey crossbred cows for milk production. These findings again proved more use of HF than Jersey for crossbreeding for milk production in Jehanabad district of Bihar. In spite of all these fact, many of the dairy farmers, however, preferred Jersey crossbreed cows to HFX mainly because of its higher fat percentage in milk, docile in nature, more use of crossbred male calves, easier handling

and more resistant to diseases which requires further investigations considering all these points. All the authors Viz. Jedhav et al. (1991) Srivastava and Singh (2000), Singh et al. (2000), Priya Raj (2002), Akhter et al. (2003), Kumar[1] (2004), Kumar (2005), Sharan (2005), Kumar (2006) and Prabhakar (2007) reported significant (P<0.01) effect of genotypes on MY/day CI which are in conformity with the findings of the present study. Besides, Kumar[1] (2004) Kumar (2005), Kumar (2006) and Prabhakar (2007) also observed highest MY/day CI in HFX cows followed by JX cows under farmers' managemental conditions in Darbhanga, Patna, Nalanda and Madhepura districts of Bihar respectively which are in conformity with the findings of the present study conducted in Jehanabad district of Bihar. Apart from these, Singh et al. (2000) and Priya Raj (2002) also reported superiority of HFX cows over JX cows which are in close agreement with the findings of the present study.

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.	M.S.S.	
		MY/ Day CI	Dry period
Genetic group	2	734.6705**	101076.4**
Location of herd	3	0.8442693^{NS}	99.28134^{NS}
Herd size	2	1.069385^{NS}	885.8232^{NS}
Lactation order	4	0.6387439^{NS}	103.8821^{NS}
Season of claving	2	0.5318171^{NS}	99.13666^{NS}
Farming system	1	0.01447557^{NS}	155.2972^{NS}
Error	627	0.5237365	544.2512

** Significant at (P<0.01); NS – Non-significant

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/day CI (kg) Mean ± SE	Dry Period (days) Mean ± SE
Overall mean (μ)	4.60±0.06	110.62±1.99
Genetic factors		
Desi	2.46^{a}±0.08	138.02^{a}±2.53
HF crossbred	6.35^{b}±0.07	94.67^{b}±2.34
Jersey crossbred	5.00^{c}±0.07	99.16^{c}±2.35
Non-genetic factors		
Location of herd (zones)		
I	4.48±0.09	110.20±2.78
II	4.64±0.07	109.70±2.36
III	4.66±0.09	111.81±2.80
IV	4.62±0.09	110.76±2.77
Herd size		
3 - 4	4.49±0.09	107.71±2.73
5 - 7	4.67±0.08	113.16±2.70
8 & above	4.64±0.08	110.97±2.42
Season of calving		
Winter	4.55±0.08	109.85±2.60
Summer	4.66±0.07	110.67±2.35
Rainy	4.59±0.07	111.33±2.30
Lactation order		
1^{st}	4.48±0.08	109.49±2.57
2^{nd}	4.63±0.08	110.16±2.44
3^{rd}	4.60±0.07	109.99±2.31
4^{th}	4.57±0.06	111.81±2.72
5^{th} & above	4.73±0.15	111.63±4.81
Farming system		
Dairying alone	4.61±0.11	111.62±3.63
Agriculture + Dairying	4.59±0.04	109.61±1.39

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

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Location of herd did not influence MY/day CI which ranged from 4.48 kg in Zone I to 4.66 kg in zone III in this study (table-22). Priya Raj (2002), Kumar[1] (2004), Kumar (2006) and Prabhakar (2007) also reported non-significant effect of location of herd in Desi, HFX and JX cows under farmers' managemental conditions in Patna, Darbhanga, Nalanda and Madhepura districts of Bihar respectively. The findings of the present study conducted in Jehanabad district of Bihar is in close agreement with the findings of all the above authors. It is worth mentioning here that the present study was conducted in a radius of about 20 kms only in and around Jehanabad which was divided into four zones and therefore there might not be much variations in agro-climatic conditions of the different zones along with managemental practices. However, Jadhav et al. (1991) and Kumar (2005) reported significant ($P<0.01$) effect of location of herd on MY/day CI. Jadhav et al. (1991) studied the effect of farms which were located quite distantly having different agro-climatic and managemental environments.

HERD SIZE :

Least squares analysis of variance (Table-22) reflected non-significant effect of herd size on MY/day CI in this study. Priya Raj (2002), Kumar[1] (2004), Kumar (2005) and Prabhakar (2007) observed non-significant effect of herd size on MY/day CI in different districts of Bihar which are in close agreement with the findings of the present study conducted in the district of Jehanabad. However, contrary to the findings of the present study, Srivastava and Singh (2000) and Kumar (2006) observed significant effect of herd size on MY/day CI.

SEASON OF CALVING :

Least squares analysis of variance, as depicted in Table -22, presented non-significant effect season of calving on MY/day CI which varied from 4.55 kg in winter to 4.66 kg in summer calvers. Yadav et al. (1992), Yadav and Rathi (1992), Shrivastva and Singh (2000), Singh et al. (2000), Priya Raj (2002), Akhter et al. (2003), Kumar (2005) and Prabhakar (2007) reported 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) observed significant effect of season of calving on MY/day CI.

LACTATION ORDER :

Least squares analysis of variance (Table-22) revealed non-significant effect of sequence of lactation on MY/day CI. Sharan (2005) observed that parity of lactation did not influence MY/day CI in Hariana cows and its crosses with Holstein Friesian which is in conformity with the findings of the present study. However, contrary to the findings of this study, authors like Yadav and Rathi (1992), Yadav et al. (1992), Srivastava & Singh (2000), Priya Raj (2002), and Prabhakar (2007) observed significant ($P<0.05$) effect of lactation order on MY/day CI which, in general, increased up to third lactation after which it tended to decline.

FARMING SYSTEM :

Least squares analysis of variance as depicted in (Table-22), presented non-significant effect of system of farming on MY/day CI which is in conformity with the findings of Kumar[1] (2004), Kumar (2005) and Kumar (2006) who conducted their studies in different districts of Bihar

under farmers' managemental conditions. However, Prabhakar (2007) observed significant (P<0.01) effect of farming system on MY/day CI

DRY PERIOD :

Dry period is of high importance in the economy of dairy enterprises. Shorter the dry period more economical is the milk production and dairy farming.

AVERAGE DRY PERIOD :

The least squares means (Table -23) of dry period were observed to be 138.02, 94.67 and 99.16 days in Desi, HFX and JX cows respectively in this study. As reported in the literature, the dry period (days) ranged from 114.75 days (Vij et al., 1992) to 228.0 days (Pundir and Raheja, 1997) for Desi cows, from 72.82 days (Akhter et al., 2003) to 264.44 days (Kumar[2], 2004) for HFX at different levels of HF inheritance and from 70.44 days (Kumar, 2005) to 166.8 days (Thakur et al., 1999) for JX cows at different levels of Jersey inheritance in indigenous cows in which the findings of the present study are also included.

Variations in genotypes of the cows, levels of exotic inheritance in the crossbred with indigenous cows, managemental and environmental factors might be attributed to differences in the days of dry period.

EFFECT OF GENETIC FACTORS. :

Dry period is the number of days from the cessation of milk yield to the subsequent parturition for each lactation for which genetic architecture has an important role. Least squares analysis of variance, as depicted in Table -22, reflected highly significant (P<0.01) influence of genetic group on dry period days. The HF crossbred and Desi cows had the shortest and longest dry period days respectively in this study. HF crossbreds had

significantly (P<0.01) 43.35 days and 4.49 days shorter dry period (days) than Desi and Jersey crossbred cows respectively. Besides, JX cows had also significantly (P<0.01) 38.86 days shorter dry period (days) than Desi cows. An appraisal of the dry period days again revealed that HFX and Jersey crossbreds are well adapted in the agro-climatic environment of Jehanabad district and also much superior to Desi cows Akhter et al. (2003), Kumar[1] (2004), Kumar[2] (2004), Kumar (2005), Kumar (2006) and Prabhakar (2007) reported significant (P<0.01) effect of genetic group on dry period in Desi, HFX and JX cows. All the above authors reported significantly (P<0.01) shorter dry period of HFX and JX than Desi cows which are in conformity with the findings of the present study. However, Priya Raj (2002) could not find significant effect of genetic group on dry period.

EFFECT OF NON-GENETIC FACTORS :

LOCATION OF HERD :

Least squares analysis of variance (Table-22) presented non-significant effect of location of herd on dry period (days) in Desi, HFX and JX cows under farmers' managemental conditions in the district of Jehanabad which is in conformity with the findings of Priya Raj (2002), Kumar[1](2004), Kumar (2005) and Prabhakar (2007) who conducted their studies in different districts of Bihar at farmers' door. However, Kumar (2006) reported significant (P<0.01) effect of location of herd on dry period days in Nalanda district of Bihar.

HERD SIZE :

As evident from least squares analysis of variance (Table –22), size of herd did not influence dry period days significantly. The findings of all the

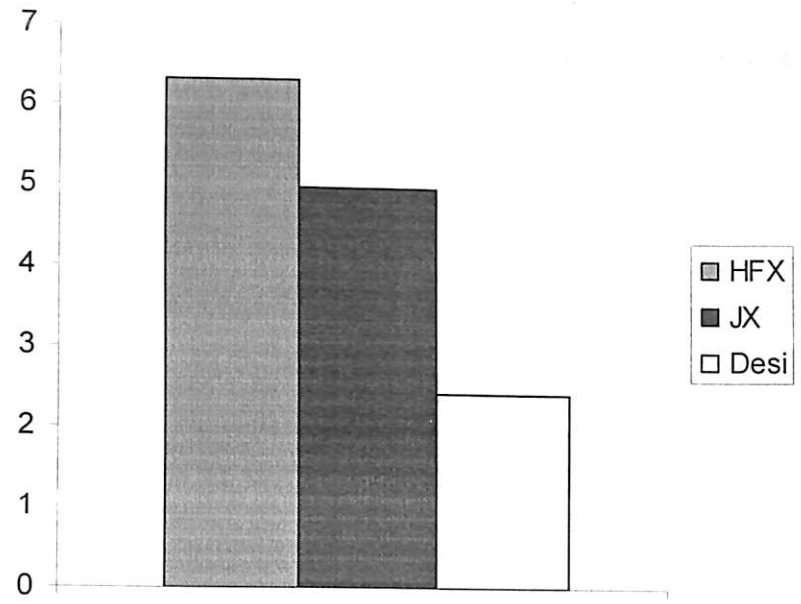

Figure 7: MY/day CI (kg) in HFX, JX and Desi cows under farmers' managemental conditions in Jehanabad district of Bihar

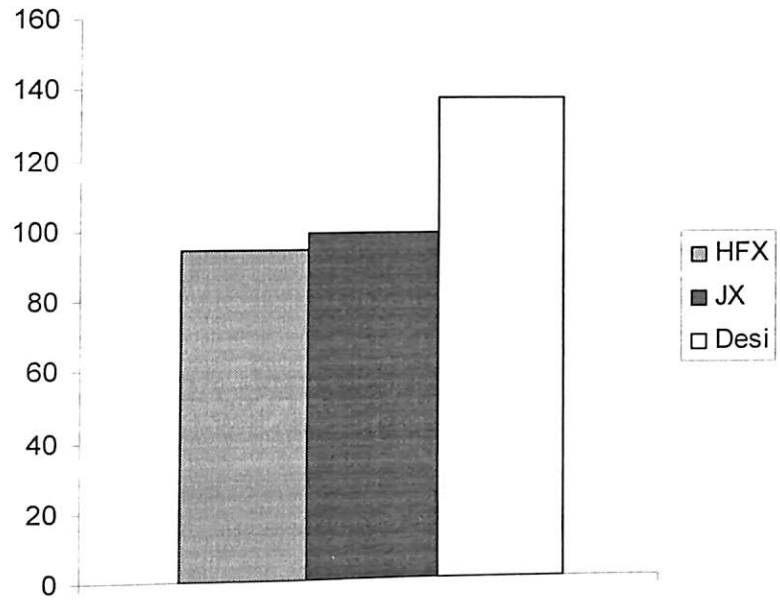

Figure 8: Dry period (days) in HFX, JX and Desi cows under farmers' managemental conditions in Jehanabad district of Bihar

authors (Priya Raj 2002), Kumar[1] (2004), Kumar (2005), Kumar (2006) and Prabhakar (2007) who conducted their studies in Desi, HFX and JX cows under farmers' managemental conditions presented non-significant effect of herd size on dry period days which are in conformity with the results obtained in this study.

SEASON OF CALVING :

As evident from least squares analysis of variance (Table-22) season of calving did not influence dry period (days) significantly. It ranged from 109.85 days in winter calvers to 111.33 days in rainy calvers. Singh et al. (1993), Thakur et al. (1999), Priya Raj (2002), Kumar[1] (2004), Kumar[2] (2004), Kumar (2005), Prabhakar (2007) and Raja and Narula (2008) 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) observed significantly ($P<0.05$) shorter dry period in winter clavers. Prabhakar (2007) also obtained the trend of shorter dry period in winter calvers. The trend obtained in the present study, although non-significant, is also having similar trend as obtained by all the three authors mentioned above.

LACTATION ORDER :

The sequence of lactation did not play significant role on dry period days in this study. Kumar[1] (2004) and Kumar (2005) in Desi, HFX and JX cows maintained under farmers' managemental conditions in Darbhanga and Patna districts of Bihar respectively as well as Kumar (2004) in Hariana and its crosses with HF and Jersey in organized farms reported non

significant effect of parity of lactation on dry period (days) which are in agreement with the findings of the present study conducted in Jehanabad district of Bihar. However, Vij et al. (1992), Priya Raj (2002), Kumar (2006) and Prabhakar (2007) observed longer dry period (days) in 4th and above lactations. The result obtained in the present study, although non-significant, is also having similar trend i.e. longer dry period (days) in and after 4th sequence of lactations.

FARMING SYSTEM :

The system of farming could not influence dry period (days) significantly. Kumar[1] (2004) observed non-significant effect of farming system on dry period under farmers' managemental conditions in Darbhanga district of Bihar which is similar to the trend obtained in this study. However, Kumar (2005) and Prabhakar (2007) reported shorter dry period days in dairying integrated with agriculture than dairying alone. The result obtained in this study, although non-significant, has similar trend as reported by the above authors.

NET COST :

The net cost per kg of milk production is dependent upon cost of variable and fixed items in different periods, expenditure incurred on management, quantity of milk yield and other important factors required for maintenance. Therefore, it varies from time to time and place to place.

AVERAGE :

The average net cost/kg of milk production in Desi, HFX and JX cows were found to be Rs. 11.41±0.16, Rs. 9.80±0.14 and Rs. 10.23±0.15 respectively. Kumar (2005), Kumar (2006) and Parbhakar (2007) reported the average net cost per kg of milk production in Desi cows to be Rs. 10.28 , Rs. 10.14 and Rs. 10.05 respectively. The corresponding values for HFX were Rs. 8.60, Rs. 8.60 and Rs. 8.43 and for JX Rs. 9.64, Rs. 9.33 and Rs. 9.22 under farmers' managemental conditions in different districts of Bihar. The net cost per kg of milk production obtained in this study for all the three genetic groups is observed to be higher than the net cost obtained by the above authors. It is but natural as the net cost per kg of milk production varies according to price index and cost of variable times at different period of time.

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.
		Net cost
Genetic group	2	127.4705**
Location of herd	3	2.906286^{NS}
Herd size	2	5.691535*
Lactation order	4	2.469375^{NS}
Season of claving	2	0.9239200^{NS}
Farming system	1	1.040787^{NS}
Error	627	2.068506

** Significant at (P<0.01), * Significant at (P<0.10)
NS – Non-significant

EFFECT OF GENETIC FACTOR :

As depicted in least squares analysis of variance (Table –24) genotype played highly significant (P<0.01) effect on Net cost per kg of milk production in this study. An appraisal of least squares means (Table-25) revealed that HF crossbred cows had the lowest net cost per kg of milk production followed by JX and Desi cows reflecting the HFX to be the most economical. The HFX had significantly (P<0.01) Rs. 1.61 and Re. 0.43 lower net cost per kg of milk production than Desi and JX cows respectively. Besides, JX cows had also significantly (P<0.01) Rs. 1.18 lower net cost per kg of milk production than Desi cows. These findings again suggested more use of HF and Jersey for crossbreeding for economical milk production. Priya Raj (2002), Kumar[1] (2004), Kumar (2005), Kumar (2006) and Prabhakar (2007) also reported lowest net cost of milk production in HF crossbred cows followed by JX and Desi cows under farmers' managemental conditions in different districts of Bihar. The findings of the present study are in very close agreement with the result and trend obtained by all the above authors. Although the net cost per kg of milk production of HF crossbreds was lower than JX cows, yet during questionnaires many of the dairy farmers preferred Jersey 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
Overall mean (μ)	10.48±0.12
Genetic factors	
Desi	11.41^{a}±0.16
HF crossbred	9.80^{b}±0.14
Jersey crossbred	10.23^{c}±0.15
Non-genetic factors	
Location of Herd (zones)	
I	10.46±0.17
II	10.37±0.15
III	10.70±0.17
IV	10.38±0.17
Herd size	
3 - 4	10.31^{a}±0.17
5 - 7	10.74^{b}±0.17
8 & above	10.38^{a}±0.15
Season of calving	
Winter	10.42±0.16
Summer	10.47±0.15
Rainy	10.55±0.14
Lactation order	
1^{st}	10.44±0.16
2^{nd}	10.44±0.15
3^{rd}	10.70±0.14
4^{th}	10.41±0.17
5^{th} & above	10.40±0.30
Farming system	
Dairying alone	10.40±0.22
Agriculture + Dairying	10.56±0.09

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

to HFX because of more milk fat percentage, better reproductive performances and more diseases resistance of JX cows.

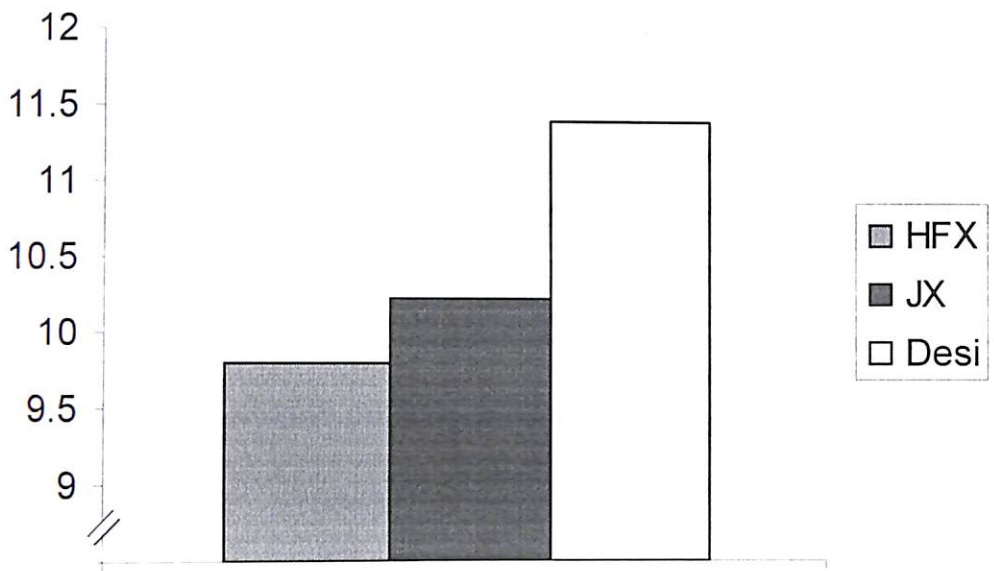

Figure 9: Net cost per kg of milk production (Rs.) in HFX, JX and Desi cows

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 per kg of milk production. Singh (1984), in Friesian x Zebu cows, Priya Raj (2002) in crossbred cows under farmers' managemental conditions in Patna district of Bihar and Prabhakar (2007) in Desi, HFX and JX cows under farmers' managemental conditions in Madhepura district of Bihar reported non-significant influence of location of herd on net cost per kg of milk production which are in conformity with the findings of the present study. It is to be pointed out here that all the four zones in this study are located in a radius of about 20 kms of Jehanabad and therefore there might not have been any remarkable differences in feeds and fodders, managemental conditions and prices of variable and fixed items. However, Kumar[1] (2004), Kumar (2005) and Kumar (2006) observed significant effect ($P<0.05$) of location of herd on average net cost of per kg of milk production.

HERD SIZE

Least squares analysis of variance (Table-24) presented significant effect of herd size on net cost per kg milk production. Average net cost per kg of milk production increased in herd size of 5-7 from 3-4 herd size and decreased by Re. 0.36 in herd size of 8 & above from 5-7 herd size. Significant ($P<0.05$) effect of herd size on average net cost/kg of milk

production in Desi, HFX and JX cows under farmers' managemental conditions in different districts of Bihar have also been reported by Priya Raj (2002), Kumar[1] (2004), Kumar (2005), Kumar (2006) and Prabhakar (2007). All the authors reported lower net cost in higher herd size. The findings of this study also suggested that herd size of 8 & above had cheaper milk production than the size of 5-7 herd.

SEASON OF CALVING :

Season of calving did not influence net cost / kg of milk production significantly which ranged from Rs. 10.42 among winter calvers to Rs. 10.55 among rainy calvers. Priya Raj (2002), Kumar (2005) and Prabhakar (2007) observed non-significant effect of season of calving on net cost/kg of milk production which are in close agreement with the findings of the present study. However, contrary to the findings of the present study. Kumar (2004) and Kumar (2006) found significant ($P<0.05$) effect of season of calving on net cost/kg of milk production.

LACTATION ORDER :

The sequence of lactations did not influence net cost / kg of milk production significantly. Kumar (2006) in Desi, HFX and JX cows under farmers' managemental conditions in Nalanda district of Bihar observed non-significant effect of lactation order on average net cost/kg of milk production which is in close agreement with the findings of the present study conducted in Jehanabad district of Bihar. However, Kumar[1] (2004)

Kumar (2005) and Prabhakar (2007) reported significant (P<0.05) effect of lactation order on net cost / kg of milk production.

FARMING SYSTEM :

The system of farming did not play significant role on net cost / kg of milk production. Kumar (2005) and Kumar (2006) in Desi, HFX and JX cows under farmers' managemental conditions in Patna and Nalanda districts of Bihar respectively reported non-significant effect of farming system on net cost / kg of milk production which are in conformity with the findings of the present study. However, Kumar[1] (2004) and Prabhakar (2007) observed significant (P<0.05) effect of farming system on net cost/ kg of milk production.

ECONOMICS OF MILK PRODUCTION:

COST COMPONENTS:-

Various cost components and their relative contributions to gross cost of milk production in different genetic groups have been depicted in table -26.

The various cost components included feed cost, labour cost, depreciation cost, Veterinary and A.I. cost, interest of fixed capital and miscellaneous cost. All these cost components were calculated relative to their gross cost in each genetic group. Among various variable cost items, feed cost was observed to be the major cost component which contributed 70.171%, 73.084% and 72.410% of their respective gross costs in Desi, HFX and JX cows respectively. The second major cost component was found to be the labour cost which contributed 14.957%, 17.036% and

16.553% of their respective gross costs in desi, HFX and JX cows respectively. The third major cost component was observed to be the interest on fixed capital which contributed 4.523% in Desi cows, whereas the third cost components in HFX and JX were found to be depreciation which contributed 4.032% and 4.066% respectively. However, Kalra et al. (1995) observed lower percentage of cost contribution of feed cost than obtained in this investigation. Besides, Chandra and Agarwal (2000) reported higher labour cost than obtained in this study.

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	8.21 (70.171)	7.25 (73.084)	7.48 (72.410)	7.647 (71.80)
Labour cost	1.75 (14.957)	1.69 (17.036)	1.71 (16.553)	1.717 (16.12)
Depreciation	0.52 (4.444)	0.40 (4.032)	0.42 (4.066)	0.447 (4.20)
Veterinary and A.I. cost	0.34 (2.906)	0.16 (1.613)	0.16 (1.549)	0.22 (2.066)
Interest on fixed capital	0.53 (4.523)	0.33 (3.326)	0.34 (3.291)	0.40 (3.76)
Miscellaneous cost	0.35 (2.991)	0.09 (0.907)	0.22 (2.129)	0.22 (2.066)
Gross cost of milk production(A)	11.70	9.92	10.33	10.65
Income from dung (B)	0.29 (2.479)	0.12 (1.203)	0.10 (0.968)	0.17
Net cost of milk production (A-B)	11.41	9.80	10.23	10.48

Figures in parentheses indicate percentage of respective gross cost.

Differences in managemental practices in different dairy units, variable feeds & fodder used in different ecological conditions, variations in

degree of demand from place to place influencing price of milk, change in price index, variable simple size and different degree of sampling, different ecological regions, different period of study, variations in genetic architecture of cows, inflation rate etc. might be responsible for variations in the estimate of contribution of different cost items to the gross costs per day of milk productions. The depreciation in Desi cows contributed 4.444% of its gross cost. The depreciations on fixed assets like depreciations on housing equipments, machinery etc. were taken together as one item namely "depreciations". The veterinary and A.I. cost shared 2.906%, 1.613% and 1.549% of their respective gross cost in Desi, HFX and JX cows respectively. The miscellaneous cost contributed 2.991%, 0.907% and 2.129% 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 2.479%, 1.203% and 0.968% of their respective gross cost in Desi, HFX and JX cows respectively.

Badal and Dhaka (1998), Priya Raj (2002), Kumar[1] (2004). Kumar (2005), Kumar (2006) and Prabhakar (2007)reported a similar trend of cost components to the trend obtained in the present study. Prabhakar (2007) and Bhowmik and Sirohi (2008) obtained more feed cost and labour cost in crossbred cows than Desi cows which are in conformity with the findings of the present study.

CONSTRAINTS PERCEIVED BY THE OWNERS OF DAIRY UNITS :

The livestock owners of various dairy units under study in and around Shahanabad were interviewed to enumerate the constraints related to availability of good dairy animals, finance/credit facilities, feeding, management, breeding, disease control, results of A.I. etc. in order of priority. These constraints varied according to location of the dairy units,

genetic group of the cows, herd size, feeding schedules, managemental practices etc. The constraints perceived by owner of the dairy units were ranked and have been depicted in Table -27. High cost of crossbred cows ranked 1st of various dairy units in and around Jehanabad. This might be, probably, due to non-availability of good dairy animals in the locality which has also been ranked second and in this study.

Table-27: Constraints perceived by the dairy farmers in and around Jehanabad (Bihar) in rearing Desi, HF and Jersey crossbred cows.

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

As such the owners of the dairy units were compelled to purchase high producing cross bred cows of superior genetic architecture from out side the State mostly from Haryana and the Punjab resulting into high cost of crossbred cows. High incidence of repeat breeding ranked as the 3rd constraint, specially among crossbred cows, perceived by the dairy owners. This might be, possibly, due to poor health conditions of the cows, non-availability of quality feed & fodder to them and lack of mineral supplements. High cost of feeds and fodders and feed supplements which contributed as highest cost components in all the three genetic groups of cows ranked 4th in this study.

The small dairy unit owners, in general and below poverty line owners in particular, were unable to purchase quality feeds & fodder which might be responsible for high incidences of deficiency diseases, poor health and low production of the cows. Non-availability of green fodder throughout the year ranked as 5th major constraint which might be responsible for poor dairy performance as well as high incidence of repeat breeding of the cows.

High cost of Veterinary medicines ranked 6th constraint perceived by the dairy owners. As such many of the dairy farmers could not provide better treatment to their ailing animals. Poor results of A.I. ranked as 7th major constraint perceived by the dairy owners in the district of Jehanabad. This might be, possibly, due to lapses in timely detection of heat and timely insemination with quality semen by trained personnel. However, many of the dairy farmers preferred natural services by the bulls to A.I.

Lack of proper housing ranked as 8th major constraints perceived by the dairy owners. The dairy units in rural areas have mostly Kacha houses with improper drainage and sanitation facilities which required improvement.

Lack of finance / credit facilities ranked as 9th constraint perceived by the dairy farmers. Although, there are many nationalized commercial banks including Magadh Gramin Bank located in and around Jehanabad, yet the dairy farmers of the area could not be benefited much mainly because of complexity of the procedures of financing.

The owner of the dairy units observed the crossbred male calves to be unsuitable for farm operations. Therefore, most of the farmers of the dairy units used to sale the crossbred male calves at very low price.

The dairy farmers observed the price of milk to be non-remunerative in the area of the study. However, they also reported about the exploitation by the middlemen.

The results obtained in this area are on the basis of the work done in and around Jehenabad. It could not be compared with identical studies conducted in different parts of the country. It is because the constraints varied from place to place, one dairy unit to another, availability feeds, fodders and feed supplements, genotypes of the cows,, feeding schedules and managemental practices, administrative and managerial control, availability of crossbred cows, awareness and education of the dairy farmers, trained personnel in A.I. etc. Variations in the ranks of perceived by the dairy farmers might be attributed to variations in the important factors mentioned above.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The present investigation was conducted on 99 randomly selected private dairy units consisting of 163 Desi, 258 HFX and 221 JX cows utilising the procedures of "Stratified random sampling with proportional allocation" (Snedecor and Cochran, 1967) in Jehanabad, Ghosi, Kako and Modanganj blocks of Jehanabad district. The main aim of this investigation was to study the effects of genetic and various non-genetic factors on milk production efficiency traits under farmers' mangemental conditions. Besides, various constraints perceived by the dairy framers were also examined to suggest a suitable package of dairy practices for economic milk production.

The milk production efficiency traits included lactation milk yield (LMY, kg), Lactation length (LL, days), Peak yield (kg), Days to attain peak yield (DAPY), Milk yield/day lactation length (MY/day LL) and milk yield/day of calving interval (MY/day CI). The reproduction efficiency traits consisted of dry period (DP) days and calving interval (CI) days.

Apart from these, cost of milk production was also taken into account as one of the economic efficiency traits in this study.

The genetic groups consisted of Desi, HFX and JX cows, whereas the non-genetic factors included location of herd, herd size, season of calving, parity 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 cross-bred cows and Jersey cross-bred cows maintained in unorganized farm in and around Jehanabad, Bihar.

2. To study the nature and magnitude of variation in various measures of milk production efficiency due to genetic and non-genetic factors in and around Jehanabad, Bihar.
3. To study the various constraints perceived by the dairy farmers in and around Jehanabad in rearing high yielding cows.
4. To provide suggestions for suitable dairy practices for economic milk production to the dairy farmers in and around Jehanabad, Bihar.

The research data were provided statistical treatment through computer in the **division of 'Livestock Economics and Statistics' of Indian Veterinary Research Institute, Izzatnagar, Bareilly (UP).** 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 different levels of probability.

The average Lactation milk yields (kg) of Desi, HFX and JX cows were observed to be 1009.16±15.52, 2410.68±14.37 and 1974.67±14.43 respectively. Genetic groups had highly significant ($P<0.01$) effect on LMY (kg). HFX and JX cows had significantly ($P<0.01$) 1401.52 kg and 965.51 kg higher LMY than Desi cows maintained in the Jehanabad district of Bihar. Thus, HFX cows had nearly two and a half times and JX cows had also nearly double LMY than those yielded by desi cows reflecting that both HFX and JX cows are well adapted in the agro-climatic region of Jehanabad district of Bihar. Besides, HFX cows had also significantly ($P<0.01$) 436.01 kg higher LMY than JX cows suggesting more use of HF than Jersey for crossbreeding to enhance milk production in and around Jehanabad (Bihar). The non-genetic factors did not play significant role on LMY.

The least squares means of lactation length in Desi, HFX and JX cows were obtained as 335.68±1.89 days, 336.37±1.75 and 327.33±1.76 days respectively

Genetic group had highly significant (P<0.01) effect on LL days. HF crossbreds had the highest LL days followed by Desi and JX cows-Duncan's Multiple Range test (DMRT) revealed that both Desi and HFX cows had significantly (P<0.01) 8.35 days 9.09 days longer LL days than JX cows. However, the mean LL days of desi and HFX did not differ significantly.

However, the non-genetic factors had non-significant effects on lactation length in this study. Since the present study was conducted in a radius of about 20 Kms in and around Jehanabad, there might not be much variations in agro-climatic, managemental, feeding schedule and other environmental factors resulting into similar effect of various zones on LL days.

The average peak yield (kg) in Desi, HFX and JX cows were found to be 5.76±0.27, 11.68+0.25 and 9.24±0.25 respectively under framers' managemental conditions in Jehanabad district of (Bihar).

There was highly significant (P<0.01) effect of genotypes on peak yield. The highest peak yield was observed to be in HF crossbred cows which was significantly (P<0.01) higher by 5.92 kg and 2.44 kg than Desi and JX cows respectively. Besides, Jersey crossbred cows had also significantly (P<0.01) 3.48 kg higher PY than Desi cows. The non-genetic factors except lactation order could not affect peak yield significantly. However, winter calvers had higher peak yield than summer and rainy calvers which might be possibly, due to availability of more green fodders during winter.

The average days to attain peak yield (DAPY) in Desi, HFX and JX cows were obtained as 51.12±0.72, 46.57±0.66 and 50.57±0.67 days respectively. Genotypes had highly significant (P<0.01) effect on DAPY. The shortest DAPY was observed to be in HF crossbred cows, whereas the longest DAPY was found to be in Desi cows. HF crossbred cows had significantly 4.55 days and 4.00 days lower DAPY than Desi and Jersey crossbred cows respectively. Although JX cows had 0.55 days shorter DAPY than Desi cows, yet the mean DAPY of Desi and JX cows did not differ significantly. The non-genetic factors did not play significant role on DAPY. However, the DAPY increased in 5th & above lactations suggesting lower performance with the increase of lactation order.

The average milk yield/day of LL (MY/ day LL) (kg) of Desi, HFX and JX cows were found to be 3.40±0.06, 8.05+0.05 and 6.61+0.05 respectively under farmers' managemental conditions in Jehanabad district of Bihar. Genotypes had highly significant (P<0.01) effect on MY/day LL. HFX had the highest MY/day LL followed by JX and Desi cows. HFX had significantly (P<0.01). 4.65 kg and 1.44 kg higher MY/day LL than Desi and JX cows respectively. Besides, JX cows had also 3.21 kg significantly (P<0.01) higher MY/day LL than Desi cows. HFX had more than double and JX had also nearly double MY/day LL than Desi cows under farmers' managemental conditions in Jehanabad district of Bihar. These findings suggested that crossbreeding of indigenous/Desi cows with HF and Jersey exotic inheritance would be helpful in rapid increase of milk production in Jehanabad district of Bihar narrowing the gap between availability and requirement of milk yield. The non-genetic factors like location of herd, herd size, season of calving, lactation order and farming system did not play significant role on MY/day LL.

The average calving interval days in Desi, HFX and JX cows were observed to be 461.67+2.18, 422.33±2.02 and 430.41±2.03 days respectively under farmers' managemental conditions in Jehanabad district of Bihar. Genetic group and herd size had highly significant (P<0.01) effect on CI days. HF crossbred cows had the lowest CI days followed by JX and Desi cows. HFX had significantly (P<0.01) 39.34 days and 8.08 days lower CI than Desi and JX cows respectively. Besides, JX cows had also significantly (P<0.01) 31.26 days lower CI than Desi cows. These findings suggested the superiority of crossbred cows over Desi. Herd size also played significant (P<0.01) effect on CI days. The herd size of 8 & above had significantly (P<0.01) 8.04 days lower calving interval than the herd size of 3-4. Besides, the herd size of 5-7 had also significantly (P<0.01) 5.70 days lower CI than herd size of 3-4. All these findings suggested higher the herd size lower was the calving interval days. However, other non-genetic factors had non-significant effect on CI days.

The MY/day CI (kg) in Desi, HFX and JX cows were observed to be 2.46±0.08, 6.35±0.07 and 5.00±0.07 respectively under farmers' managemental conditions. Genotypes had highly significant (P<0.01) effect on MY/day CI. HFX had significantly (P<0.01) 3.89 kg and 1.35 kg higher MY/day CI than Desi and JX cows respectively. Besides, Jersey crossbred cows had also significantly (P<0.01) 2.54 kg higher MY/day CI. HF cross bred cows had significantly (P<0.01) more than two and a half times and Jersey crossbred cows had more than double MY/days CI than Desi cows. These findings again suggested well adaptation of HF and Jersey inheritance in crossbred cows with Desi genotypes. However, the non-genetic factors did not play significant role on My/day CI.

The average dry period (days) in Desi, HFX and JX cows were observed to be 138.02±2.53, 94.67±2.34 and 99.16±2.35 respectively. Genotypes had highly significant (P<0.01) influence on dry period days. The HF crossbred cows had the shortest, whereas Desi cows had the longest dry period days. HF crossbreds had significantly (P<0.01) 43.35 days and 4.49 days shorter dry period days than Desi and Jersey crossbred cows respectively. Besides, JX cows had also significantly (P<0.01) 38.86 days shorter dry period than Desi cows. However, the non-genetic factors had non-significant role on dry period days.

The average net cost per kg of milk production in Desi HFX and JX cows were found to be Rs. 11.41+0.16, Rs. 9.80+0.14 and Rs. 10.23+0.15 respectively under farmers' managemental conditions in Jehanabad (Bihar). Genotype played highly significant (P<0.01) role on net cost per kg of milk production. HF crossbred cows had the lowest net cost per kg of milk production followed by JX and Desi cows reflecting the HFX to be the most economical. The HFX had significantly (P<0.01) Rs. 1.61 and Re. 0.43 lower net cost per kg of milk production than Desi and JX cows respectively. Besides, JX cows had also significantly (P<0.01) Rs. 1.18 lower net cost/kg of milk production than Desi cows. Herd size had also significant effect on net cost/kg of milk production. The herd size of 8 & above had significantly Re. 0.36 lower net cost/kg of milk production than herd size of 5-7 suggesting 8 & above had cheaper milk production than the herd size of 5-7. However, the other non-genetic factors had non-significant effect on net cost/kg of milk production.

All these findings suggested well adaptation of HF and Jersey inheritance in crossbred cows with local genotypes. Besides, HFX crossbred cows proved themselves to be superior to Jersey crossbred cows for milk production efficiency traits. Inspite of all these fact many of the dairy

framers of Jehanabad district, however, preferred Jersey crossbred cows to HFX mainly because of its higher fat percentage in milk, docile in nature, more use of crossbred male calves, easier handling and more resistant to diseases.

The farmers of the dairy units located in and around Jehanabad (Bihar) perceived eleven constraints of which high cost of crossbred cows ranked 1st followed by non-availability of good dairy animals in the locality, high incidences of repeat breeding, high cost of feeds, fodder & feed supplements, non-availability of green fodder throughout the year, high cost of veterinary medicines, poor results of A.I., lack of proper housing, lack of finance/ credit facilities, uneconomical crossbred male calves and non-remunerative price of milk which require due consideration on priority basis.

RECOMMENDATION:

On the basis of the findings of the present investigations, it was observed that both HFX and JX cows are well adapted for milk production efficiency in the agro-climatic region of Jehanabad district of Bihar. Both HFX and JX had more than double LMY, MY/day LL and MY/day CI than Desi cows. Thus, both HF and Jersey exotic inheritance can well be introduced in crossbreds with zebu cattle for increase in milk production and other milk production efficiency traits.

However, HF crossbred cows should be preferred to Jersey crossbred cows for lactation milk yield, lactation length, peak yield, days to attain peak yield, MY/day LL, CI, MY/day CI, dry period and net cost/kg of milk production suggesting more use of HF than Jersey for crossbreeding in and around Jehanabad Bihar. Besides, the herds size of 8 & above cows would be relatively economical for milk production in this area.

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