Genetic Studies on Milk Production Efficiency in Various Crossbred Grades of Cattle in and Around Pusa (Samastipur) Bihar

THESIS

SUBMITTED TO THE

RAJENDRA AGRICULTURAL UNIVERSITY

(FACULTY OF VETERINARY AND ANIMAL SCIENCES)

PUSA (SAMASTIPUR) BIHAR

By

Dr. Rupesh Kumar

Registration No. - M/ABG/58/2003-2004

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

PATNA (BIHAR)

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

2007

In Reverent

Dedicated

To

My Respected

Parents

In Reverent

Dedicated

To

My Respected

Parents

DEPARTMENT OF ANIMAL BREEDING & GENETICS
BIHAR VETERINARY COLLEGE, PATNA – 14
RAJENDRA AGRICULTURAL UNIVERSITY
PUSA (SAMASTIPUR), BIHAR

Dr. Siya Ram Singh
M.V.Sc., Ph.D
University Professor and Chairman

CERTIFICATE – I

This is to certify that the thesis entitled "***Genetic studies on milk production efficiency in various crossbred grades of cattle in and around Pusa (Samastipur) 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. Rupesh Kumar, Registration No. M/ABG/58/2003-04,** 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

19/2	19/2/07
(S. R. Singh)	**(Siya Ram Singh)**
Chairman of the Department	Major Advisor

DEPARTMENT OF ANIMAL BREEDING & GENETICS
BIHAR VETERINARY COLLEGE, PATNA – 14
RAJENDRA AGRICULTURAL UNIVERSITY
PUSA (SAMASTIPUR), BIHAR

CERTIFICATE – II

We, the undersigned members of the Advisory Committee of **Dr. Rupesh Kumar**, Registration No. **M/ABG/58/2003-2004**, a candidate for the Degree of Master of Veterinary Science with major in **Animal Breeding & Genetics** have gone through the manuscript of the thesis and agree that the thesis entitled "***Genetic studies on milk production efficiency in various crossbred grades of cattle in and around Pusa (Samastipur) Bihar***" may be submitted by **Dr. Rupesh Kumar** in partial fulfilment of the requirements for the degree.

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PUSA (SAMASTIPUR), BIHAR

CERTIFICATE – III

This is to certify that the thesis entitled "***Genetic studies on milk production efficiency in various crossbred grades of cattle in and around Pusa (Samastipur) Bihar***" submitted by **Dr. Rupesh Kumar, Registration No. M/ABG/58/2003-04** 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 24.8/2007 / ~~2006~~ 2007

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Date : 19.02.07

Place : B.V.C., Patna

Rupesh Kumar

(Rupesh Kumar)

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INTRODUCTION

1. INTRODUCTION

In India the milk production is predominantly in the hands of small and marginal farmers scattered all over the country. The major portion of the milk produced in the country comes through these small producers. Therefore, for augmentation and sustainability in milk production in the country, it is desirable to strengthen the small dairy units in private sectors where dairy animals are managed under farmers' managemental system.

The truncated Bihar is a milk deficient state (Bihar Govt. Report 2001) and there is a great need to promote milk production to keep pace with the increasing demand for rapidly growing human population. Milk production in Bihar also is predominantly a domain of small and marginal households contributing more than 65% to the state milk pool. Thus, it is vivid that systematic studies are essentially required to formulate suitable package of dairy practices to maximize milk production in the small dairy units distributed throughout the state under farmers' managemental system.

To cope with the ever growing per capita requirement, crossbreeding of native cattle with exotic bulls of high breeding values were initiated during mid sixties and it was accepted as one of the cattle breeding policies of India. The systematic crossbreeding in cattle was initiated in the country with potent exotic breeds like Holstein-Friesian, Jersey, Brown – Swiss etc. Both Government and non-government agencies had been engaged in implementing specific target oriented programs to improve the qualities of inputs for optimum productivities of crossbred animals and also for building up strategic systems to sustain improved milk production.

Crossbreeding has certainly resulted increase in milk production in the state but still we are lagging behind in meeting the recommended requirement of 250 gm of milk/capita/day. In Bihar, the per capita availability of milk is significantly lower than the present national average of 226 gms. A considerable number of crossbred cows, with variable level of Jersey and Holstein-Friesian inheritance in combination with indigenous cattle, are available in the state. There is great need to assess the adaptability of cross-breds of different genetic grades (animals with different levels of exotic inheritance) in terms of their production, reproduction and economic efficiency to formulate a suitable strategy for enhancing milk production in the different agro-climatic zones of the state.

Further, profitability is the prime objective of any enterprises and the concept of profit provides an alternative approach to the analysis of production. In dairy enterprises also it is essential to know the nature as well as magnitude of the determinants of profit and for this it is necessary to study the economic aspect of dairy farming. Economic analysis of milk production is also needed for providing effective linkage among producers, consumers and policy makers for fixing prices of the inputs and outputs in a rational way.

Reports are available to indicate that high yielding dairy animals require some hi-tech management and as such farmers are facing several constraints in adoption and rearing of high yielding stock. Hence, it is necessary to study and enlist the different constraints perceived by the dairymen in adoption and rearing of superior stock in priority order. It will facilitate in suggesting suitable solutions to both the dairymen as well as the policy makers to make necessary amendments in existing provisions pertaining to milk production.

Pusa is the University headquarter of Rajendra Agricultural University. Animal Production Research Institute (APRI) is operative at Pusa since long and scientist of this institute are engaged in expertise support to dairy farmers in the neighbouring villages. A number of A.I.

unit-cum-health centers have been operative in the area. Resultantly, high yielding cross-bred cows of different grades are available in considerable number in and around Pusa. The milk producers of the area are progressive and linked with the net-work of dairy co-operatives run under COMPFED (Bihar). The village co-operatives are maintaining records pertaining to production and reproduction performances of registered animals. A well established University cattle farm is also managed at Pusa where performance records of cross-bred animals are maintained. No systematic study has been undertaken to estimate the phenotypic parameters of milk production efficiency measures of the cows being maintained in and around Pusa. The magnitude as well as direction of the effects of genetic as well as non-genetic factors on milk production efficiency traits of these animals needs to be known in order to formulate and suggest suitable package of dairy practices for economic milk production. As such, this study has been undertaken to evaluate the performance of cross-bred cows managed in Unorganized Private & Organized Public sectors in hot-humid climate in and around Pusa (Samastipur) with the following objectives:

(i) To estimate phenotypic parameters of the various economic indicators in cross-bred grades managed in organized and unorganized sectors in the study area.

(ii) To analyse the nature as well as magnitude of variation in the different economic indicators due to genetic and some of the non-genetic causes in the crossbred grades.

(iii) To enlist and rank the constraints perceived by the farmers in rearing high yielding cross-bred cattle.

(iv) To study and compare the performance of different grades of cross-bred cow in co-operative and non-cooperative sectors in the study area.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

1.1 PRODUCTION AND REPRODUCTION TRAITS

(a) ORGANIZED HERD

Raheja and Bhat (1982) reported that the overall average value, irrespective of their lactation sequence, for MY/CI in Friesian crossbred cows was 5.2 kg. However, their findings were based on half breds maintained in relatively better management of Military Dairy Farm as compared to those in small dairy units in private sector.

Pander and Chopra (1986) studied the factors affecting the average daily milk yield in cows of different genetic grades and reported the average daily milk yield in halfbreds of Holstein Friesian and Jersey with Hariana as the base to be 9.25 $\pm$ 0.41 and 7.73 $\pm$ 0.53 kg respectively.

Pyne *et al.* (1987) reported highly significant ($P<0.01$) effect of genetic group on calving interval and HF X Hariana crossed were reported to have significantly ($P<0.05$) longer calving interval than the Jersey x Hariana.

Chopra (1990) compared the performance of half breds of Holstein Friesian, Brown Swiss and Jersey with Hariana and reported the 1st lactation length in ½ HF crossbred, ½ Hariana and ½ J crossbred ½ Hariana to be 344.4$\pm$ 5.3 and 328.3 $\pm$ 6.5 days respectively.

Pundir and Raheja (1997) reported the average 1st lactation length in Hariana cows to be 336 $\pm$ 4.3 days.

Tomar *et al.* (1998) calculated the first lactation lenght in HF halfbreds to be 234.49 days.

Thakur *et al.* (1999) observed the 1st lactation length to be 314.7 ± 9.9 and 356.1 ± 14.5 days in ½ J x ½ H and > ½ J crossbreds respectively.

Singh *et al.* (2000) studied the factors affecting lactation performance in Jersey and Friesian crossbred cows. The overall mean, irrespective of the genetic groups of the cows, for calving interval, lactation yield, lactation length and peak yield were reported to be 434.77±2.74 days, 2748.20±18.93 kg, 338.78 ± 1.76 days and 13.92 ± 0.07 kg respectively. When taken genetic –group wise, the corresponding values for Jersey crossbreds were 405.94± 8.17 days, 2355.42 ± 56.29 Kg, 322.50 ± 5.3 days and 13.27 ± 0.30 kg and in HF crossbreds the estimates were 429.47 ± 40.53 days, 3021.73 ± 40.53 Kg, 337.73 ± 3.77 days and 15.23 ± 0.21 Kg respectively. The breed of the sire was reported to have significant effect on lactation yield, lactation length and peak yield but did not influence calving interval. The effect of parity was significant on all the traits under the study, but the season of calving did not influence the traits.

Thakur *et al.* (2000) recorded the average 300 days milk yield, daily milk yield per day of lactation length and per day of calving interval in Jersey crossbred cows ranging from 1652.2 ± 129.4 Kg to 2044.55 ± 55.5 Kg, 5.81 ± 0.60 Kg to 7.25 ± 0.26 Kg and 4.28 ± 0.40 Kg to 5.43 ± 0.17 Kg respectively. The corresponding overall least squares means were reported to be 1850.1 ± 31.8 Kg, 6.61 ± 0.15 Kg and 4.76 ± 0.50 Kg respectively. The period had significant influence on the traits under investigation.

Pramanik *et al.* (2000) reported highly significant ($P< 0.01$) effect of season of calving on 300 days lactation milk yield in Jersey x Hariana and Holstein Friesian x Hariana halfbreds. The winter calvers were reported to have significantly ($P<0.05$) higher lactation milk yield than the summer and rainy calvers.

Sil and Tripathi (2001) studied the effect of season of calving on total lactation yield in crossbreds of Hariana with Holstein Friesian and Jersey. The season of calving was reported to have significant ($P<0.05$) effect on total lactation yield. Spring calvers were reported to yield highest quantity of milk whereas rainy calvers yielded the lowest quantity.

Dutt and Bhusan (2001) studied the peak yield and its association with production and reproduction traits in crossbreds. The mean peak yield in Friesian and Jersey half breds were reported to be 11.08 $\pm$ 0.22 and 8.89 $\pm$ 0.35 Kg respectively. Genetic grade and season of calving had no significant influence on peak yield.

Srivastava *et al.* (2001) reported that the average daily milk yield and lactation length in crossbred cows maintained at Faizabad varied from 7.47 ± 0.17 to 9.62 ± 0.38 kg. More duration of shower provided to the cows in summer gave better results.

According to ICAR (2002) report the average calving interval of pure Hariana, HF X H (F_1) and HF X H (F_2) to be 535, 465 and 592 days respectively.

Dhirendra Kumar (2004) reported the average 300 days lactation yield in Hariana and different genetic grades of Hariana with Holstein Friesian and Jersey such as HF<50%, HF 50%, HF 62.5%, HF 75% and J 50% to be 909.88 $\pm$ 150.04, 1085.32 $\pm$ 69.30, 1836.52 $\pm$ 78.72, 860.89 $\pm$ 89.28, 1669.58 $\pm$ 106.58 and 1740.43 $\pm$ 47.35 kg respectively.

(b) UNOGRNISED HERD

Performance characteristics and economics of milk production produced by the crossbred cows managed under farmers' managemental conditions have been a subject of investigation of research workers in recent past and sporadic reports on this aspect are available from the different milk producing states of the country.

Rathi (1975) reported the average days to attain peak milk yield in Haryana based Friesian cows to be 54.25 days.

Kaul et al. (1977) reported that on an average, Zebu based Friesian crossbred cows attained peak yield in 41.27$\pm$ 7.31 and 42.45$\pm$ 6.96 days respectively in their first and second lactations. However, the order of lactation did not have any significant influence on this economic trait.

Raheja (1982) reported that on an average, Zebu based Friesian crossbred cows attained peak yield in 41.6 $\pm$ 1.60 days after calving. The effect of season of calving is reported to have no significant effect on this trait. However, cows calved during cold season were observed to attain early peak yield.

Singh (1984) reported the effect of genetic grades, zones, season of calving and parity to be significant on peak yield in Friesian x Zebu cows belonging to unorganized herds in and around Ranchi. The size of the herd did not have significant influence on peak yield.

Singh *et al.* (1986[a]) made a comprehensive study on economics of milk production and effect of genetic and different non-genetic factors in Friesian crossbred cows maintained in small dairy units of private sector in and around Ranchi. Least squares means for lactation length, lactation yield, dry days, calving interval, milk yield per day of lactation, milk yield per calving interval and peak yield in higher (> 50 % of Friesian), first (50 % of Friesian) and lower (< 50 % of Friesian) crossbred cows were recorded to be 310.2 ± 1.6, 305.3 ± 2.4 and 292.8 ± 3.0 days; 3556.2 ± 83.6, 3655.1 ± 125.6 and 2288.8 ± 158.5 kg ; 82.2 ± 2.4, 82.4 ± 3.7 and 105.9 ± 4.6 days ; 398.3 ± 2.4, 388.0 ± 3.5 and 398.8 ± 4.6 days; 10.9 ± 0.3, 11.2 ± 0.2 and 9.3 ± 0.4 kg ; 8.9 ± 0.2, 9.4 ± 0.3 and 5.7 ± 0.4kg. and 14.4 ± 0.3, 16.0 ± 0.3 and 13.6 ± 0.5 kg. respectively.

Singh *et al.* (1986[b]) reported that the overall estimates of mean for lactation length, lactation yield and calving interval in local based Friesian crossbred cows in private sector in and around Ranchi, were 302.8 ± 1.4 days, 3166.7 ± 74.4 kg and 395.0 ± 2.1 days respectively. Size of the unit had significant influence on all the traits under study. Genetic grade of the cows and location of the herd influenced lactation yield and calving interval significantly, but their effects on lactation length was not significant. Parity effect was significant on lactation length and lactation yield but not significant on calving interval. The season of calving was reported to influence calving interval significantly.

Singh *et al.* (1989) analysed the data on milk yield per day of lactation length and calving interval in Friesian crossbred cows. The overall mean for these two efficiency traits were reported to be 7.929±0.216 and 5.916±0.418 kg respectively. Period as well as season of calving and lactation order had significant influence on both the efficiency traits.

Kumar and Gupta (1992) worked out the economics of milk production in buffaloes maintained in different categories of households in Muzaffarnagar district (U.P). The overall mean lactation period, inter-calving period and lactation yield were estimated to be 331 days, 484 days and 1648.38 lits. respectively.

Singh *et al.* (1993[a]) estimated the average value for lactation length, lactation yield, dry period, daily yield, peak yield and days to attain peak yield in Jersey crossbred cows to be 298.5$\pm$7.31 days, 2286.20$\pm$77.8 kg, 120.0$\pm$8.74 days, 7.82$\pm$0.16 kg, 12.28$\pm$0.38 kg and 41.46$\pm$1.70 days respectively. The season of calving was reported to have non-significant effect on all the traits under reference.

Singh *et al.* (1993[b]) under took a study on milk production efficiency traits in crossbred cattle (1st parity) at G.B. Pant University of Agriculture and Technology, Pantnagar and reported the lactation milk yield, lactation length, dry period, milk yield per day of lactation length, peak-yeild and days to attain peak–yeild to be 2580.98$\pm$ 77.8 kg, 306.08$\pm$7.31 days, 106.15$\pm$8.74 days, 7.11 $\pm$ 0.16 kg., 13.27 $\pm$ 1.69 Kg. and 3865 $\pm$ 1.70 days respectively. The effect of genetic group was significant ($P \leq 0.01$) on lactation yield, daily milk yield and peak-yield, while period-effect contributed significantly to the variation in daily milk yield only.

Dev Raj and Gupta (1994) found significant effect of season on average daily milk production in local cows in Churu district of Rajasthan. The average lactation length and daily milk yield were reported to be 270 days and to be 2.13 lits respectively.

Shah and Sharma (1994) conducted a comparative study on economic performance of milch animals of different genetic groups in typical rural conditions of Bulandshahar district of Uttar Pardesh. The district was divided into two areas, the one covered by Dugdh Utpadak Sahkari Sangh (DUSS) and the other not covered by DUSS (NDUSS). The study revealed that the net income derived from different groups of bovines was much higher in DUSS area than in NDUSS area. The estimates of lactation length in local cow and crossbred cows were 317±19.95 and 359±13.73 days in DUSS and 336±5.23 and 334±7.59 days in NDUSS. The corresponding means for dry period were estimated to be 134±10.02 and 80±5.56 days in DUSS and 131±8.12 and 99±9.68 days in NDUSS. The average estimates of calving interval were recorded to be 451±28.64 and 439±17.03 days for local cow and crossbred cows respectively in DUSS whereas 467±7.43 and 443±9.04 days in NDUSS. The average estimates of lactation yield in local and crossbred cows were 926.61 and 1972.99 lits. in DUSS and 918.61 and 1995.07 lits. in NDUSS respectively.

Chaudhary *et al.* (1995) estimated the average calving interval in Jersey crossbred cows to be 451.70±7.76 days. The influences of season of calving and parity on calving interval were statistically not significant.

Deshmukh *et al.* (1995) reported the least squares means for lactation milk yield, peak yield, lactation length and dry period in Jersey X Sahiwal cows to be 1954.53 ± 68.99 kg, 10.41 ± 0.33 Kg. 309.87 ± 3.56 days and 141.8 ± 6.02 days respectively. It was observed that period of calving had significant influence on dry period only, while parity had highly significant effect on lactation yield and peak yield.

Singh (1995) reported that in Friesian X Zebu cows of organized herds in and around Ranchi (Jharkhand) the average values for lactation length, lactation yield and peak yield were 324.7 ± 6.4 days, 2370.8 ± 66.0 kg and 13.3 ± 0.3 kg respectively. The effect of the level of Friesian inheritance was significant for the all traits except the lactation length. Herd-size and period effects were significant for all the three traits under study, whereas the effect of season of calving was significant only on peak yield. Half-breds were recommended to be the grade of choice for economic milk production in the study area.

Shrivatava *et al.* (1996) made a study to find out the effects of various genetic and non-genetic factors on dry period and calving interval in Friesian x zebu crossbred cows maintained under farmers managemental conditions in Chotanagpur .The estimates of overall mean dry period and calving interval were found to be 85.98 ± 1.36 and 384.48±1.40 days respectively. The effects of zone and season of calving were non-significant on both the traits. However the size of the herd had significant influence on dry days and inter-calving period. Cows in smaller herds i.e. groups of 1-2, 3-5 and 6-8 cows had significantly shorter dry and inter- caving periods as compared to those in herds of 9-11 and more than 12 cows.

Venkatasubramanian and Fulzele (1996) conducted a study involving 288 small dairy units under private sector distributed in villages of Tamilnadu and recorded average lactation yield of crossbred and indigenous cows to be 2075.00±20.26 and 950± 07.86 litres respectively. The average estimates of lactation length in the cows of both the genetic groups were 9.11± 0.05 and 8.18±0.02 months respectively. The Management in the herd had highly significant ($P \leq 0.01$) positive relationship with the production performance in crossbred cattle.

Mishra and Prasad (1998) reported the average values for first lactation peak yield, milk production efficiency per Kg. body weight and milk production efficiency per day calving interval in crossbred cows to be 13.665±0.229 kg, 8.202±0.182 kg and 6.060 ± 0.140 kg respectively.

Shrivastawa *et al.* (1998) studied the effect of different genetic and non-genetic factors on some dairy traits in Friesian X zebu cows of unorganized herds in and around Ranchi (Bihar). The overall least squares means for lactation yield, lactation length and peak-yield were estimated to be 2716.03 ± 7.89 kg, 298.73±0.48 days and 13.52 ±0.04 kg respectively. The cows belonging to individual farmer had significantly higher lactation yield and peak-yield than those of commercial Khatals. Level of Friesian inheritance, location of the herd (zone), herd-size, management (individual farmer vs khatal) and lactation order of the cows were reported to have significant influence on production traits. The season-effect was non-significant on all the three traits under investigation. Study revealed that managemental system and genetic grade had highly significant ($P \leq 0.01$) influence on lactation length and lactation milk yield but its influence on peak-yield was significant at 5% level of significant. The cows in smaller herds (1-2 and 3-5 cows) had higher lactation and peak yield in comparison to the larger herds (6-8, 9-11 and 12 and above cows group). However, the lactation length and lactation yield in larger herds increased linearly with increase in sequence of lactation up to fifth lactation.

Tomar *et al.* (1998) calculated the first lactation length, peak yield, calving interval, dry period, average milk yields per day of lactation length and calving interval in HF half-breds to be 234.46 Kg, 8.51 Kg, 403.72 days, 167.07 days, 6.75 Kg and 4.18 Kg respectively.

Rao *et al.* (2000) studied the performance of crossbred cows under field conditions of Vishakhapatnam district of Andhra Pradesh. The least squares mean for calving interval, lactation milk yield, lactation period, and dry period in Jersey crossbred cows were 453.73 ± 4.43 days, 1899.81 ± 47.60 lits., 351.76 ± 3.03 days and 83.93 ± 3.10 days respectively. The corresponding values in HF crossbred were 472.82 ± 10.78 days, 2790.90 ± 115.85 lits 380 ± 7.52 days and 90.53 ± 7.54 days. Location and genetic group of the animal had significant effect on calving interval, lactation milk yield and dry days.

Shrivastava and Singh (2000) studied the factors influencing efficiency of milk production in Friesian x Zebu crossbred cows in unorganized herds. The overall mean MY/ CI and MY/LL were 7.11± 0.03 and 9.09 ± 0.03 Kg respectively. The effect of management, location of the herd, herd size and parity were reported to be statistically significant on both the traits. The effect of season of calving had non-significant influence on the traits under investigation.

Hemlatha *et al.* (2003) made an attempt to work out economics of milk production of different breeds of bovines in Ahmadnagar district of Maharashtra and reported that the average profit per animal was maximum in Jersey crossbred cows as compared to HF crossbreds. Even buffaloes were found to be more profitable. Among economic indicators, the average lactation length was the longest (320 days) in HF crossbreds followed by Jersey crossbreds (298 days), graded buffaloes (278 days) and non-descript cows (240 days). The average dry period was recorded to be 90, 93, 180 and 135 days in HF crossbreds, Jersey crossbreds, non-descript cows and graded buffaloes respectively. The average inter-calving period was maximum in non-descript cows (420 days) followed by buffaloes (413 days) , HF crossbreds (410 days) and Jersey crossbreds (381 days). The average daily milk in HF, Jersey and non descript cows as well as buffaloes were recorded to be 13.0, 11.0 and 3.0 and 6.5 lits respectively.

Kumar[1] (2004) Studied the production & reproduction efficiencies of Desi Cattle and their crosses with Holstein Frisian and Jersey managed by the farmers in and around Darbhanga district of North Bihar and reported the overall least squares means for lactation milk yield, lactation length, peak yield, days to attain peak yield, milk yield per day of lactation length, milk yield per day of calving interval, dry period and calving interval to be 1575.51±11.79 kg, 320.62±1.13 days, 9.85±0.09 kg, 40.11±0.30 days, 4.87±0.04kg, 3.55±0.03kg, 125.03±2.02 dyas and 445.56±2.33 days respectively. Genetic group wise the average estimates for lactation milk yield of Desi, HF crossbreds and J crossbreds were reported to be 734.45, 2160.16 and 2037.54 kg, respectively, for lactation length 293.29, 334.64 and 333.43 days respectively, for peak yield 4.99, 12.30 and 11.89 kg respectively, for days to attain peak yield 35.90, 43.02 and 42.51 days respectively, for milk yield per day of lactation length 2.54, 6.47 and 6.16 kg respectively, for milk yield per day of calving interval 1.71, 4.79 and 4.58 kg respectively, for Dry period 134.82, 118.52 and 117.81 days respectively and for calving interval 427.08, 453.45 and 451.85 days respectively.

Ayub (2005) studied the production and reproduction efficiencies of Desi cattel and their crosses with Holstein-Friesian and Jersey managed by the farmers in and around Muzaffarpur (Bihar) and reported the overall least squares mean for lactation milk yield, lactation length, peak milk, days to attain peak yield, milk yield per day of lactation length, milk yield per day of calving interval, dry period and calving interval to be 1638.73±67.99kg, 318.05±2.44 days, 10.14±0.36 kg, 40.54±0.48 days, 5.07±0.19kg, 3.71±0.15kg, 118.92±21.60 days and 436.52±2.76 days respectively. Genetic group-wise the average estimates for lactation milk yield of Desi, HF crossbreds and J crossbred cows were reported to be 792.86, 2111.80 and 2179.48 kg respectively, for lactation length 291.76, 332.75 and 334.87 days respectively, for peak yield 5.60, 12.96 and 12.78 kg respectively, for days to attain peak yield 36.41, 43.05, 43.00 days respectively, for milk yield per day of lactation length 2.72, 6.43 and 6.51 kg respectively, for milk yield per day calving interval 1.89, 4.73 and 4.90kg respectively, for Dry period 129.48, 114.05 and 111.23 days respectively and for calving interval 420.48, 446.22 and 446.10 days respectively.

B. ECONOMICS OF MILK PRODUCTION:

Singh, L. (1992) analyzed the structure and pattern of capital investment in various productive farms assets by marginal farmers in rural area and reported that the level of investment differed according to place, person, time, agro-climatic conditions and marketing facilities of the outputs. In dairy farming on an average per farm capital investment on milch animals, dairy equipments and sheds were recorded to be 59.6, 26.5 and 14.1 percent respectively.

Grover *et al.* (1992) worked out the cost of maintenance of milch cattle on different farm-size groups and found that in the case of cow and buffalo, the expenditure on green fodders, dry roughages and concentrate taken together as feed cost accounted for 73.00 and 68.42 percent of the total expenditure of the average annual net maintenance cost respectively. Average milk yield per cow did not show any definite relationship with the farm size.

Ram *et al.* (1993) made an economic analysis of milk production in rural households in sugarcane tract of western Uttar Pradesh and reported that feeds and fodders were the major component accounting for 64.4 percent of the total cost followed by labour (14.9%), fixed cost (13.58%) and miscellaneous recurring expenditures (7.32%). Dairying was reported to be a remunerative proposition for weaker section of population with a vast scope of development and a potential source of income and employment for the rural poor in the study area.

Rejendran and Prabaharan (1993) worked out the economies for milk production in buffaloes, crossbred and desi cows under different categories of farmers in Tamlinadu. The percent contribution of different fixed and variable cost items to the total cost of maintenance of crossbred cows reared by different categories of farmers has been summarised as follows:

Cost Items	LL	MF	SF	LF	Overall
Fixed Cost	14.16	16.59	13.87	13.72	14.59
Variable Costs					
Labour cost	33.64	28.73	31.83	34.23	32.11
Cost of Dry Fodder	3.95	4.43	4.13	3.78	4.07
Cost of Green Fodder	22.78	25.65	23.09	23.48	23.75
Cost of Concentrate	20.04	18.89	20.88	18.49	19.57
Total feeding cost	46.77	48.97	48.10	45.75	47.39
Medicine & Very . Charges	1.98	2.10	2.59	2.57	2.31
Miscellaneous Cost	3.45	3.61	3.16	3.73	3.60
Total variable cost	85.84	83.41	86.13	86.28	85.41
Input output ratio	1:121	1:140	1:1:34	1:1:23	1:1:29

LL = Landless farmers, MF = Marginal Farmers, SF = Small Farmers LF = Large Farmers. The contributions of fixed and variable costs ranged from 13.72% to 16.59 % and 83.41% to 86.78 % respectively.

Shah and Sharma (1994) reported the cost of production per litre of milk to be the lowest in Crossbred cows followed by Murrah buffaloes, Local cows and Local Buffalos. They observed that the fixed and variable costs per litre of milk had significant ($P \leq 0.01$) negative impact and price of milk had significant ($P \leq 0.01$) positive influence on profit per liters of milk in all the breeds / species of the milch animals. The magnitude of elastic ties from the exponential model revealed that one percent increase in price of milk resulted into 5.5 to 13.7 percent increase in profit, one percent decrease in variable cost resulted into 2.2 to 9.5 percent increase in profit and one percent decrease in fixed cost resulted into 2.4 to 3.4 percent increase in profit in different categories of animal. The analysis of contribution of various factors to the variation in profit revealed that fixed cost exerted maximum influence (53.55%) followed by the price of milk (35.49%) and variable cost (10.96%) in the case of crossbred cows covered by Dugdha Utpadak Sahakari Sangh (DUSS). Corresponding figures for the milch animals not covered by DUSSS varied from 17 to 47 percent.

Shah and Sharma (1994[b]) while evaluating the comparative economic performance of different breeds of milch animals in Bhuladshahar district of U.P (1989-90) found that depreciation on fixed assets and interest on fixed capital, contributed 6.77 and 10.89 percent respectively to the gross cost of maintenance for crossbred cows under DUSS. The corresponding values for NDUSS to be 8.20 and 11.27 percent. Among variable cost items the feeding cost accounted for 60.52 percent (green fodder – 22.14%,dry fodder – 14.80% and concentrate – 23.58%) followed by labour cost (19.94) and miscellaneous expenditure (1.88%) for the cows under DUSS. The corresponding values for the cows under NDUSS were 60.41, 17.99 and 2.13 percent respectively. The input-output ratio in this study for crossbred cows under DUSS and NDUSS were 1:1.36 and 1:1.29 respectively, i.e. the cows under DUSS were found to be more economical.

Sharma and Singh (1994[a]) worked out the cost and returns from different breeds / grades of milch animals maintained by different categories of farmers of Himachal Pradesh. They found that in the crossbred cows the operational cost comprising of feed cost (64.15%), human labour (19.03%) and miscellaneous expenditures (1.41%) was 84.59 percent of the total maintenance cost. The fixed cost, comprising depreciation on assets and interest on fixed capital accounted for 15.41 and 50.65 percent respectively in crossbred and Desi cows. Among the operational cost components, feed cost contributed 64.50 and 61.33 percent while human labour contributed 19.03 and 20.81 percent respectively in crossbred and desi cows. The contribution of miscellaneous cost varid from 1.41 to 2.21 percent. Variation in the different cost items due to variation in categories of farmers was non-significant. The findings also indicated that farming of crossbred was relatively more profitable as compared to that of local cows.

Ahir and Singh (1994) studied the cost of maintenance and return from the milch animals in South Gujrat. They reported that among the various cost items contributing to the gross cost of maintenance, the contribution of cost of feeds and fodder was the highest (54.75, 59.19 and 63.90 percent) and Veterinary and miscellaneous charges (2.20, 2.20 and 1.74 percent) to be the lowest respectively in crossbred and local cows as well as buffaloes. Interest on working capital and managerial cost were 7.79 and 7.54 percent in XB, 6.08 and 7.72 percent in local cows and 4.55 and 3.08 percent in buffaloes. The estimates of cost of production per litre of milk were Rs.4.92, 4.38 and 6.09 in crossbred cows, local cows and buffalo respectively. Results also revealed that crossbred cows were relatively most profitable as it gave a net profit of 17 percent over the investment.

Dev Raj and Gupta (1994) reported that the variation in gross cost of milk production of local cow in Churu district of Rajasthan due to fixed and variable cost items were 24.68 and 72.32 percent respectively. Among the variable cost, feeding cost was the highest (68.33%) followed by labour cost (29.50%), miscellaneous expenditures (2.09%) and Veterinary cost (0.085).

Jahangir *et al.* (1994) analysed the economics of milk production in Bangladesh and found that variable and fixed cost items contributed 61.31 and 38.69 percent respectively to the total cost of milk production of crossbred cows.

Kalra *et al.* (1994) analysed comparative economics of milk production in rural and urban areas of Hariana and reported that in urban area the fixed and variable costs in maintaining crossbred cows were 7.99 and 92.01 percent respectively. Among the variable cost items the cost of feed and fodder accounted for 67.70 percent followed by labour cost (15.50%), miscellaneous expenditures (4.65%) and cost of annual repairs (1.86%).

Kalra *et al.* (1995) made an attempt to analyse cost and returns from milk production. Results revealed that variable and fixed costs contributed 80.74 and 19.26 percent respectively to the total cost of milk production in crossbred cows. The variable cost items on feeds and fodders contributed 54.67 percent followed by labour (18.14%), miscellaneous (6.23%) and annual repair (1.70%). Average daily milk yield in crossbred cows was reckoned to be 6.42 litres. The gross cost of production of milk was estimated to be Rs. 3.53 per litre and after deducting the income from dung i.e. Rs. 0.20 per litre of milk, the net cost of milk production was reckoned to be Rs. 3.33 per litre.

Shiyani *et al.* (1995) studied the cost and return structure in dairy enterprises under different herd sizes in Junagarh district of Saurashtra. Results revealed that in the case of cows, the feed cost accounted for about two – third (65.46 - 67 .446%) of the total cost of milk production. It was followed by labour cost (20.37 - 22.12%), interest on fixed capital (4.28%) and depreciations (3.16%).

Sangu (1995) analysed the economies of milk production in different type of milch animals of Western Uttar Pradesh and concluded that in towns, the investment on Crossbred milch animals occupied a major share (84.50%) of the cost of fixed assets followed by buildings (13.76%) and equipments as well as machineries with there installation charges (1.74%). Among the different components of maintenance cost, the contribution of feed cost was the highest (65.81%) followed by labour charge (21.78%), interest on fixed capital (8.76%), veterinary charges (1.48%), depreciation on buildings, machinery etc. (1.105) and miscellaneous expenditure including water and electricity charged (1.075).

Baruah *et al.* (1996) studied the economics of milk production in Assam. Among the variable cost items, contribution of feed cost, labour cost, Veterinary charges and miscellaneous expenses to the gross cost of milk production were estimated to be 70.59, 14.98, 0.57 and 1.23 percent respectively.

Kumar and Balishter (1996) undertook an economic study of milk production in Crossbred cows in Firozabad district of U.P. and reported that the cost of milk production was Rs. 3.53 per lit. Findings also revealed that the variable and fixed costs formed about 78.0 and 22.0 percent respectively of the total cost in crossbred cows. It was farther reported that concentrate was an imported item, contributing 24.83 percent to the total maintenance cost. Among variable cost items, feeding, labour and miscellaneous expenses contributed 54.70, 21.26 and 2.09 percent respectively to the gross cost of milk production. Whereas, the fixed cost items contributed 8.96 percent to the gross cost of milk production. The total return per animal was found to be more in the units of 4-6 crossbred animals in comparison to the other unit sizes considered in the study. The cost of production per litre of milk was recorded to be Rs. 8.47, Rs. 8.23, Rs.8.28, Rs.8.38 and Rs.8.08 in the herds of less than 4, 4-6, 7-9,10-12 and more than 12 animals.

Badal and Dhaka (1998) in a study on economics of milk production in different categories of milch animals (Buffaloes, local cows, crossbred cows) in Gopalganj district of Bihar reported that feed, labour and Veterinary and miscellaneous expenditures contributed 54.5, 17.1 and 2.2 percents to the gross cost of production (Rs.5.84/lit milk). The fixed cost items i.e. depreciation on value of milch animals, cattle shed and dairy equipments contributed 26.2 percent to the gross cost of production. Cow dung, taken as the source of income, other than milk to the dairies, reduced the gross cost of production on an average by Rs. 0.17/lit of milk and thus, the net cost of milk production in the case of crossbred cows was calculated to be Rs.4.91 per litre.

Singh *et al.* (1998) reported significant influence of genetic constitution of the animal, size of the herd and lactation order on the cost of milk production. The location of the herd (zone) and season of calving did not influence the cost of milk production significantly. They concluded that under the farmers managemental conditions dairy units of 6-8 Friesian half-breds in 2nd – 4th lactations provided highest return from the milk production in the plateau region of Jharkhand.

Chandra and Agarwal (2000) worked out the cost and returns from milk production of crossbred cows in Farukhabad districts of U.P. The finding indicated that the feeds and fodder accounted for 69.8 percent of the gross cost of maintenance, followed by labour cost (21.5 percent) and miscellaneous expenditure (1.0 percent). Among the fixed cost items, depreciations on fixed assets were 2.8 percent and interest on fixed capital accounted for 4.9 percent. The value of dung reduced the gross cost of milk production by Rs.0.46/litre in crossbred cows.

Hemalatha *et al.* (2003) made an attempt to work out economics of milk production in different breeds of bovines in Ahmadnagar district of Maharastra and reported that the average profit per animal was maximum in Jersey crossbred cows as compared to HF crossbreds. Even buffaloes were found to be more profitable. Among the various components of cost of milk production, feed cost contributed maximum followed by labour cost, depreciation on animal, miscellaneous cost, Veterinary cost and supervision cost, the range of contribution in the cases of animals of different genetic groups being 60.84- 68.88, 16.85- 22.25, 8.25-13.50, 1.62-2.11, 0.72-2.00 and 1.07-1.86 percent respectively. Finally, the net cost of milk production was Rs.8.10per litre. Dairy farming was recommended to be a suitable venture to harvest constant income from sale of milk unlike in crop production.

Bardhan *et al.* (2004) carried out a study in Udham Singh Nagar district of Uttranchal to analyze the cost and returns involved in milk production from indigenous cattle in different seasons for different categories of farmers. The results showed that milk production in indigenous cattle in the study area was a highly unprofitable business. Net return over total cost on an average basis was found to be negative for winter, summer and rainy seasons. Among the overall estimates of different cost components, feed cost was the highest (57.32%) followed by labour charge (19.50), depreciations (8.42 %), interest on fixed capital (6.24 %), working capitals (3.12 %) and Veterinary charges (2.25 %). The major constraints contributing to unprofitable milk production were high cost of feeds and fodder and non-remunerative price of milk paid to the producers.

CONSTRAINTS

Bhoite and shinde (1987) studied the constraints perceived by the farmers in adoption of scientific Animal Husbandry technology and found that the major constraints in respect of animal breeding was non-availability of crossbred cattle in local market following the high breeding charges, inadequate knowledge of A.I., costly treatment of repeat breeders and unavailability of timely A.I. facilities. The main constraints in feeding of animals were the high cost of feed and fodders. Inadequate of scientific animal management (65.66%), shortage of capital (90.0%) and low price of milk (99.0%) were the serious constraints in successful dairy farming. In respect of animal health, availability of space for isolating sick animals (76.7%), inadequate knowledge to identify contagious and infectious diseases (71.0%) and non-availability of Veterinary aid at the door step (46.0%) were the major constraints.

Singh and Thomas (1992) reported that type and level of constraints in dairy farming differ from farmer to farmer and place to place. Non-availability of Veterinary aid in emergency at door step, the problem of longer distance of stockman centers and Veterinary hospitals, poor market value of male crossbred calves and lack of finance were the common constraints in rearing high producing cows.

Rejendran and Prabaharan (1993) reported that in Dharampuri district of Tamilnadu the important problems encountered in the management of crossbred cows in priority order were higher incidence of repeat breeding, high capital investment, high frequency of illness of animals costly feeds and high cost on treatment of animals.

Raju *et al.* (1993) reported that in rearing of crossbred cattle lack of knowledge of approved dairy practices, non-remunerative price for milk, non-availability of Veterinary services, green fodders, labour etc. were the major constraints perceived by dairy farmers.

Shyani and Singh (1995) conducted season-wise analysis of economies of milk production for members and non-members of Dairy Co-perative Societies in the Saurashtra region of Gujarat and reported that the milk yield of cow as well as buffalo was maximum during winter season.

Velmurugan (1998) concluded that in Pondicherry, the land and credit constraints acted powerfully and inexonerably on dairy households resulting in a problem in maintaining different land size-classes with number of milch stock.

Yedukondalu *et al.* (2000) carried out a study on diary development and the constraints perceived by dairy farmers in randomly selected two Mandals in Medak district of Andhra Pradesh. Majority of farmers reported that non-remunerative price for milk, lack of transport facilities for inputs and outputs, non-availability of good dairy animals, high cost of concentrates, non-availability of green fodders, high cost of crossebred animals, non-availability of Veterinary services, distant location of A. I. centers, non-availability of good breeding bulls, no knowledge of correct time of insemination, lack of credit facilities, high cost of Veterinary medicines and lack of proper housing for animals were the major problems in profitable dairy farming.

Sawarker *et al.* (2001) recorded that in Wardha district of Vidarbha, the major constraints in adoption of A. I for breeding dairy animals were non-availability of door-to-door service of A.I and difficulty to take animals in heat to A. I. center in time. Moreover, 20.55% respondents were of opinion that A. I. practice is against religion. Findings suggested that more Veterinary extension efforts are required for changing the attitude of large number of dairy owners, who are still following the age-old natural insemination practices.

Mishra and Pal (2003) made a comprehensive study on constraints in dairy farming in West Bengal and reported that among the various constraints perceived by the respondents, inadequacy of technical knowledge (40.3%), poor organizational support (28.6%) and lack of financial sources (20.1%) were the major constraints for the dairy sector. Among the technical constraints, repeat breeding problem (14.6%), low conception rate through A.I. (9.6%), calf mortality (7.0%) , lack of knowledge of heat detection (5.0%) and inadequate knowledge of animal management (4.1%) were the main. High cost of Veterinary services (13.8%), lack of credit facilities (4.1%) and non-availability of green fodder (2.2%) constituted the economic constraints. Among the organizational constraints, distant location of A.I. centre (11.0%), lack of extension workers for motivation (5.2%), paucity of trained stockmen (5.2%), non-availability of A.I. facility (5.2%) were the major constraints. Besides that some constraints (11.0%) were also perceived by the farmers which included low level of literacy (4.4%), lack of support from elders (4.4%) and social dogma (2.2%).

MATERIALS AND METHODS

3. MATERIALS AND METHODS

3.1 SOURCE OF DATA

Desi and its HF / Jersey Crossbreds maintained at Cattle Farm of Rajendra Agricultural University, Pusa (Samastipur) and as well as in the private dairy units under co-operative and non-cooperative sectors located in a radius of 10 kms in and around Pusa (Samastipur) were the experimental animals for the present study.

3.2 GEOGRAPHIC AND CLIMATOLOGICAL DESCRIPTION OF THE LOCATION

Pusa, the place of orchard with highly fertile soil in Samastipur district, is located in Northern part of Bihar on the bank of Gandak river at an altitude of about 60 meters from the mean sea level. The climate of this zone is primarily hot-humid with moderate to high rainfall. The climatological records during the experimental period is presented in table 3.1.

Table 3.1 : Climatological details of PUSA (Samastipur)

Month	Temp. in ^{0}C (Max – Min)	Humidity in % (Max – Min)	Rainfall in mm
May 04	35.3 – 24.4	77% - 48%	133
June 04	32.7 – 25.5	81% - 66%	185
July 04	38.0 – 25.8	90% - 79%	392.7
August 04	30.8 – 26.7	87% - 76%	99.2
September 04	33.0 – 26.9	88% - 64%	57
October 04	30.9 – 21.1	88% - 54%	Nil
November 04	30.9 – 13.8	89% - 43%	Nil
December 04	26.7 – 11.1	93% - 53%	Nil
January 05	24.8 – 9.7	92% - 52%	10.8
February 05	26.5 – 13.6	88% - 39%	14
March 05	33 – 18.3	82% - 40%	150.1
April 05	37.2 – 21.8	72% - 30%	Nil

Based on records of Department of climatology, RAU, Pusa(Samastipur)

3.3 COLLECTION OF DATA

The private dairy units, popularly known as KHATALS, were classified into unorganized co-operative and unorganized non-cooperative sectors where as RAU Cattle Farm, Pusa was categorized as organized sector dairy unit.

3.3.1 ORGANISED SECTOR

The data were recorded from the history sheet maintained in the RAU Cattle Farm, Pusa during the period of last ten years. The cows completing atleast three lactations were included in this study. Altogether 452 observations were recorded for each character. The following parameters were recorded :

(i) Production Traits :

(a) Lactation milk yield (kg) - LMY

(b) Lactation length (days) - LL

(c) Peak milk yield (kg) - PMY

(d) Days to attain peak milk yield - DAPMY

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

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

(g) Life time milk production (kg) - based on 3 lactations - $LTMP_3$

(ii) Reproduction Traits :

(a) Dry period (days) - DP

(b) Calving interval (days) - CI

3.3.2 UNORGANISED SECTOR

The data from the private dairy sectors were collected through survey method. In primary survey, the private dairy units consisting of three or more HF / Jersey crossbreds and Desi cows were enumerated through "door-to-door survey" method utilizing the procedure of Multistage Stratified Random Sampling with Proportional Allocation keeping herd size, sector as well as genetic grades as its strata.

In unorganized non-cooperative sector the small dairy units were called as Khatals where cows were managed for milk production with the objective of "profitable production". Irrespective of the sectors, in most of the Khatals, the animals were managed under sub-optimal conditions of housing and sanitation but were supplied with high quality concentrate mixture, even more than requirement of the animals, in order to challenge them to produce milk to their maximum. The animals were relatively well managed in co-operative sector in comparison to the non-cooperative as the Dairy Co-operative societies extended all kinds of help to the members units in respect to Veterinary aids and balanced feeds and fodder under no loss no profit basis.

Altogether 400 animals (262 from co-operative sector and 138 from non-cooperative sector) were identified from unorganized sector of the study area and accordingly 400 observations were recorded for each character for the present study.

3.4 GENERAL MANAGEMENT PRACTICES

3.4.1 RAU Cattle Farm, Pusa

Uniform management practices were provided to all the dairy animals in RAU Cattle Farm, Pusa. The animals were maintained under semi-intensive system under optimal housing and sanitary condition.

Individual feeding was practiced. The vaccination schedules, parasitic and disease control measures were followed as per schedule.

3.4.2 Private Dairy Units (Khatals)

The management in all the khatals were not quite uniform. In general, the dairy animals were stall fed. Individual feeding was in practice. Concentrates were fed on the basis of milk production and other physiological status of the animals. Except a few, home made concentrate mixtures were fed to the animals in almost all the units.

Chaffed paddy straw, wheat bhusha and hay constituted the common ingredients of dry fodders. Green Maize, Jowar, Barseem, Oat, Meth and Dub grasses were the main source of green fodder. Linseed and / or Mustard cake along with cereals like maize, mung & pulses and cereal by-products like wheat bran, dal chunnies (mung, arhar, khesari) were the main constituents of concentrate mixture.

3.5 Performance Record :

The performance records of each animal under the different genetic groups were taken for the study. The recording of milk yield was carried out from the beginning of lactation at the interval of every fortnight till the end of lactation. The recording of milk yield was carried out only in healthy cows, conforming to the breed and herd groups specified in the plan of work. The information recorded from the unorganized sectors were as follows:

3.5.1 Information on the unit :

(a) Herd size

(b) Herd Constitution

3.5.2 Information on the animals :

(i) General:

(a) Genetic group

(b) Date of calving

(c) Parity of lactation

(ii) 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/LL

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

(iii) Measures of Reproduction efficiency:

(a) Dry period (days) - DP

(b) Calving interval - CI

(iv) Measures of Economic efficiency:

(a) Cost of milk production

Schedules and questionnaires were developed and supplied to the Respondent units to record the relevant information in the light of the objectives of this study. The Respondent units were approached at regular intervals to collect and monitor the data recording. The information gathered through personal interviews were also incorporated.

The average daily milk yield was obtained by averaging the bi-weekly records during the lactation. The lactation yield was obtained by multiplying the average daily yield with number of days the animal remained in milk. The economic traits like lactation length, peak-yield, days to attain peak-yield, dry period (this period taken from the date of dry to subsequent calving) and calving interval were recorded in the schedules supplied to the units.

The "Net cost of maintenance of an animal for each kg. of milk she produced per day of an inter-calving period" was taken as the measure of cost of milk production for that animal. Statistically, it was the "ratio of average daily maintenance cost of an animal during an inter calving period and cost of average daily milk she produced during that inter-calving period", i.e.

$$\text{Cost per kg of milk produced by an animal} = \frac{\text{Average maintenance cost (Rs.) of an animal during inter calving period (days)}}{\text{Value of average daily milk yield (Rs.) produced by that animal during the inter calving period (days)}}$$

The different components of expenditure on maintenance of milch animals were broadly categorized into:

I. Fixed cost items.

II. Variable cost items.

III. Miscellaneous cost items.

I. Fixed cost items :

(i) Depreciation on animal :

It was worked out by straight-line method based on the market value of the milch animals during the period of study. A general prediction formula to estimate approximate market value of a lactating cow in and around Pusa, could be derived on the basis of the purchase cost of milch animals based on their milk yield and lactation order at the time of purchase. It has been presented as follows:

Lactation No.	Rate of calculating price (Rs.) for each cow
1^{st}	Milk yield (kg) x 1500=00
2^{nd}	Milk yield (kg) x 1400=00
3^{rd}	Milk yield (kg) x 1100=00
4^{th}	Milk yield (kg) x 900=00
5^{th}	Milk yield (kg) x 600=00

Animals beyond fifth lactation were excluded from this study. A sum of Rs. 500 and Rs. 800 was added respectively to the cost of a cow having crossbred female calf of Jersey or Friesian origin. The productive life of a milking cow was taken as of five lactations and depreciation was calculated @ 12 percent of the estimated cost per calving interval under the assumption that 40 percent of the animal's cost would be refundable even after completion of its fifth lactation as "salvage value". Per day depreciation value for a cow was calculated as the "Ratio of 12 percent of the estimated cost of the animal and number of days in the inter-calving period".

(ii) Depreciation of cow sheds :

As mentioned earlier, the animals in khatals were managed under sub-optimal housing and sanitation. Animals were provided with variable types of houses in different dairy units. For calculation of the cost of housing and depreciation of dairy sheds provided to milch animals in different khatals, the houses were grouped into four types: -

Type A - Full kachcha house

Type B - Half puccka house (only walls pucka with plaster)

Type C - Three-fourth puccka house (walls, floor and feeding troughs puccka)

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

On the basis of enquiries made to khatal owner and information collected, classified and analysed, the following approximate rates could be derived to estimate the cost of different types of houses built up and utilized to run khatals in and around Pusa.

The basic assumptions for fixing the cost of animal shed was to provide 40 sft. covered area to each milch animal and the construction cost of troughs etc. varied according to the type of its construction.

Categorization of different types of housings with its estimated cost :

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)	40.00	200.00	2500.00
Type (B)	60.00	300.00	3500.00
Type (C)	110.00	500.00	5000.00
Type (D)	130.00	550.00	8000.00

The total life of (A) to (D) type houses were accounted to be 5 and 20 years respectively. Depreciation on housing was calculated as the ratio of "cost of housing per animal and the estimated life of that house in days x av. daily milk produced by an animal for that calving interval".

$$\textbf{Depreciation on housing} = \frac{\text{Housing cost for an animal}}{\text{Estimated life of that house (in days) x Av. daily milk produced by that animal during the calving interval}}$$

(iii) Depreciation on Farm Utensils, Machinery, Equipments and other assets except Animals and Housing :

To estimate this depreciation value, the total cost of utensils, equipments, machinery and other assets of daily use, like chaff cutter, electric motor, canes, buckets, chains, milk pots, cycles etc. with each and every selected Respondent units was estimated. The depreciation was calculated @10 percent of the total cost per annum. The depreciation per kg of milk produced at the khatal was reckoned as the ratio of "10 percent of the total cost of utensils, equipments, machinery etc. at a khatal and 365 x Average milk yield (kg) / day of calving interval for that khatal. This was done under the assumption that utensils, equipments, machineries etc. at a khatal were equally used for every animal at that khatal irrespective of its level of milk production. As such this cost item has been taken as fixed for every animal in Respondent units.

(iv) Interest on fixed capital :

In this study, fixed capital comprised of all the assets of a Respondent unit including cost of animals, housing, utensils, equipments and machineries etc. and the interest on the fixed capital was worked out @11 percent per annum, the amount rate fixed by government financial institutions for such type of loans for short duration.

II. Variable cost items :

(i) Cost of feeds and fodders:

Average quantity of fodder fed per animal was obtained by dividing the total quantity of fodder supplied by the number of animals fed. The prevailing market rates, including transportation cost, were taken as the purchase price for various green and dry fodders as well as concentrates.

For house-grown feeds and fodders the prevailing market rates were considered. The seasonal variation in the market rates of different feeds and fodders were also taken into account for averaging the prices. Accordingly the average daily expenditure on feeds and fodders was worked out for each animal under the investigation.

(ii) Labour Cost :

The aggregate of paid (hired) and unpaid (family) labour was taken as the total labour cost of milk production. For working out labour cost, the actual time spent on different operations concerned to milch animals was recorded for each unit and apportioned suitably for each animal. For family labour, the actual time spent daily for looking after the animals and other farm operations by each of the family members, including women, were recorded and apportioned for each animal. The cost of family labour was also calculated at the rate of the wage paid to the hired labour i.e. @ Rs. 70.00 per day (8 hrs.).

(iii) Cost of A.I. and Veterinary Aids :

This cost item comprised of costs of medicines, vaccines, semen and other sanitary items along with the remuneration paid to veterinarians, inseminators and other technical persons, whose services were utilized for taking prophylactic and / or curative measures to keep the animal under sound physical and sexual physique. It is worth mentioning here that majority of respondent units could not provide individual records of expenditure on this cost item. As such on the line of proposition of Tripathi *et. al.* (1978), Veterinary and A.I. costs were taken as fixed @ Rs. 600/- per animal per calving interval.

III. Miscellaneous cost items :

Revenue of the land, electric and water tariff, cost of repair of buildings / utensils / machineries etc. as well as unforeseen minor contingent expenditures comprised the miscellaneous cost item. In this study it was kept fixed @ Rs. 500.00 / animal / calving interval. Finally, the cost on account of this component of expenditure was apportioned for each kg. of milk produced by an animal :-

$$\text{Miscellaneous cost / kg. milk} = \frac{\text{Rs. 500}}{\text{Inter calving period (days) of an animal} \times \text{Average milk yield per day of calving interval of that animal.}}$$

IV. Gross cost of maintenance :

The gross cost of maintenance of an animal was reckoned by adding the expenditures on all cost components, viz. depreciation on animal, buildings / sheds, farm utensils, machineries, equipments and other assets; interest on fixed capital; cost of feeds and fodders; labour cost; cost of A.I. and Veterinary aids as well as miscellaneous expenditures.

V. Income :

Other than milk, dung as well as empty bags were the only source of income to the khatals. It was observed in general practice that the empty bags of jute were used to cover the animals as well as windows, doors etc. in winter to protect them from cold. The plastic bags were generally utilized for making ropes to tie the animals. However, it was in general practice to sale the animal dung or FYM time to time at reasonable price. It is pertinent to mention here that it could not be possible to have précised record of income from individual animal on account of the dung or FYM produced at the khatals. However, under the assumption that an adult cow excretes on an average 20 kg. of wet dung daily (Reddy et al. 1972) and the current market rate of wet dung in and around Pusa being an average Rs. 15.00 per quintal it was kept as a fixed income @ Rs. 0.75 per animal per day.

VI. Net cost of maintenance :

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

3.6 Classification of Data :

To study the effects of the different genetic and non-genetic factors on the economic traits under study, the data collected from the private dairy units were classified on the basis of size (herd-size) of the unit; genetic group of the animal, season of calving and lactation order of the animals. Whereas, the data recorded from the organized herd were classified on the basis of genetic group, season of calving and lactation order only. The various factors were sub-classified as followed:

3.6.1 Genetic Group of the Animals :

The milch animals included in this investigation pertained to the following three Genetic- groups.

(i) Desi Cows.

(ii) Jersey Crossbred Cows. - J x $_B$

(iii) Friesian Crossbred Cows. - HF x $_B$

3.6.2 Herd-Size :

The herd size was considered only for private dairy units where the dairy units were grouped into the following three categories on the basis of number of milch animals (Desi and crossbred cows) they possessed :

(i) Units having 3-5 milch animals,

(ii) Units having 6-8 milch animals,

(iii) Units having 9 and above milch animals.

HF and Jersey crossbred cows were identified on the basis of phenotypic appearance of the animals, irrespective of the level of exotic inheritance they possessed.

3.6.3 Season of Calving :

The year was further classified into following four seasons on the basis of change in climate:

(i) Hot and humid / Rainy

(ii) Cold- comfort / Winter

(iii) Spring

(iv) Summer.

3.6.4 Lactation order :

Data on Performance were recorded up to 4th lactation in private dairy units and 5th lactation in organized herd. Accordingly, the performance of the animals from 1st to 5th lactations were in the sequence of 1, 2, 3, 4 and 5.

3.7 Statistical method :

3.7.1 Stratified random sampling with proportional allocation :

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

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

Let sample of sizes n_1, n_2, n_3, ... n_k be drawn from these strata respectively so that,

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

Let $n_i \propto N_i$

or $n_i = CN_i$ -------------------- (i)

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 = CN

Hence, n / N = C (constant)

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

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

let y_{ij} be the value of j^{th} unit in the i^{th} strata of population (i = 1, 2, 3, ……………….., K and j = 1, 2, 3 …………………… N_i and y_{ij} be the corresponding sample observation (i = 1, 2, 3, ……………. K and j = 1, 2, 3, ………………… n_i), then population mean Y given by:

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

$$= 1 / N \sum_{i=1}^{K} N_i\, Y_{ij}$$

Where,

$$Y_i = 1/ N_i \sum_{j=1}^{N_i} Y_{ij}$$, which is the mean of the i^{th} strata of the population.

The population variance

$$V(Y) = \sum_{i=1}^{N_i} \frac{(N_i)^2}{N} (1/n_i - 1/N_i)Si^2$$

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

Where, $w_i = n_i/N$ and $S_i^2 = 1/ (N_i - 1) \sum_{j=1}^{N_i} (y_{ij} - Y_i)^2$

Similarly, the sample mean can be defined as:

$$Y = 1/ n_i \sum_{j=1}^{n_i} y_i$$

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

$$V(Y) = \sum_{i=1}^{N_i} wi^2 (1/n_i - 1/N_i)\, Si^2$$

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

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

3.7.2 Least squares analysis :

To quantify the variation in different efficiency traits due to genetic and various non-genetic factors, the data recorded on animals in the organized and unorganized sectors were subjected separately to Least Squares analysis of variance (Harvey, 1966). Accordingly, the different linear mathematical models were used for different sector.

The following mathematical model was utilized for analysis of the data of organized sector:

$$Y_{ijkl} = \mu + G_i + SC_j + P_k + e_{ijkl}$$

Where,

Y_{ijkl}	=	The value of the l^{th} individual under i^{th} genetic group, j^{th} season of calving and k^{th} parity.
μ	=	The population mean
G_i	=	The effect of i^{th} genetic group (i = 1, 2, 3)
SC_j	=	The effect of j^{th} season of calving (j = 1, 2, 3, 4)
P_k	=	The effect of k^{th} parity (k = 1, 2, 3, 4, 5)

e_{ijkl}	=	The random error associated with individual which is randomly and independently distributed with mean zero and variance σ^2.

The following mathematical model was utilized for analysis of the data of unorganized sectors (For both cooperative and non-cooperative sectors)

$$Y_{ijklm} = \mu + G_i + HS_j + SC_k + P_l + e_{ijklm}$$

Where,

Y_{ijklm}	=	The value of m^{th} individual under i^{th} genetic group, j^{th} herd size, k^{th} season of calving and l^{th} parity.
μ	=	Population mean
G_i	=	i^{th} genetic group (I=1, 2, 3)
HS_j	=	j^{th} herd size (j=1, 2, 3)
SC_k	=	k^{th} season of calving (k=1, 2)
P_l	=	l^{th} parity (l=1, 2, 3, 4)
e_{jklm}	=	The random error associated with individual which is randomly and independently distributed with mean zero and variance σ^2.

3.7.3 Duncan's multiple range test (DMRT) :

The Duncan's Multiple Range (DMR) Test (Kramer, 1957) was utilized for pair wise comparison of the Least Square Means at 5 and 1 percent level of probability.

3.8 Constraints in dairy farming :

To conduct studies on the constraints in the adoption and management of milch animals, the respondents were requested to give the important technological and managemental problems, as they perceived. Garett's ranking technique was used to rank the problems. The orders of merit, thus given by the respondents, were converted into ranks by using the following formula (Garett & Woodworth, 1969):

$$\text{Percent position} = \frac{100\,(R_{ij} - 05)}{N_j}$$

Where,

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

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

The percent position of each rank, thus obtained, was converted into scores by referring Garett's ranking table. Then for each factor the scores of individual respondents were added. The mean scores for all the factors were arranged in descending order and ranked.

RESULTS AND

DISCUSSION

4. RESULTS AND DISCUSSION

4.1 LACTATION MILK YIELD

Total amount of milk given by a cow during a normal lactation period was considered as lactation milk yield (LMY). The overall estimates of least squares mean for lactation milk yield pooled over the three genetic groups viz. Desi, and its crosses with Jersey and Friesian cows, were estimated to be 1933.65±27.45, 1926.56±31.24 and 1503±52.16 kg respectively in unorganized co-operative and non-cooperative as well as in organized sectors (Table-4.2). The overall least squares mean for lactation milk yield of crossbred cows in private dairy units in and around Ranchi (Jharkhand) was reported to the 2748.20 ± 18.93 kg by Singh et el.(2000) which was much higher than the average lactation yield obtained in the present study. However, kumar (2004) reported the average lactation yield of dairy animals comprising of local and crossbred cows as well as buffaloes in a private dairy units in and around Darbhanga (Bihar) to be 1575.5 ± 11.79kg which was fairly lower than the average lactation yield obtained in the present study. The plateau of Chotanagpur might be more congenial in terms of environment as a whole for crossbred farming, whereas the hot-humid climate of Darbhanga might be stressful and a probable reason for relatively lower lactation yield in crossbred cows as compared to those in and around Pusa.

4.1.1 FACTORS AFFECTING LACTATION MILK YIELD

The least squares analysis of variance (Table-4.1) revealed that genetic constitution of the animals and order of lactation had significant influence on lactation milk yield in the different sectors of management, whereas

Table-4.1 : Least squares analysis of variance for the effect of genetic and non-genetic factors on Lactation Yield in co-operative, non-cooperative and organized sectors in and around Pusa.

Source of Variation	Unorganised Cooperative Sector				Unorganised Non-Cooperative Sector				Organised Sector			
	DF	MSS	F	R^2 (%)	DF	MSS	F	R^2 (%)	DF	MSS	F	R^2 (%)
Genetic Group	2	19570980.0	134.9332**	94.36	2	12231520.0	208.7159**	92.15	2	3686334000.0	53.5952**	83.66
Herd size	2	589797.0	4.0664*	2.84	2	37200.830	0.6348	0.28				
Season of calving	1	5384.9960	0.0371	0.02	1	113422.90	1.9354	0.85	3	480326500.0	6.9834**	10.90
Parity	3	429854.30	2.9637*	2.07	3	832861.50	14.2118**	6.27	4	170760100.0	2.4827*	3.88
Error	253	145042.0		0.69	129	58603.660		0.44	442	68781030.0		1.56

*** = P<0.05, ** = P<0.01**

Table –4.2 : Least squares mean ± S.E. of Lactation milk yield of cows managed in different sectors in and around Pusa.

Particulars	Unorganised Co-operative Sector	Unorganised Non-cooperative Sector	Organised Sector
Population Mean	1933.65±27.45	1926.56±31.24	1503.68±52.16
Genetic Group			
Desi	1260.62^{a}±43.28	1240.95^{a}±54.35	963.07^{a}±128.86
Friesian x B	2361.62^{b}±58.02	2213.20^{b}±44.19	1430.06^{b}±63.92
Jersey x B	2178.46^{c}±40.74	2325.54^{b}±46.28	2117.91^{c}±45.90
Herd size			
3-5	1929.09^{ab}±48.10	1939.64±29.35	-
6-8	2017.20^{a}±44.52	1970.97±46.27	-
9-above	1854.64^{b}±38.68	1869.08±81.73	-
Season of calving			
Rainy/Hot & Humid	1939.06±40.12	1896.81±37.93	1172.76^{a}±93.42
Winter/Cold & Comf	1939.06±38.41	1956.32±37.78	1612.81^{b}±81.31
Spring	-	-	1647.44^{b}±78.66
Summer	-	-	1581.71^{b}±92.87
Parity			
1^{st}	1835.53^{a}±44.66	1704.22^{a}±44.16	1673.54^{a}±87.94
2^{nd}	1900.50^{a}±42.90	1893.6^{b}±43.94	1589.47^{ab}±87.94
3^{rd}	2029.50^{b}±9.90	2006.65^{c}±51.00	1542.58^{ab}±87.09
4^{th}	1969.05^{ab}±70.73	2101.77^{d}±60.92	1321.78^{b}±87.94
5^{th}	-	-	1391.04^{b}±110.73

Values with different superscripts (column wise) differed significantly from each other.

variation in herd size and season of calving had significant effect on LMY only in unorganized co-operative sector.

4.1.1.1 Genetic Group

The least squares analysis of variance indicated highly significant (P<0.01) effect of genetic group on lactation milk yield of cows maintained in co-operative, non-cooperative and organized sectors in and around Pusa (Table-4.1). The contributions of genetic group to the total variation in LMY were estimated to be 94.36, 92.15 and 83.66% in co-operative, non-cooperative and organized sectors respectively. It indicated that for more lactation milk yield the cows should have good genetic merit. The present findings were in consonance with the reports of Kumar (2006) in HF crossbred and J crossbred, and Priya Raj (2000) in HF and J crossbred cows. Kumar (2005) reported more than double LMY in HF and Jersey cross-bred cows than in Desi. Hytnagarkar et al. (1990), Jadhav et al. (1991), Singh et al. (1993), Thakur et al. (1999), Bhattacharya et al. (2002), Akhtar et al. (2003), Bhadauria and Katpatal (2003), Kumar[1] (2004), Kumar[2] (2004), Kumar (2005) and Sharan (2005) also reported highly significant (P<0.01) effect of genetic group on LMY.

The overall least squares mean of lactation yield of Desi, Friesian and Jersey cross-bred cows of unorganized co-operative and non-cooperative as well as organized sectors in and around Pusa were found to be 1933.65±27.45, 1926.56±36.24 and 1503.68±52.16 kg respectively (Table-4.2). The Duncan's Multiple Range Test revealed that in unorganised co-operative sector HF crossbred had the highest average LMY (2361.62±58.02 kg) followed by Jersey crossbred (2178.46±40.74 kg) and Desi cows (1260.62±43.28 kg), the differences being statistically highly significant. In unorganized non-cooperative sector Jersey and HF crossbred cows did not differ significantly in respect to LMY, while the average yield of Desi cows was significantly the lowest (Table-4.2). The situation in organized sector was quite different. Jersey crossbred had the highest LMY (2117.91±45.9 kg) followed by HF crossbred (1430.06±63.92 lit.) and Desi cows (963.07±128.86 kg). The findings were indicative of the facts that in present management system prevalent in and around Pusa (Samastipur) Jersey crossbred cows can sustain for higher LMY as compared to HF crossbred and Desi cows. Hyatnagarkar *et al.* (1990), Jadhav *et al.* (1991), Singh *et al.* (1993), Thakur *et al.* (1999), Bhattacharya *et al.* (2002), Priya Raj (2002), Akhtar *et al.* (2003), Bhadauria and Katpat *et al.* (2003), Kumar[1] (2004), Kumar[2] (2004), Kumar (2005) and Sharan (2005) have also reported significant ($P<0.01$) effect of genetic group on LMY.

4.1.1.2 Herd Size

The least squares analysis of variance indicated significant ($P<0.05$) effect of herd size on the LMY only in unorganized co-operative sector, its contribution to the total variation being 2.84% of (Table-4.1). The least squares means (Table-4.2) revealed that the highest milk yield was produced by the animals in the herd of 6-8 animals followed by those in the herds of 3-5 and 9 & above. However, the cows in herd of size 3-5 animals did not differ significantly from those in herds of 6-8 and 9 & above milch animals. The cows in herds of 9 and above milch animals had significantly ($P<0.05$) lower milk yield than those in the group of 6-8 animals.

Although herd size had no significant effect on LMY in unorganized non co-operative sector but the highest milk production was recorded in the cows in group of 6-8 animals followed by those in the groups of 3-5 animals and 9 and above. Kumar[1] (2004) and Kumar (2005) observed significant (P<0.05) effects of herd size on LMY which were in agreement with the findings of the present investigation. The findings of the present study was suggestive to the fact that the management system prevailing in the khatals/dairy units in and around Pusa was found to be optimum to sustain 6-8 milch animals in the herd for maximum milk production in a lactation. Better care and management of cows in group of 6-8 animals might be the probable reason of such findings. It may plausibly be explained that in larger herds all the individuals are not cared properly. Moreover, a herd of 3-5 cows might not be generating so much income to make the house-hold self sufficient and resultantly, the farmers might had been compelled to divert their attention including resources to some other venture and the dairy animals were not properly cared and as such producing relatively lower average LMY, as recorded in this study.

4.1.1.3 Season of Calving

The effect of season of calving on LMY in both co-operative and non co-operative sectors was statistically not significant, but the season effect contributed significantly ($P \leq 0.01$) to the total variation in LMY of the cows in organised sector, the magnitude of contribution being 10.90% (Table-4.1). DMRT revealed that in general the cows calved in winter and spring seasons had relatively higher LMY in the different management systems included in this study. The relatively lower quantity of milk produced in hot-humid and rainy seasons might be attributed to the fact that Pusa falls in the very hot humid and high rainfall zone of Bihar which appeared to give negative impact on high metabolic rate of high milk producing animals. Shettar and Govindaiah (1999), Akhtar et al. (2003), Kumar[1] (2004), Kumar (2005), and Sharan (2005) also reported significant effect of season of calving on LMY. However, Jadhav et al. (1991), Yadav and Rathi (1992), Singh et al. (1993), Raheja (1997), Singh et al. (2000), Priya Raj (2002), Shiv Prasad (2002), Bhadauria and Katpatal (2003) and Kumar[2] (2004) did not find the effect of season of calving on LMY to be significant.

4.1.1.4 Parity of Calving

Order of lactation had significant ($P<0.05$) influence on LMY in both organized and unorganized cooperative sectors but the effect was highly significant ($P<0.01$) in unorganised non co-operative sector (Table-4.1). However, the contribution of parity to the total variation in LMY was almost negligible in both organized and unorganized sectors.

Table-4.2 revealed that LMY increased gradually with the increase in order of lactation in both co-operative and non-cooperative dairy units of unorganized sector but no such trend is observed in organized sector (Table-4.2). In unorganized co-operative sector the highest LMY was found to be in third lactation which was significantly ($P<0.05$) more than that of first and second parities. In unorganized non-cooperative sector highest LMY was estimated in fourth lactation which was significantly more than the first, second and third lactations by 397.55, 208.17 and 95.12 kg respectively. The results of this study were in accordance to the findings of Singh et al. (1968[b]), Priya Raj (2002), Shiv Prasad (2002), Kulkarni et al. (2003) and Kumar (2005) who reported significant effect of parity of calving on the LMY. However, Kumar[2] (2004) observed that the parity of lactation did not play any significant role on 300 days or less milk yield in

Hariana and its crosses with Holstein-Friesian and Jersey. Sharan (2005) also observed non-significant effect of parity of lactation on LMY in Hariana and its crosses with Holstein Friesian. Such variation in results may be attributed to variable management in different groups of animals taken as experimental animals in different studies.

4.2 LACTATION LENGTH

Lactation length is one of the important factors influencing the economics of dairy enterprises. From economic as well as cow's health point of view either too long or too short lactation length is not desirable. The ideal lactation length of cattle is considered to be 305 days. The overall least squares means for lactation length pooled over the three different genetic groups viz. Desi, Jersey and Friesian cross-breds included in this study, were estimated to be 298.61±1.34, 304.41±2.16 and 374.25±8.20 days in unorganized co-operative, unorganized non-cooperative and organized sectors respectively. The overall least squares means, irrespective of genetic group, for lactation length of cows reported by Singh *et al.* (1986[b]) in and around Ranchi (Jharkhand) and Kumar (2004) in and around Darbhanga (North Bihar) were in close agreement with the findings of the present study.

4.2.1 FACTORS AFFECTING LACTATION LENGTH

4.2.1.1 Genetic Group

The least squares analysis of variance indicated highly significant (P<0.01) effect of genetic group on the lactation length in unorganized co-operative and non co-operative sectors as well as in co-operative sectors (Table-4.3). However, the contributions of genetic factor to the total variation in lactation length were estimated to be 85.69, 59.39 and 63.35% in unorganized co-operative, non-cooperative and organized sectors

Table-4.3 : Least squares analysis of variance for the effect of genetic and non-genetic factors on lactation length in cooperative, non-cooperative and organised sectors in and around Pusa.

Source of Variation	Unorganised Cooperative Sector				Unorganised Non-Cooperative Sector				Organised Sector			
	DF	MSS	F	R^2(%)	DF	MSS	F	R^2(%)	DF	MSS	F	R^2(%)
Genetic Group	2	18249.2500	52.5371**	85.69	2	9216.7380	32.6288**	59.39	2	470019.6000	27.5986**	63.32
Herd size	2	681.7533	1.9627	3.20	2	2145.1090	7.5940**	13.82				
Season of calving	1	968.0715	2.7869	4.55	1	3331.6340	11.7945**	21.47	3	141610.2000	8.3151**	19.08
Parity	3	1048.7990	3.0193*	4.93	3	542.2108	1.9195	3.49	4	113606.1000	6.6707**	15.31
Error	253	347.3597		1.63	129	282.4729		1.82	442	17030.5500		2.29

* = P<0.05, ** = P<0.01

respectively. Significant effect of genetic group on LL (days) have also been reported by Jadhav et al. (1991), Priya Raj (2002), Kumar[2] (2004) and Sharan (2005) in different genetic groups of cows. However, contrary to the findings of the present study, Raj Kumar (1985) in Jersey and Friesian crosses, Singh et al. (1993) in Sahiwal and its crosses with Jersey and Red Dane, Shettar and Govindaiah (1999) in different levels of HF, Jersey and Red Dane inheritance with indigenous cows and Kumar (2005) in Desi, HF cross and Jersey cross reported that the genetic group did not influence lactation length significantly. Such variations may be attributed to variable genetic constitution of the experimental animals and environment including managerial practices to which the animals were subjected to in different experiments.

The least squares means with SE of lactation length of Desi, HF cross and Jersey cross managed under different sectors have been presented in table 4.4. Table-4.4 reflected that Jersey crossbred cows had the longest lactation length in all the three sectors and it differed significantly ($P<0.05$) from Desi and Friesian crosses. In unorganized co-operative sector the overall lactation length of Jersey crossbreds was estimated to be 313.01 ± 1.99 days which was significantly ($P<0.05$) longer by 31.66 and 11.55 days than the Desi and Friesian crosses respectively. Friesian crosses had also significantly ($P<0.05$) longer lactation length than the Desi. In unorganized non-cooperative sector the average lactation length of Jersey crossbred cows was estimated to be 319.35 ± 3.21 days which was significantly longer by 27.69 and 23.14 days than the Desi and HF crosses respectively. However, HF cross did not differ significantly from Desi cows in this regard.

Table – 4.4 : Least squares mean ± S.E. of Lactation Length of cows managed in different sectors in and around Pusa.

Particulars	Unorganised Co-operative Sector	Unorganised Non-cooperative Sector	Organised Sector
Population Mean	298.61±1.34	302.41±2.16	374.25±8.20
Genetic Group			
Desi	281.35^{a}±2.11	291.66^{a}±3.77	314.41^{a}±120.27
Friesian x B	301.46^{b}±2.83	296.21^{a}±3.06	364.91^{b}±10.05
Jersey x B	313.01^{c}±1.99	319.35^{b}±3.21	443.42^{c}±8.79
Herd size			
3-5	301.05±2.35	292.58^{a}±2.03	-
6-8	295.25±2.17	305.79^{b}±3.21	-
9-above	299.53±1.89	308.86^{b}±5.67	-
Season of calving			
Hot & Humid/Rainy	300.90±1.96	307.51^{a}±2.63	335.87^{a}±14.70
Cold & Comfort / Winter	297.31±1.88	297.31^{b}±2.62	366.52^{a}±12.79
Spring	-	-	420.51^{b}±12.37
Summer	-	-	374.09^{a}±14.61
Parity			
1^{st}	294.26^{a}±2.18	297.82±3.06	428.51^{a}±13.83
2^{nd}	295.60^{a}±2.09	299.33±3.05	354.27^{bc}±13.72
3^{rd}	303.12^{b}±2.44	306.28±3.54	363.52^{bc}±13.70
4^{th}	301.46^{ab}±3046	306.21±4.22	388.12^{ab}±16.37
5^{th}	-	-	366.8^{c}±17.42

Values with different superscripts (column wise) differed significantly from each other.

Similarly, in organized sector, Jersey cross had the longest lactation length which was significantly (P<0.01) higher by 129.01 and 78.51 days than the Desi and Friesian cross-bred cows. Friesian cross-bred cows also had significantly (P<0.01) longer lactation length than the Desi cows. The longer lactation of Jersey crossbred cows in all the sectors indicated that Jersey crossbred cows are more suitable and adaptable in the agro-climatic conditions in and around Pusa.

The ranges of lactation length as mentioned in the literature varied from 268.28 days (Yadava and Rathi, 1992) to 385.3 days (Parmar et al. 1986) for indigenous cows, 247.87 days (Bhattacharya et al. 2002) to 432.7 days (Parmar et al. 1986) for HF crosses and 306.08 days (Singh et al. 1993) to 462.69 days (Kumar[2], 2004) for Jersey crossbred cows. The findings of the present study in all the three genetic groups of cows fall within the reported ranges. Besides, the average estimates of LL (days) obtained in the present investigation were in closed proximity to the findings of Kumar (2005) for Desi, Kumar[1] (2004) and Kumar[2] (2004) for HF cross and Thakur et al. (1999) and Kumar[1] (2004) for JX cows. Significant effect of genetic group on LL (days) have also been reported by Jadhav et al. (1991), Thakur et al. (1999), Priya Raj (2002), Kumar[2] (2004) and Sharan (2005) in different genetic groups of cows. However, Kumar (2005) obtained longest lactation length (days) in Desi cows followed by HFX and JX under farmers management system which is contrary to the findings of the present study. On the other hand Priya Raj (2002) observed longer LL (days) in JX than HFX which is in close agreement with the findings in the present study.

4.2.1.2 Herd Size

The least squares analysis of variance for the effect of herd size on lactation length was found to be non-significant in co-operative sector and highly significant (P<0.01) in non-cooperative sector (Table-4.3). The contribution of herd size to the total variation in lactation length was estimated to be 3.20% in co-operative sector and 13.82% in non-cooperative sector.

Least squares means of LL (days) in co-operative and non co-operative sectors have been presented in table 4. In co-operative sector, the herd consisting of 3-5 animals had the longest lactation length which did not differ significantly from the herd of 6-8 and 9 & above animals. Kumar (2005) and Kumar (2006) observed longer lactation length in the herd of 7 & above animals than the herd of 3-6 animals which is contrary to the finding of the present study. However, non-significant effect of herd size on lactation length observed by them was in agreement to the observations made in the present investigation.

In non-cooperative sector, the longest LL (days) was observed in the herd of 9 and above animals which was significantly (P<0.05) longer than the herd of 3-5 animals but did not differ significantly from the herd consisting of 6-8 animals. Contrary to this Priya Raj (2002), Kumar(2004), Kumar (2005) and kumar (2006) reported non-significant effect of herd size on lactation length.

4.2.1.3 Season of Calving

The least squares analysis of variance revealed highly significant (P<0.01) effect of season of calving on the lactation length in the cows of organized sector and non co-operative units of unorganized sector

(Table-4.3). The contribution of season of calving to the total variation in lactation length was next to genetic effect and the magnitudes of variation were recorded to be 4.55, 21.47 and 19.08% in co-operative, non-cooperative and organized sectors respectively. The DMRT also indicated significant (P<0.01) difference of lactation length (days) in non co-operative and organized sectors (Table-4.4). The cows calved in spring season had the longest lactation length (420.51 days) followed by summer calver and shortest in hot-humid rainy calvers. However, Kumar (2006) reported longest lactation length (days) in cows calved during rainy season. Priya Raj (2002) also reported longer LL (days) in rainy season calvers than those calved in summer. Contrary to this, Jadhav et al. (1991) observed longer LL (days) in summer and winter calvers. Kumar (2005) also reported that the summer calvers had longer lactation length than winter calvers in Desi, HF cross-bred and Jersey cross-bred cows. However, Yadav et al. (1992) in Sahiwal, Yadava and Rathi (1992) in Hariana, Singh et al. (1993) in Sahiwal and its crosses with Red Dane, Thakur et al (1991) in Jersey X, Kumar[1&2] (2004) and Sharan (2005) in Hariana and its crosses with HF and Jersey reported non-significant effect of season of calving on LL (days). Variation in availability of quality grasses to the experimental animals may be the causes for variable results in different studies.

4.2.1.4 Parity of Calving

The least squares analysis of variance indicated highly significant (P<0.01) effect of parity on lactation length in unorganized cooperative and organized sectors. The contributions of parity to the total variation in lactation length were calculated to be 4.93, 3.49 and 15.31% in unorganized co-operative, unorganized non-cooperative and organized sectors respectively.

The Duncan's Multiple Range Test revealed that lactation length increased with the increase in order of lactation in both co-operative and non-cooperative units in unorganized sector. However, no definite trend was observed in organized sector (Table-4.4). The longest average lactation length was found to be 303.12 $\pm$ 2.44 days in third parity of unorganized co-operative sector which differed significantly ($P<0.05$) from lactation length of 1st and 2nd parities. In organized sector, the first parity had the longest lactation length (428.51 days) which differed significantly from 2nd and 3rd parities.

The significant effect of sequence of lactation on LL (days) has been reported by Yadav and Rathi (1992) in Hariana cows, yadav et al. (1992) in Sahiwal cows, Singh and Nagarcenkar (1997) in Sahiwal cows, Shethi *et al.* (2000) in Sahiwal cows, Singh *et al.* (2000) in different genetic groups of crossbreds, Priya Raj (2002) in crossbred cows, Kumar[1] (2004) in different genetic groups in cattle and Kumar (2006) in Desi and its cross with HF and Jersey. However, Kumar[2] (2004), Kumar (2005) and Sharan (2005) did not find significant role of sequence of lactation on lactation length in zebu and their exotic crosses.

4.3 PEAK YIELD

Peak milk yield (PMY) is an important economic indicator which directly reflects the economic worth of the animal as well as sustainability of the dairy farming. The population means of peak milk yield pooled over all the genetic groups viz. Desi and its crosses with Friesian and Jersey were estimated to be 8.29$\pm$0.21, 8.64$\pm$0.50 and 5.72$\pm$0.16 kg in unorganized co-operative; unorganized non-cooperative and organized sectors respectively.

The overall least squares means for peak yield, irrespective of genetic groups, in Desi and its crosses with Friesian and Jersey were reported to be 9.85 $\pm$ 0.09 and 10.14 $\pm$ 0.36 kg by Kumar (2004) respectively in private dairy units of North Bihar which is in close agreement with the findings of the present study.

4.3.1 FACTORS AFFECTING PEAK YIELD

4.3.1.1 Genetic group

The Least squares analysis of variance revealed significant (P<0.01) effect of genetic constitution on peak milk yield in unorganized co-operative and non-cooperative dairy units as well as in organized sector (Table-4.5). The magnitudes of variation contributed by the genetic constitution to the total variation in peak milk yield were reckoned to be 65.97, 54.58 and 90.69% in unorganized co-operative, unorganized non-cooperative and organized sectors respectively. The highest PMY was recorded in Friesian crosses followed by Jersey crosses and Desi in unorganized co-operative sector, while in unorganized non-cooperative and organized sectors Jersey crossbreds had the highest PMY which differed significantly (P<0.01) from Friesian cross in organized sector but did not differ significantly in non-cooperative sector. However, in all the three sectors, Desi had the lowest PMY.

Jersey crosses appeared to have edge over Friesian crosses which could be attributed to their relatively better adaptation in hot-humid climate in and around Pusa. Friesian crossbreds excelled in peak yield in co-operative sector, the reasons could be attributed to relatively better

Table - 4.5 : Least squares analysis of variance for the effect of genetic and non-genetic factors on peak yield in cooperative, non-cooperative and organised sectors in and around Pusa.

Source of Variation	Unorganised Cooperative Sector				Unorganised Non-Cooperative Sector				Organised Sector			
	DF	MSS	F	R^2 (%)	DF	MSS	F	R^2 (%)	DF	MSS	F	R^2 (%)
Genetic Group	2	14729.5700	17.0408**	65.97	2	14845.1600	11.2078**	54.58	2	3804316.0000	56.6456**	90.69
Herd size	2	4561.4780	5.2772**	20.43	2	31.7545	0.0240	0.12				
Season of calving	1	69.6846	0.0806	0.31	1	5464.7860	4.1258*	20.09	3	236208.3000	3.5171*	5.63
Parity	3	2103.1310	2.4331	9.42	3	5530.7090	4.1756**	20.34	4	86948.4700	1.2946	2.07
Error	253	864.3715		3.87	129	1324.5340		4.87	442	67160.0000		1.60

* = P<0.05, ** = P<0.01

management and disease control measures in co-operative sector. The results obtained elsewhere (Kumar[2], 2004; Shiv Prasad, 2003 and Kumar, 2005; Singh et al. 1993) were in close agreement to the findings of the present investigation. Priya Raj (2002) observed highly significant effect of genetic group on peak yield and higher peak yield in HF crossbred than Jersey crossbred. Kumar (2005) also reported the highest peak yield (12.19 kg.) in HF crossbred followed by Jersey crossbred (7.96 kg.) and Desi (4.21 kg), the trend of which is in conformity with the findings in co-operative sector of the present study. Besides, Judhav et al. (1991), Nayak and Raheja (1996), Dutta and Bhushan (2001), Kumar[2] (2004) and Singh et al. (2004) also reported significant effect of genetic group on peak yield.

4.3.1.2 Herd Size

The least squares analysis of variance indicated highly significant ($P<0.01$) effect of herd size on peak milk yield in cooperative sector but such evidence was inconspicuous in non-cooperative sector (Table-4.5). The contribution of herd size to the total variation in PMY in co-operative and non-cooperative sectors were recorded to be 20.43 and 0.12 percent respectively.

The Duncan's Multiple Range Test indicated significantly ($P<0.01$) more peak yield in the animals in herd of 6-8 animals than those in the herd of 9 and above. Although the herds of size 6-8 animals had the higher peak milk yield than the herd of 3-5 animals but did not differ significantly from each other. Similarly, the herd of 3-5 animals had the higher estimates of Peak yield than the herd of 9 & above animals but did not differ significantly from each other. Thus, it appeared that the herd of 6-8 animals had better response at farmer's door step than the herds of 3-5 and 9 &

above animals in and around Pusa in respect to peak milk yield. Priya Raj (2002), Kumar (2004) and Kumar (2005) reported non significant effect of herd size on the Peak yield.

4.3.1.3 Season of Calving

The least squares analysis of variance revealed significant ($P<0.05$) effect of season of calving on peak yield in non-cooperative sector and highly significant ($P<0.01$) effect in organized sector (Table-4.3). But, the effect of season was not significant in co-operative sector. The contribution of season of calving to the total variation in Peak milk yield for co-operative, non-cooperative and organized sectors were estimated to be 0.31, 20.09 and 5.63 percent respectively. Findings indicated better and uniform management systems in co-operative sector as compared to non-cooperative one. It is evident from table-6 that average estimates of Peak milk yield in co-operative sector were higher and uniform in comparison to other two sectors. The Duncan's Multiple Range Test indicated significant ($P<0.05$) difference between hot-humid and cold comfort climates in both non co-operative and organized sectors. The cold-comfort season group had significantly ($P<0.05$) higher peak yield than hot and humid/rainy season groups of animals. However, in organized sector, PMY obtained in spring did not differ significantly from cold and comfort. Significantly ($P<0.05$) lower PMY was observed in summer than in cold-comfort / winter and spring but did not differ significantly from hot and humid/rainy. Similar results were obtained by Jadhav et al. (1991) in HF crossbred and Sahiwal grades; Priya Raj (2002) in HF crossbred and Jersey crossbred cows, Singh et al. (2004) in Friesian × Hariana, Brown Swiss × Hariana and Jersey × Hariana crosses and Kumar (2006) in HF crossbred and Jersey crossbreds.

Contrary to the findings of the present study observed in co-operative sector, Singh et al. (1993) in Sahiwal and its crosses with Jersey and Red Dane , Singh et al. (2000) in crosses of HF, BS and Jersey with Hariana, Dutt and Bhushan (2001) in half-breeds and three breed crosses of HF, BS and Jersey with Hariana, Kumar[2] (2004) in HF and Jersey crosses with Hariana and Kumar (2005) in Desi, HF crossbred and Jersey crossbred cows did not find significant effect of season of calving on peak yield.

4.3.1.4 Parity of Calving

The least squares analysis of variance (Table-4.6) indicated highly significant ($P<0.01$) effect of parity of calving on peak yield in non co-operative sector with the highest milk production in 4th lactation. The contribution of parities to the total variation in peak milk yield was found to be 20.34 percent in non-cooperative sector while in co-operative and organized sectors the magnitudes of variation were reckoned to be only 9.47 and 2.07 percent respectively.

The Duncan's multiple range test revealed almost uniform magnitudes of PMY in co-operative and organized sectors (Table-4.6) while in non-cooperative sector the mean values of PMY in different lactations differed significantly ($P<0.01$) among each other. The highest PMY was found to be in 4th lactation. The gradual rise in peak yield in subsequent lactations confirmed the full inherited expression of milk production in 4th lactation in non cooperative sector.

In co-operative sector there was gradual rise of peak yield from 1st to 3rd lactation, although the differences were not statistically significant. But such trend was not evident in the peak yield in organized sector (Table-4.6). Yadav *et al.* (1992) in Sahiwal, Bhattacharya *et al.* (1999) in Hariana,

Table – 4.6 : Least squares mean ± S.E. of peak milk yield of cows managed in different sectors in and around Pusa.

Particulars	Unorganised Co-operative Sector	Unorganised Non-cooperative Sector	Organised Sector
Population Mean	8.29±0.21	8.64±0.50	5.72±0.16
Genetic Group			
Desi	6.49^{a}±0.33	6.62^{a}±0.82	3.99^{a}±0.40
Friesian x B	9.82^{b}±0.45	8.86^{ab}±0.66	5.49^{b}±0.20
Jersey x B	8.56^{c}±0.31	10.45^{b}±0.70	7.70^{c}±0.17
Herd size			
3-5	8.29^{ab}±0.37	8.66±0.44	-
6-8	9.01^{a}±0.34	8.51±0.70	-
9-above	7.58^{b}±0.30	8.75±1.23	-
Season of calving			
Hot & Humid/Rainy	8.35±0.31	7.99^{b} ±0.57	5.93^{a}±0.29
Cold & Comf./ Winter	8.23±0.30	9.30^{a} ±0.57	6.10^{b}±0.25
Spring	-	-	6.11^{b}±0.25
Summer	-	-	5.55^{ab} ±0.29
Parity			
1^{st}	7.93±0.34	7.10^{a} ±0.66	5.97±0.27
2^{nd}	8.23±0.33	8.57^{ab}±0.66	5.95±0.27
3^{rd}	9.15±0.39	8.18^{a}±0.77	5.98±0.27
4^{th}	7.86±0.55	10.72^{b}±0.92	5.37±0.33
5^{th}	-	-	5.35±0.35

Values with different superscripts (column wise) differed significantly (P<0.05) from each other

Kumar[2] (2004) in different genetic grades of Hariana with Friesian and Jersey, Kumar (2005) in Desi, HF crossbred and Jersey crosses and Kumar (2006) in HF crossbred and Jersey crossbred found non-significant effect of parity of calving on peak yield which is similar to the findings of the present study pertaining to unorganised co-operative and organized sectors. However, contrary to this, Yadav and Rathi (1992) in Hariana cows, Singh et al. (2000) in HF, BS and Jersey crosses with Hariana and Priya Raj (2002) in HF crossbred and Jersey crossbred observed significant ($P<0.05$) effect of sequence of lactation on peak yield. They further reported the highest peak yield in 3rd lactation, where as in the present investigation the peak yield was found significantly maximum in 4th, that also in unorganized non-cooperative sector.

4.4 DAYS TO ATTAIN PEAK YIELD

A milch animal is supposed to be economical if she attains peak yield shortly after calving and has higher persistency of peak yield. The overall least squares means for Days to attain peak milk yield in cows of different genetic groups viz. Desi and its crosses with Friesian and Jersey were estimated to be 43.96 ± 0.55, 46.78 ± 1.07 and 42.86 ± 0.17 days in unorganized co-operative, non-cooperative and organized sectors respectively (Table-4.8). However, contrary to the findings of the present study, irrespective of genetic groups, Kumar (2004) and Ayub (2005) observed relatively shorter days to attain peak yield in private dairy units of North Bihar.

4.4.1 FACTORS AFFECTING DAYS TO ATTAIN PEAK MILK YIELD

The least squares analysis of variance (Table-4.7) revealed that the genetic constitution of animals and herd size had significant effect on days

Table -4.7 : Least squares analysis of variance for the effect of genetic and non-genetic factors on Days to attain Peak milk yield in co-operative and non-cooperative and organized sectors in and around Pusa.

Source of Variation	Unorganised Cooperative Sector				Unorganised Non-Cooperative Sector				Organised Sector			
	DF	MSS	F	R^2(%)	DF	MSS	F	R^2(%)	DF	MSS	F	R^2(%)
Genetic Group	2	390.6690	6.5727**	53.38	2	118.6469	1.6974	20.46	2	23.3603	2.8889	17.23
Herd size	2	211.1763	3.5529*	28.86	2	93.1025	1.3319	16.05				
Season of calving	1	46.8756	0.7886	6.41	1	191.2703	2.7363	32.98	3	11.9674	1.4800	8.82
Parity	3	23.6564	0.3980	3.23	3	106.9885	1.5306	18.45	4	92.1876	11.4005**	67.99
Error	253	59.4381		8.12	129	69.9004		12.05	442	8.0863		5.96

* = $P<0.05$, ** = $P<0.01$

to attain peak milk yield in unorganized co-operative sector, while lactation order had significant effect on it in organized sector.

4.4.1.1 Genetic Group

The least squares analysis of variance indicated highly significant (P<0.01) effect of genetic group on days to attain peak milk yield (DAPY) in co-operative sector. The effect was non-significant in non co-operative and organized sectors (Table-4.7). The contribution of variation due to genetic constitution to the total variation was found to be 53.38 percent in co-operative sector, whereas 20.46 and 17.28 percent in non-cooperative and organized sectors respectively, reflecting better and uniform management provided to the animals in the private dairy units run under co-operative sector. Table-4.8 revealed that Desi cows attained the peak yield earlier than the cross-bred cows. The difference was significant (P<0.05) between Desi and Jersey crossbreds only. HF crossbred and Desi cows did not differ significantly from each other in this regard. Among the cross-breds, Friesian crosses attained the peak yield significantly (P<0.01) earlier than the Jersey cross-bred cows by 2.99 days. Kumar[2] (2004) observed lower DAPY in HF and Jersey crossbreds than Hariana cows. Singh et al. (2004) reported significantly (P<0.01) longer DAPY in ½ J: ½ H genetic group than ½ HF : ½ H which supports the findings of this investigation. Singh et al. (1993) observed non-significant effect of genetic group on DAPY. Kumar[1] (2004) reported lower DAPY in Desi cows than Jersey crossbred and HF crossbred which is in close agreement with the findings of the present study.

4.4.1.2 Herd Size

The least squares analysis of variance indicated significant ($P<0.05$) effect of herd size on DAPY in co-operative sector but it was non-significant in non-cooperative sector (Table-4.7). The contribution of herd size to the total variation in DAPY was estimated to be 28.86 percent in co-operative sector which was next to the contribution of genetic group indicating that herd size had significant role in optimum and economic milk production. The corresponding value in non-cooperative sector was found to be 16.05 percent which directly reflects the lack of knowledge of the farmers on management system. The least squares means (Table-4.8) revealed that the animals in the herd of 6-8 attained the peak yield earlier than those in the groups of other sizes. It was significantly ($P<0.05$) lower by 3.02 and 2.66 days than the herd size of 3-5 and 9 & above respectively. Though the mean differences in days to attain peak yield under non-cooperative sector were not significant, but the herd of 6-8 animals herd had the lowest mean value for this trait. The longer DAPY in 9 & above herd size might be due to lack of proper care to individual animals resulting into lower level of management in larger herd. Kumar (2005) and Kumar (2006) reported significant ($P<0.05$) influence of herd size on DAPY in Desi and its crosses with HF and Jersey which was similar to the findings of the present study in case of co-operative sector. On the other hand Kumar[1] (2004) found non-significant effect of herd size on DAPY which corroborated the observation of the present study in relation to non-cooperative sector.

Table – 4.8 : Least squares mean ± S.E. of days to attain peak milk yield of cows managed in different sectors in and around Pusa.

Particulars	Unorganised Co-operative Sector	Unorganised Non-cooperative Sector	Organised Sector
Population Mean	43.96±0.55	46.78±1.07	42.86±0.17
Genetic Group			
Desi	42.06[a]±0.87	45.51±1.87	41.86±0.44
Friesian x B	43.41[a]±1.17	49.42±1.52	42.99±0.21
Jersey x B	46.40[b] ±0.82	45.42±1.59	42.95±0.19
Herd size			
3-5	45.08[a]±0.97	46.92±1.01	-
6-8	42.06[b]±0.90	44.56±1.59	-
9-above	44.72[a]±0.78	48.87±2.82	-
Season of calving			
Hot & Humid/Rainy	44.46±0.81	45.56±1.31	42.14±0.32
Cold & Comf./ Winter	43.45±0.77	48.08±1.30	42.97±0.27
Spring	-	-	42.59±0.26
Summer	-	-	42.69 ±0.31
Parity			
1st	43.31±0.90	47.76±1.52	41.46[a] ±0.27
2nd	43.92 ±0.86	45.78±1.51	41.75[a] ±0.27
3rd	43.54±1.01	49.12±1.76	42.79[b] ±0.29
4th	45.05±1.43	49.12±1.76	44.08[c] ±0.33
5th	-	-	42.90[b] ±0.37

Values with different superscripts (column wise) differed significantly (P<0.05) from each other.

4.4.1.3 Season of Calving

The season of calving did not have significant influence on days to attain peak yield in organized and unorganized sectors (Table-4.7). However, the least squares mean for DAPY was slightly longer in cold comfort season than the hot humid climate. However, Singh et al. (2004), Kumar[1] (2004), Kumar[2] (2004), Kumar (2005) and Kumar (2006), reported the season effect to be significant in DAPY in crossbred and Desi cows.

4.4.1.4 Parity of Calving

Non-significant effect of parity of calving on days to attain peak yield in co-operative and non- cooperative sectors indicated almost independency of the characters to the order of lactation. However, the parity of calving had highly significant (P<0.01) effect in cows of organized sector. The contribution of parity to the total variation in days to attain peak milk yield was reckoned to be 67.99 percent in organized sector. It is evident from table-4.8 that least squares means for days to attain peak milk yield increased significantly (P<0.01) with the increase in order of lactation. Significantly (P<0.01) the shortest (41.46 ± 0.27days) and longest (44.08 ± 0.33days) days to attain peak milk yields were found to be in first and fourth lactations respectively. Kumar (2005) also reported significant effect (P<0.05) of parity of lactation on DAPY in Desi, HF crossbred and Jersey crossbred cows under farmers management condition in and around Patna. He further observed reduction in DAPY to the minimum in 3rd lactation. This was also supported by Kumar (2006) in Desi, HF crossbred and Jersey crossbred. In conformity to the results obtained in co-operative and non co-operative sectors of the present study, Kumar[2] (2004) did not find significant effect of parity of lactation on DAPY.

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

The milk yield per day of lactation length was taken as one of the measures of production efficiency in cows. The overall estimates of least squares mean ± SE of milk yield per day of lactation length pooled over all the genetic groups viz. Desi as well as HF and Jersey crossbred cows were found to be 6.57 ± 0.40, 6.35 ± 0.96 and 3.98 ± 0.17 kg in co-operative and non-cooperative sectors of private dairy units and organized sector respectively (Table-4.10). Average estimates of MY/LL in private dairy units reported by Kumar (2004) and Ayub (2005) were much lower than the findings of the present investigation in the unorganized sector. But the estimate of the overall mean for MY/LL for the cows in organized sector obtained in the present study was much lower than the aforesaid reports in literature.

4.5.1 FACTORS AFFECTING MILK YIELD PER DAY OF LACTATION LENGTH

4.5.1.1 Genetic Group

The least squares analysis of variance indicated highly significant ($P<0.01$) effect of genetic group on the milk yield per day of lactation length in all the types of dairy units viz. unorganized co-operative, non-cooperative and organized sectors in and around Pusa (Table-4.9). The contribution of genetic constitution to the total variation was found to be 55.76, 89.08 and 66.62 percent respectively. The Duncan's multiple range test indicated significant ($P<0.05$) differences between Desi and Friesian crosses as well as Desi and Jersey crosses in both co-operative and non co-operative sectors. Although Jersey crosses had the highest milk yield in

Table – 4.9 : Least squares analysis of variance for the effect of genetic and non-genetic factors on MY/LL (kg) in co-operative, non-cooperative and organised sectors in and around Pusa.

Source of Variation	Unorganised Cooperative Sector				Unorganised Non-Cooperative Sector				Organised Sector			
	DF	MSS	F	R^2 (%)	DF	MSS	F	R^2 (%)	DF	MSS	F	R^2 (%)
Genetic Group	2	17507.3000	5.5616**	55.76	2	10574.0900	187.4800**	89.08	2	1005338.0000	13.5875**	66.62
Herd size	2	3190.9890	1.0137	10.16	2	71.8227	1.2734	0.60				
Season of calving	1	2632.3300	0.8362	8.38	1	536.9502	9.5202**	4.53	3	258940.5000	3.4997*	17.16
Parity	3	4921.8000	1.5635	15.67	3	630.7606	11.1835**	5.32	4	170612.4000	2.3059**	11.30
Error	253	3147.8830		10.02	129	56.4012		0.48	442	73989.8500		4.90

* = P<0.05, ** = P<0.01

co-operative sector but did not differ significantly from Friesian crosses. Non-significant difference between HF crossbred and Jersey crossbred was also observed in non-cooperative sector. In organized sector, the Jersey crossbreds had significantly (P<0.01) higher milk yield per day of lactation length than both Desi and Friesian crosses but Friesian crossbreds did not differ significantly from Desi. Significant effects of genetic group on milk yield per day of lactation length was also reported by Hayatnagarkar et al. (1990); Jadhav et al. (1999); Singh et al. (1993); Thakur et al. (1999); Shrivastava and Singh (2000); Singh et al. (2000); Bhattacharya et al. (2002); Priya Raj (2002); Akhtar et al. (2003); Kumar[1] (2004); Kumar[2] (2004); Kumar (2005); Sharan (2005) and Kumar (2006). Priya Raj (2002), Akhtar et al. (2003) and Kumar (2005) reported the superiority of HF crossbred cows over Jersey crossbreds with respect to average milk yield per day of lactation length. However, Kumar (2006) reported superiority of Jersey cross over HF cross with respect to milk yield per day of lactation length.

4.5.1.2 Herd Size

The least squares analysis of variance indicated non significant effect of herd size on milk yield per day of lactation length (Table-4.9). The contribution of herd size to the total variation in MY/LL was 10.16 percent in co-operative sector and only 0.60 percent in non-cooperative sector. Although the differences were non-significant but MY/LL was found to have an increasing trend with the increase in herd size and resultantly the 9 & above group had the highest mean value for this trait (Table-4.10). Such trend was also observed in non-cooperative sector. Similar results were also reported by Priya Raj (2002), Kumar (2005) and Kumar (2006). However,

Table – 4.10 : Least squares mean $\pm$ S.E. of Milk yield per day of lactation length (MY/LL) of cows managed in different sectors in and around Pusa.

Particulars	Unorganised Co-operative Sector	Unorganised Non-cooperative Sector	Organised Sector
Population Mean	6.57±0.40	6.35±0.96	3.98±0.17
Genetic Group			
Desi	$4.68^{a}\pm0.64$	$4.26^{a}\pm0.12$	$3.08^{a}\pm0.42$
Friesian x B	$7.27^{b}\pm0.85$	$7.39^{b}\pm0.14$	$3.85^{a}\pm0.21$
Jersey x B	$7.75^{b}\pm0.60$	$7.39^{b}\pm0.14$	$4.99^{b}\pm0.18$
Herd size			
3-5	5.94±0.71	6.50±0.09	-
6-8	6.61±0.66	6.49±0.14	-
9-above	7.15±0.57	7.05±0.85	-
Season of calving			
Hot & Humid/Rainy	6.95±0.59	$6.14^{b}\pm0.12$	$3.53^{a}\pm0.31$
Cold & Comf./Winter	6.19±0.57	$6.56^{a}\pm0.17$	$4.65^{b}\pm0.27$
Spring	-	-	$3.77^{a}\pm0.26$
Summer	-	-	$3.95^{ab}\pm0.30$
Parity			
1^{st}	5.75±0.66	$5.76^{a}\pm0.14$	$4.59^{a}\pm0.29$
2^{nd}	7.65±0.63	$6.19^{b}\pm0.14$	$4.09^{ab}\pm0.29$
3^{rd}	6.43±0.74	$6.54^{c}\pm0.16$	$4.08^{ab}\pm0.29$
4^{th}	6.45±1.04	$6.90^{c}\pm0.19$	$3.30^{b}\pm0.34$
5^{th}	-	-	$3.86^{ab}\pm0.36$

Values with different superscripts (column wise) differed significantly (P<0.05) from each other

Shrivastava and Singh (2000) and Kumar[1] (2004) observed significant effect of herd size on average milk yield per day of lactation length.

4.5.1.3 Season of Calving

The least squares analysis of variance revealed significant (P<0.01) effect of season of calving on MY/LL in organized sector and unorganized non-cooperative sector (Table-4.9). However, it had non-significant effect on this trait in unorganized co-operative sector. Contribution of season of calving to the total variation in MY/LL was reckoned to be 8.38, 4.53 and 17.16 percent in co-operative, non-cooperative and organized sectors respectively. The DMRT indicated significant (P<0.05) difference in MY/LL between the cows calved in hot humid and cold comfort seasons in both non-cooperative and organized sectors. The cows calved in cold comfort season had higher MY/LL than those calved in hot-humid season. In organized sector also, the cows calved in cold-comfort season had significantly (P<0.05) higher MY/LL than those in spring and summer seasons. Significant season-effect on MY/LL were also reported by Jadhav et al. (1991) and Kumar[1] (2004). However, Yadava and Rathi (1992), Yadava et al. (1992), Singh et al. (1993), Thakur et al. (1999), Shrivastava and Singh (2000), Singh et al. (2000), Priya Raj (2002), Akhtar et al. (2003), Kumar[2] (2004), Kumar (2005) and Kumar (2006) reported non-significant effect of season of calving on the MY/LL which is similar to the findings of the present study pertaining to co-operative sector. However, the average MY/LL of cows calved in hot-humid, spring and summer seasons did not differ significantly among each other (Table-4.10).

4.5.1.4 Parity of Calving

The least squares analysis of variance revealed highly significant (P<0.01) effect of parity on MY/LL in unorganized non-cooperative and organized sectors. However, the effect was non-significant in co-operative sector (Table-4.9). The sequence of calving contributed 15.67, 5.32 and 11.30 percent to the total variation in MY/LL for co-operative, non-cooperative and organized sectors respectively. The least squares means (Table -4.10) increased significantly (P<0.05) with the increase in order of lactation in organized sector. Fourth lactation had the highest MY/LL which differed significantly (P<0.05) from the 1^{st} and 2^{nd} parities, but did not differ significantly from third parity. However, in organized sector, the MY/LL was found to be significantly (P<0.05) higher in 1^{st} lactation than the fourth lactation but did not differ significantly from 2^{nd}, 3^{rd} and 5^{th} lactations. Yadava and Rathi (1992), Kumar[2] (2004) and Kumar (2006) reported non- significant effect of order of lactation on MY/LL which was similar to the findings recorded in co-operative sector. On the other hand, Shrivastava and Singh (2000), Singh et al. (2000), Priya Raj (2002) and Kumar[1] (2004) reported significant effect of parity of lactation on this efficiency trait which was in agreement with the efficiency trait findings of the present investigation in non-cooperatives and organized sectors.

4.6 MILK YIELD PER DAY OF CALVING INTERVAL

Average daily milk yield by a cow during its one calving interval was taken as another criterion to compare their milk production efficiency. The overall estimates of least squares mean for milk yield per day of calving interval (MY/LL) pooled over three genetic groups viz. Desi and its crosses with Friesian and Jersey were reckoned to be 4.85 ± 0.07,

Table - 4.11 : Least squares analysis of variance for the effect of genetic and non-genetic factors on MY/CI (kg) in co-operative, non-cooperative and organised sectors in and around Pusa.

Source of Variation	Unorganised Cooperative Sector				Unorganised Non-Cooperative Sector				Organised Sector			
	DF	MSS	F	R^2 (%)	DF	MSS	F	R^2 (%)	DF	MSS	F	R^2 (%)
Genetic Group	2	1259450.0000	141.2550**	96.06	2	682047.9000	154.4970**	93.97	2	722792.5000	31.5311**	79.64
Herd size	2	54162.6300	6.0747**	4.03	2	2613.5770	0.5920	0.36				
Season of calving	1	177.8033	0.0199	0.02	1	7219.5500	1.6354	0.99	3	101982.7000	4.4489**	11.23
Parity	3	19629.0800	2.2015	1.46	3	29479.1100	6.6776**	4.06	4	59814.9000	2.6094*	6.59
Error	253	8916.1420		0.66	129	4414.6360		0.60	442	22923.1700		2.52

* = P<0.05, ** = P<0.01

Table – 4.12 : Least squares mean ± S.E. of milk yield per day of calving interval (MY/CI) of cows managed in different sectors in and around Pusa.

Particulars	Unorganised Co-operative Sector	Unorganised Non-cooperative Sector	Organised Sector
Population Mean	4.85±0.07	4.87±0.09	2.90±0.10
Genetic Group			
Desi	3.14^{a}±0.11	3.21^{a} ±0.15	2.01^{a} ±0.24
Friesian x B	5.99^{b}±0.14	5.64^{b} ±0.12	2.91^{b} ±0.12
Jersey x B	5.42^{c} ±0.10	5.74^{b} ±0.13	3.77^{c} ±0.10
Herd size			
3-5	4.73^{a} ±0.12	4.94±0.08	-
6-8	5.15^{b} ±0.11	4.97±0.13	-
9-above	4.68^{a} ±0.10	4.69±0.22	-
Season of calving			
Hot & Humid/Rainy	4.86±0.10	4.79±0.10	2.54^{a} ±0.17
Cold & Comf./ Winter	4.84±0.10	4.94±0.10	3.30^{b} ±0.15
Spring	-	-	2.90^{ab} ±0.14
Summer	-	-	2.85^{a} ±0.17
Parity			
1st	4.64±0.11	4.45^{a} ±0.12	3.08^{a} ±0.16
2nd	4.77±0.11	4.82^{b} ±0.12	3.09^{a} ±0.16
3rd	5.05±0.12	5.01^{b} ±0.14	2.86^{ab} ±0.16
4th	4.95±0.18	5.19^{b} ±0.17	2.44^{b} ±0.19
5th	-	-	3.01^{a} ±0.20

Values with different superscripts (column wise) differed significantly ($P<0.05$) from each other.

4.87 ± 0.09 and 2.90 ± 0.10 kg in co-operative, non-cooperative and organized sectors respectively (Table-4.12). The estimates obtained in this study were much higher than the results obtained by Kumar (2004) and Ayub (2005) under farmers management condition in and around Darbhanga and Muzaffarpur respectively. However, in organized sector, the overall average estimate of MY/CI was found to be lower than the available reports indicating that crossbreds do well under farmers' door step in the study area.

4.6.1 FACTORS AFFECTING MILK YIELD PER DAY OF CALVING INTERVAL

4.6.1.1 Genetic group

The analysis of variance revealed highly significant (P<0.01) effect of genetic constitution of animals on MY/CI in both organized and unorganized sectors, its contributions to the total variation being 96.06, 93.97 and 79.64 percent in co-operative, non-cooperative and organized sectors respectively (Table-4.11). It seems that under the existing management system, in both organized and unorganized sectors, the genetic constitution of the cows is vital factor influencing this milk production efficiency trait.

The Duncan's Multiple Range Test revealed that the crossbreds had significantly (P<0.05) higher mean values for MY/CI than the Desi. Friesian crosses had significantly (P<0.05) higher estimate of MY/CI than Jersey crosses in unorganized co-operative sector, whereas in organized sector the Jersey crossbreds had superiority over the Friesian crosses (Table-4.12). However, in unorganized non-cooperative sector Jersey crossbreds did not differ significantly from Friesian crosses.

Significant effects of genetic groups on MY/CI have also been reported by Jadhav et al. (1991), Shrivastava and Singh (2000), Singh et al. (2000), Priya Raj (2002), Akhtar et al. (2003), Kumar[1] (2004), Kumar (2005), Sharan (2005) and Kumar (2006). The table-4.12 further revealed that the HF crossbreds and Jersey crossbreds of both co-operative and non-cooperative sectors had almost double milk yield per day of calving interval as compared to Desi and these findings were in close agreement with the findings of Kumar[1] (2004), Kumar (2005) and Kumar (2006). Hayatnagarkar et al. (1990), Singh *et al.* (2000), Priya Raj (2002), Kumar (2005) and Kumar (2006) have reported superiority of HF crossbreds over Jersey crossbred cows, which were in conformity to the findings of the present study in reference to the co-operative sector.

4.6.1.2 Herd Size

The least squares analysis of variance (Table-4.11) indicated highly significant ($P<0.01$) effect of herd size on MY/CI in co-operative sector but the effect was non-significant in non-cooperative sector. The magnitudes of variation contributed by herd size to the total variation in MY/CI were estimated to be 4.03 and 0.36 percent in co-operative and non-cooperative sectors respectively. The DMRT revealed that the animals managed in 6-8 group of animals had significantly ($P<0.05$) higher estimate of MY/CI than those in 3-5 and 9 & above in unorganized co-operative sector (Table-4.12). In unorganized non-cooperative sector, the cows in herd of 6-8 animals had higher estimate of MY/CI than the herds of 3-5 and 9 & above animals, but did not differ significantly among each other. The results of the present study were found to be in close agreement with the findings of Shrivastava and Singh (2000) and Kumar (2006). However, Priya Raj (2002), Kumar[1]

(2004), and Kumar (2005) did not find significant influence of herd size on MY/CI.

4.6.1.3 Season of Calving

Season of calving had non-significant influence on MY/CI in co-operative and non-cooperative sectors but highly significant effect (P<0.01) in the organized sector. The season of calving contributed only 0.02 and 0.99 percent to the total variation in co-operative and non-cooperative sectors respectively. However, in organized sector the contribution of season-effect was 11.23 percent. The Duncan's Multiple Range Test (Table-4.12) revealed that in the organized sector there was significant (P<0.05) difference in MY/CI between hot-humid, cold-comfort and summer calvers. The highest MY/CI (3.30±0.15 kg.) was observed in the cows calved in cold-comfort season which appears to be highly favourable to crossbreds with abundance of availability of quality green fodder after calving. The findings of the present study were in close agreement with the findings of Jadhav et al. (1991), Kumar[1] (2004) and Kumar (2006). However, Shrivastava and Singh (2000) and Akhtar et al. (2003) reported non-significant effect of season of calving on MY/CI which is similar to the findings of the present investigation for crossbred cattle in co-operative and non co-operative sectors. They further observed that winter calvers had higher MY/CI than the cows calved in other seasons which was in close agreement with the findings of the present study.

4.6.1.4 Parity of Calving

The least squares analysis of variance (Table-4.11) indicated non-significant effect of parity of calving on MY/CI in co-operative sector, highly significant effect (P<0.01) in non-cooperative sector and significant

(P<0.05) effect in the organized sector. The parity of calving contributed 1.46, 4.06 and 6.59 percent to the total variation in co-operative, non-cooperative and organized sectors respectively.

The Duncan's Multiple Range Test revealed that in co-operative sector the mean values for MY/CI increased gradually with the increase in lactation order and highest mean for MY/CI was observed in 3rd lactation which did not differ significantly from the estimates of 1st, 2nd and 4th lactations. Although a similar trend was observed in non-cooperative sector but the average MY/CI was significantly (P<0.05) higher in 4th lactation than the first lactation but did not differ significantly with 2nd and 3rd lactations. However, in organized sector, although the differences in average MY/CI were statistically significant (P<0.05) but no definite trend could be established. The reason could be attributed to poor management system in terms of maintaining the optimum dry period required. Vij et al. (1992) reported significant effect of lactation order on MY/CI but did not find any definite trend. Similar results were also obtained by Kumar (2006) which is in close agreement with the findings of the present study. Besides, Priya Raj (2002), Kumar[1] (2004) and Kumar (2005) also observed declining trend in MY/CI after 3rd lactation.

4.7 Dry Period

The overall estimates of least squares means of dry period, pooled over three genetic groups viz. Desi and its crosses with Friesian and Jersey were found to be 101.54± 2.57, 96.64±0.91 and 165.79±9.97 days in co-operative, non-cooperative and organized sectors respectively (Table -4.14). It indicated that farmers were aware about the significance of dry period in dairy farming. However, contrary to the findings of the present study,

Table - 4.13 : Least squares analysis of variance for the effect of genetic and non-genetic factors on Dry Period (days) in co-operative, non-cooperative and organized sectors in and around Pusa.

Source of Variation	Unorganised Cooperative Sector				Unorganised Non-Cooperative Sector				Organised Sector			
	DF	MSS	F	R^2(%)	DF	MSS	F	R^2(%)	DF	MSS	F	R^2(%)
Genetic Group	2	26403.1500	20.7553**	61.07	2	6001.8950	118.6627**	77.29	2	41740.4300	1.6603	13.72
Herd size	2	14684.1600	11.5431**	33.96	2	57.1096	1.1291	0.73				
Season of calving	1	78.8826	0.0620	0.18	1	1606.5090	31.7621**	20.68	3	138963.6000	5.5274**	45.70
Parity	3	795.1479	0.6251	1.83	3	49.0217	0.9692	0.63	4	98243.6400	3.9078**	32.30
Error	253	1272.1180		2.94	129	50.5795		0.65	442	25140.7000		8.26

* = P<0.05, ** = P<0.01

Table – 4.14 : Least squares mean ± S.E. of Dry Period of cows managed in organized and unorganized sectors in and around Pusa.

Particulars	Unorganised Co-operative Sector	Unorganised Non-cooperative Sector	Organised Sector
Population Mean	101.54±2.57	96.64±0.91	165.79±9.97
Genetic Group			
Desi	125.96^{a}±4.05	110.10^{a} ±1.59	180.12±24.63
Friesian x B	88.27^{b} ±5.43	92.05^{b} ±1.29	171.37±12.22
Jersey x B	90.39^{b} ±3.81	86.75^{c} ±1.35	145.87±10.68
Herd size			
3-5	117.37^{a} ±4.50	98.39±0.86	-
6-8	94.36^{b}±4.16	96.70±1.35	-
9-above	92.88^{b} ±3.62	94.81±2.40	-
Season of calving			
Hot & Humid/Rainy	102.19±3.75	93.09^{b} ±1.11	179.58^{ab} ±17.86
Cold & Comf./ Winter	100.88±3.59	100.18^{a} ±1.10	132.36^{a} ±15.54
Spring	-	-	141.20^{a} ±15.03
Summer	-	-	210.01^{b} ±17.75
Parity			
1st	106.16±4.18	95.62±1.29	174.99^{ab} ±16.81
2nd	102.75±4.01	95.92 ±1.29	135.76^{a} ±16.67
3rd	97.95±4.67	96.06 ±1.49	198.23^{b} ±16.65
4th	99.28±6.62	98.94 ±1.78	196.52^{b} ±19.89
5th	-	-	123.43^{a} ±21.17

Values with different superscripts (column wise) differed significantly ($P<0.05$) from each other

Kumar (2004) and Ayub (2005) observed longer dry periods of cows maintained in private dairy units in and around Darbhanga and Muzaffarpur respectively.

4.7.1 FACTORS AFFECTING DRY PERIOD

4.7.1.1 Effect of Genetic Group

The least squares analysis of variance (Table-4.13) revealed highly significant ($P<0.01$) effect of genetic grades on dry period in co-operative and non-cooperative sectors of milch animals but it had non- significant effect in organized sector. The amount of variations contributed by genetic constitution were 61.07 and 77.29 percent in co-operative and non-cooperative sectors, but only 13.72 percent in organized sector. In organized sector, the dry period might be influenced mostly by management condition.

The least squares means along with their SE for Dry period have been presented in table-4.14. In co-operative sector, the shortest dry period (88.27 $\pm$5.43 days) was recorded in Friesian crossbreds which was significantly ($P<0.05$) lower by 37.69 days from Desi cows but did not differ significantly from the estimate for Jersey crossbred cows. Jersey crosses also exhibited significantly ($P<0.01$) lower Dry period than the Desi. Similar trend was also observed in unorganized non-cooperative sector where the crossbreds of Desi with Jersey and Friesian had significantly ($P<0.05$) lower dry period than the Desi, but among the crossbreds, Jersey crosses had significantly ($P<0.05$) lower Dry period than Friesian crosses. It indicated that under farmer's management condition the Jersey crosses had slightly edge over Friesian crosses in non-cooperative sector. In organized sector, the average estimates of dry period for all the three genetic groups were observed to be higher. The average dry periods in organized sector ranged from 145.87±10.68 days in Jersey crossbreds to 180.12 ±24.63 days in Desi. Significant effect of genetic group on dry period has also been reported by Thakur et al. (1999), Akhtar *et al.* (2003), Kumar[1] (2004), Kumar[2] (2004), Kumar (2005) and Kumar (2006) which are in agreement with the findings of the present study. Kumar[1] (2004) and Kumar (2005) have also reported significantly longer dry period in Desi cows than HF crossbreds and Jersey crossbred which corroborates the findings of the present study. Priya Raj (2002) reported non significant difference between average dry periods of HF crossbreds and Jersey crossbred cows which are also in conformity with findings of the present study in organized sector.

4.7.1.2 Herd Size

The least squares analysis of variance (Table-4.13) indicated highly significant (P<0.01) effect of herd size on dry period in co-operative sector. However, the herd size did not influence the Dry period of cows in non-cooperative sector. The contribution of herd size to the total variation was calculated to be 33.96 percent in co-operative sector and only 0.73 percent in non-cooperative sector.

Least squares means along with their SE of Dry period have been presented in Table-4.14. DMRT revealed that the herd of 3-5 milch animals had the longest Dry period which was significantly (P<0.05) longer by 23.01 and 24.49 days than the cows in herds of 6-8 and 9 & above animals respectively. The cows in group of 9 & above animals although had shorter Dry period than those in 6-8 animals group but did not differ significantly indicating that the herd of 6-8 animals may be considered as optimum for this trait. Similar trend of increase in Dry period with the increase in herd size had also been observed in non-cooperative sector. The dry periods in non-cooperative sector were very much close to that observed in co-operative sector with respect to the herd size of 6-8 and 9 and above indicating better care and management of the animals of such herds. Priya Raj (2002), Kumar[1] (2004), Kumar (2005), Kumar (2006) reported non-significant effect of herd size on the length of days dry which is in conformity with the present findings in non-cooperative sector. On the other hand Shrivastava et al (1996) reported significant effect of herd size on Dry period which is in accordance with the results of the present investigation as observed in co-operative sector of milch animals.

4.7.1.3 Season of Calving

The effect of season of calving on Dry period in non-cooperative and organized sectors were highly significant ($P \leq 0.01$), but this effect was non-significant in co-operative sector (Table-4.13). The magnitudes of variation contributed by season of calving to the total variation in dry period were reckoned to be 0.18, 20.68 and 45.70 percent in co-operative, non-cooperative and organized sectors respectively.

Least squares means along with their SE have been presented in table-14. In unorganized co-operative sector, the average Dry period of the cows calved in hot–humid season did not differ significantly from those calved in cold-comfort. In non-cooperative sector, the average Dry period of the cows calved in hot-humid season was found to be significantly ($P<0.05$) shorter by 7.09 days than those calved in cold-comfort. However, in contrary to this, the shortest Dry period (132.36 ± 15.54 days) was recorded in cows calved in cold-comfort season followed by those calved in spring, hot-humid and summer seasons. The average estimates of Dry periods observed in cows calved in cold-comfort and spring differed significantly (P<0.01) from those calved in summer but the difference was not significant from the cows calved in hot-humid. It indicated that cold-comfort and spring calvers have shorter Dry periods. Vij et al. (1992) reported significant (P<0.05) effect of season of calving on Dry peiod in Tharparkar cows. Contrary to this, Singh et al. (1993), Thakur et al. (1999), Priya Raj (2002), Kumar[1] (2004), Kumar[2] (2004) and Kumar (2005) did not find significant effect of season of calving on Dry period.

4.7.1.4 Parity of Calving

The least squares analysis of variance revealed that the parity of calving did not influence the dry period significantly in both co-operative and non-cooperative sectors. But its influence was highly significant (P<0.01) in organized sector (Table-4.13). The magnitudes of variation contributed by the order of lactation to the total variation in dry period were 1.83, 0.63 and 32.30 percent in co-operative, non-cooperative and organized sectors respectively.

The least squares means along with their SE (Table-4.14) revealed that, in general, the cows managed by the farmers had the shorter average dry periods in both co-operative and non-cooperative sectors as compared to the organized sector. In co-operative sector, the average dry periods decreased gradually with the increase in order of lactation while in non-cooperative sector it was not so. No definite trend could be observed in organized sector but significantly (P<0.05) shorter (123.43 ±21.17 days) and longer (198.23 ± 16.65 days) dry periods were recorded to be in 5th and 3rd lactations respectively. Vij *et al.* (1992) reported significant effect of lactation order on dry period. However, Kumar[1] (2004), Kumar[2] (2004) and Kumar (2005) reported non-significant effect of sequence of lactation on dry period.

4.8 CALVING INTERVAL

Calving interval is the indicator of sound reproductive status of milch animals. A period of 12 ÷ 13 months has been recommended as an ideal calving interval in cows. The average calving interval pooled over all the three genetic groups viz. Desi and its crosses with Friesian and Jersey were found to be 401.83 ± 3.76, 394.63 ± 3.21 and 546.62 ± 10.19 days in co-operative, non-cooperative and organized sectors respectively (Table-4.16). Irrespective of genetic groups, the overall mean calving interval in Jersey and Friesian crossbreds was reported to be 434.77 ± 2.74 days by Singh et al. (2000) which was higher than the mean values obtained in this study for co-operative and non-cooperative sectors but lower than the value obtained for the cows in organized sector.

4.8.1 FACTORS AFFECTING CALVING INTERVAL

4.8.1.1 Genetic Group

Table-4.15 revealed that genetic constitution of the animals had significant ($P<0.01$) influence on the calving interval in unorganized non-cooperative and organized sectors but did not influence the calving interval in unorganized co-operative sector. The amount of variations contributed by the genetic constitution to the total variation in calving interval were reckoned to be 30.34, 47.70 and 24.25 percent in co-operative, non-cooperative and organized sectors respectively.

Table-4.16 revealed that the average estimates of calving interval in co-operative sector ranged from 388.96 ± 8.38 days in Friesian cross to

Table - 4.15 : Least squares analysis of variance for the effect of genetic and non-genetic factors on Calving Interval (days) in co-operative, non-cooperative and organized sectors in and around Pusa.

Source of Variation	Unorganised Cooperative Sector				Unorganised Non-Cooperative Sector				Organised Sector			
	DF	MSS	F	R^2 (%)	DF	MSS	F	R^2 (%)	DF	MSS	F	R^2 (%)
Genetic Group	2	7677.8320	2.5377	30.34	2	4271.2530	6.8803**	47.70	2	127330.4000	4.8423**	24.25
Herd size	2	9543.3250	3.1543*	37.72	2	772.9136	1.2450	8.63				
Season of calving	1	2894.0520	0.9566	11.43	1	740.8227	1.1934	8.27	3	170331.3000	6.4776**	32.45
Parity	3	2162.2020	0.7147	8.55	3	2547.2220	4.1032**	28.45	4	201009.7000	7.6442**	38.29
Error	253	3025.4710		11.96	129	620.7907		6.93	442	26295.5700		5.01

* = P<0.05, ** = P<0.01

Table – 4.16 : Least squares mean ± S.E. of Calving Interval of cows managed in different sectors in and around Pusa.

Particulars	Unorganised Co-operative Sector	Unorganised Non-cooperative Sector	Organised Sector
Population Mean	401.83±3.96	394.63±3.21	546.62±10.19
Genetic Group			
Desi	406.64±6.25	383.27^{a} ±5.59	513.62^{a} ±25.19
Friesian x B	388.96±8.38	396.73^{ab} ±4.54	542.88^{a} ±12.49
Jersey x B	409.88±5.88	403.89^{b} ±4.76	582.60^{b} ±10.93
Herd size			
3-5	413.33^{a} ±6.94	391.81±3.02	-
6-8	399.86^{ab}±6.43	400.14±4.76	-
9-above	392.30^{b} ±5.58	391.93±8.41	-
Season of calving			
Hot & Humid/Rainy	405.80±5.79	392.22±3.90	513.38^{a} ±18.26
Cold & Comf./ Winter	397.86±5.54	397.03±3.88	510.83^{a} ±15.89
Spring	-	-	577.89^{b} ±15.38
Summer	-	-	583.38^{b} ±18.35
Parity			
1st	399.90±6.45	384.99^{a} ±4.54	608.37^{a} ±17.19
2nd	409.92±6.19	387.28^{a} ±4.52	501.52^{b} ±17.05
3rd	402.72±7.20	400.59^{b} ±5.24	554.88^{c} ±17.02
4th	295.17±10.21	405.65^{b} ±6.27	570.47^{ac} ±20.35
5th	-	-	496.61^{b} ±21.65

Values with different superscripts (column wise) differed significantly (P<0.05) from each other.

409.88 ± 5.88 days in Jersey cross but the values did not differ significantly. The cow managed under unorganized non-cooperative sector had the lowest average calving interval (383.27 ± 5.59 days) in Desi which differed significantly (P<0.01) from the mean value (403.89 ± 4.76 days) obtained for Jersey cross but did not differ significantly from the average calving interval for Friesian cross. However, among the crossbreds, Friesian cross had lower CI than Jersey crosses but did not differ significantly. Almost similar trend was observed in organized sector but the average estimates of calving interval were in higher side. The shortest and longest calving intervals were found to be 513.62 ± 25.19 days and 582.60 days in Desi and Jersey crosses respectively. The inter-calving period obtained in Desi differed significantly (P<0.05) from the calving interval observed in Jersey crosses but did not differ significantly from Friesian crosses. However, mean calving interval observed in Friesian cross differed significantly from Jersey crossbreds.

It has been observed, in general that the cows maintained in organized sector had the longer calving intervals than those in the unorganized sectors. It indicated that prolonged lactation period was allowed even at lower level of milk yield in organised herd. Jadhav et al. (1991) in various genetic groups of Holstain × Sahiwal, Singh et al. (2000) in crossbreeds of HF and BS, and Jersey with Hariana cows, Priya Raj (2002) in HF crossbred and Jersey crossbred, Kumar (2005) in Desi, HF crossbred and Jersey crossbred and Sharan (2005) in different grades of HF with Hariana reported significant (P<0.05) effect of genetic group on CI which is similar to the findings of the present study in non-cooperative and organized sectors. However, Akhtar et al. (2003) reported the effect of various genetic grades of crossbred cows involving HF, Jersey and Red

Dane with Sahiwal, Hariana and Red Sindhi to be non-significant which is similar to the findings of this study in co-operative sector.

4.8.1.2 Herd Size

The least squares analysis of variance revealed significant ($P<0.05$) effect of herd size on calving interval (table-4.15) in co-operative sector only. The contribution of herd size to the total variation was reckoned to be 37.72 percent in co-operative sector and 8.63 percent in non-cooperative sector. The least squares means of calving interval were found to be ranging from 392.30 ± 5.58 days in the cows in herd of size 9 & above animals to 413.33 ± 6.94 days in those in group of 3-5 animals in co-operative sector (Table-4.16). The DMRT revealed significant ($P<0.05$) difference between the C.I. of the cows in group of 3-5 and 9 & above animals. The average inter-calving period was found to be intermediate (399.86 ± 6.43days) in the herd of 6-8 animals which did not differ significantly from the estimates for the herds of 3-5 and 9 & above animals. In non-cooperative sector the average longest (400.14 ± 4.76days) and shortest (391.81 ± 3.02days) inter-calving periods were found for the herds of 6-8 and 9 & above animals respectively. Priya Raj (2002), Kumar[1] (2004) and Kumar (2005) reported non-significant effect of herd size on calving interval in Desi and crossbred cows. But Kumar (2005) observed that cows maintained in the herd size of 3-6 animals had lower calving interval, which is similar to the findings of the present study in non-cooperative sector.

4.8.1.3 Season of Calving

The effect of season of calving on calving interval was not significant in the cows of co-operative and non-cooperative sectors, but it was highly significant (P<0.01) in the cows kept in organized sector (Table-4.15). The magnitudes of variation in C.I. contributed by season of calving to the total variation were estimated to be 11.43, 8.27 and 32.45 percent in co-operative, non-cooperative and organized sectors respectively.

The least squares means of calving interval in different seasons under organized and unorganized sectors have been presented in Table-4.16. It revealed that in organized sector the cows calved during cold-comfort season had the lowest inter calving period which was significantly (P<0.05) lower by 67.06 and 72.55 days than the spring and summer calvers respectively but did not differ significantly from hot-humid calvers. However, the cow calved during spring did not differ significantly from summer calvers. In unorganized co-operative and non-cooperative sectors also the cow calved during cold-comfort season but did not differ significantly from the hot-humid calvers. Jadhav et al. (1992), Jadhav and Rathi (1992), Singh et al. (2000) and Priya Raj (2002) also found the effect of season of calving on CI to be non-significant which was similar to the findings of the present study in co-operative and non-cooperative sectors.

4.8.1.4 Parity

The least squares analysis of variance indicated highly significant (P<0.01) effect of parity of lactation on calving interval in non-cooperative and organized sectors but did not influence it significantly in co-operative sector (Table-4.15). The amount of variations contributed by parity to the total variation in CI were reckoned to be 8.55, 28.45 and 38.29 percent in co-operative, non-cooperative and organized sectors respectively.

DMRT revealed that in non-cooperative sector the inter-calving period increased gradually with the increase in order of lactation. The calving interval observed in 1st parity was significantly (P<0.05) lower than those in 3rd and 4th parity but did not differ significantly from 2nd parity. However, in co-operative sector no definite trend could be established. No definite trend could also be observed in organized sector. However, the longest calving interval observed in 1st parity was significantly (P<0.01) longer than those in 2nd, 3rd and 5th parities. Significant effects of parity of lactation on CI reported by Yadav et al. (1992), Yadava and Rathi (1992), Singh et al. (2000), Priya Raj (2002), Kumar[1] (2004), Kumar (2005) and Kumar (2006) were in close agreement with the findings of the present study in non-cooperative and organized sectors. Further, Priya Raj (2002), Kumar[1] (2004) and Kumar (2005) also recorded this effect to be significant on C.I. but without any definite trend as recorded in the present investigation.

4.9 LIFE TIME MILK PRODUCTION

The life time milk production is an important indicator of total economic worth of milk producing animals. The life time milk production ($LTMP_3$) was estimated from the records of organized farm only (RAU Cattle Farm, Pusa) considering first three lactations. The overall populations mean of life time milk production pooled over all the three genetic groups viz. Desi and its crosses with Friesian and Jersey in organized sector was estimated to be 4778.04 ± 118.48 kg.

4.9.1 FACTORS AFFECTING LIFE TIME MILK PRODUCTION

4.9.1.1 Genetic Group

The least squares analysis of variance revealed highly significant (P<0.01) effect of genetic constitution of cow on $LTMP_3$ in organized sector (Table-4.17). Its contribution to the total variation therein being 97.39 percent.

Table - 4.17 : Least squares analysis of variance for the effect of genetic and non-genetic factors on Life time milk production ($LTMP_3$) in organized sector at Pusa.

Source of Variation	Organised Sector			
	DF	MSS	F	R^2 (%)
Genetic Group	2	3252260.0	91.6301**	97.39
Season of calving	3	51060.0	1.4386	1.53
Parity	4	701.0	0.0198	0.02
Error	442	35493.0		1.06

*** = P<0.05, ** = P<0.01**

Table – 4.18 Least squares mean $\pm$ S.E. of Life time milk production ($LTMP_3$) of cows managed in organised sector in and around Pusa.

Particulars	$LTMP_3$ (Kg)
Population Mean	4778.04±118.48
Genetic Group	
Desi	$3008.99^a \pm 292.71$
Friesian x B	$4703.19^b \pm 145.21$
Jersey x B	$6621.94^c \pm 126.98$
Season of calving	
Hot & Humid/Rainy	4477.97 ±212.21
Cold & Comf./ Winter	4755.39±184.71
Spring	4827.23±178.68
Summer	5051.58±210.96
Parity	
1st	4765.32±199.77
2nd	4818.53±198.10
3rd	4795.89±197.84
4th	4759.89±236.44
5th	4750.57 ±251.54

Values with different superscripts (column wise) differed significantly (P<0.05) from each other.

It indicated that genetic constitution is the major factor which influence this trait.

As evident from table-4.18, the highest (6621.94 ± 128.98kg) and lowest (3008.99 ± 292.71kg) life time milk productions were found in Jersey cross and Desi cows respectively. The DMRT also indicated that Jersey crosses had significantly ($P<0.05$) higher $LTMP_3$ than the Desi and Friesian crosses by 3612.95 and 1918.75 kg respectively and Friesian crosses had significantly ($P<0.05$) higher $LTMP_3$ than the Desi by 1694.20kg. It was also recorded that Jersey crossbreds produced more than double (220.07%) milk in her life time than the Desi indicating that Jersey crosses are more suitable, adaptable and profitable in the agro-climatic condition of Pusa in comparison to the animals of other genetic groups.

4.9.1.2 Season of Calving

Season of calving did not influence the life time milk production and contribution of variation due to season of calving to the total variation was only 1.53 percent (Table-4.17). The least squares means ranged from 4477.97 ±212.00 kg in hot-humid season to 5051.58 ±210.96 kg in summer which did not differ significantly from each other (Table-4.18).

4.9.1.3 Parity of Calving

The least squares analysis of variance revealed non-significant effect of parity on life time milk production and variation due to this factor was almost negligible (Table-4.17). Parity contributed only 0.02 percent to the total variation in $LTMP_3$ indicating that influence of parity to the life time milk production is not accountable. The least squares means (Table-4.18) ranged from 4750.57 ± 251.54 kg in 5^{th} lactation to 4818.53 ± 198.10kg in

2nd lactation but did not differ significantly. However, a definite trend was observed that life time milk production increased from 1st to 2nd order of lactation and then gradually declined till 5th lactation.

4.10 COST OF MILK PRODUCTION

To estimate the gross cost per kg of milk produced by the animals of different genetic groups in co-operative and non-cooperative sectors of private diary units in and around Pusa, the data on different cost components were recorded, compiled and subjected to least squares analysis of variance (Harvey –1966) to quantify the effect of genetic and various non-genetic factors on the cost of milk production.

The overall estimates of population mean for the net cost per kg of milk production pooled over all the three genetic groups viz. Desi and its crosses with Friesian and Jersey were calculated to be 959.07 ± 8.10 and 1110.90 ± 20.26 Paise in co-operative and non-cooperative sectors respectively (Table - 4.19 & 4.20). It would not be desirable to compare the estimates of net cost of milk production, obtained in the present study, with the corresponding estimates reported by other workers in different parts of the country because of the following reasons :

(i) The reports reviewed and referred pertained to the studies made in different agro-ecological regions of the country and were not cotemporary to the study.

(ii) Variable degrees of sampling errors associated with different reports due to variable sample size in different studies.

(iii) Variable managemental practices in different dairy units and different feeds and fodders in different ecological regions.

Table – 4.19 : Average of different cost components and their relative contribution to the gross cost of milk production in animals of different genetic groups of unorganized cooperative sector in and around Pusa (Samastipur).

Cost item	Mean ± SE (Paise per kg of milk)			
	Desi cow	HF crossbred	Jersey Crossbred	Overall
Feed Cost	734.14 ± 6.20 (66.24)	517.46 ± 4.87 (63.20)	600.10 ± 5.21 (65.15)	640.24 ± 5.67 (64.68)
Labour Cost	160.70 ± 3.21 (14.50)	119.21 ± 3.10 (14.56)	134.02 ± 2.82 (14.55)	143.33 ± 0.40 (14.48)
Depreciation	45.55 ± 0.32 (4.11)	50.10 ± 0.50 (6.12)	48.08 ± 0.71 (5.22)	51.27 ± 0.42 (5.18)
Veterinary and A.I. cost	23.05 ± 6.32 (2.08)	27.67 ± 0.44 (3.38)	29.10 ± 0.43 (3.16)	28.90 ± 0.32 (2.92)
Interest on fixed capital	113.93 + 2.30 (10.28)	79.01 ± 2.77 (9.65)	84.19 ± 3.02 (9.14)	97.90 ± 4.02 (9.89)
Miscellaneous cost	30.92 ± 1.12 (2.79)	25.30 ± 1.21 (3.09)	2.56 ± 2.25 (2.78)	28.21 ± 1.31 (2.85)
Gross Cost of production(A)	1108.31 ± 1.73 (100.00)	818.77 ± 1.93 (100.00)	921.11 ± 1.52 (100.00)	989.86 ± 1.77 (100.00)
Income from dung (B)	29.98 ±0.98 (2.78)	28.15 ±0.86 (3.56)	28.92 ±0.80 (3.24)	30.79 ±0.73 (3.21)
Net cost of milk production (A-B)	1078.33 ± 12.78	790.62 ± 17.13	892.69 ± 12.03	959.07 ± 8.10

Figure in parentheses indicate percentage of respective cost components.

Table – 4.20 : Average of different cost components and their relative contribution to the gross cost of milk production in animals of different genetic groups of unorganized non-cooperative sector in and around Pusa (Samastipur).

Cost item	Mean ± SE (Paise per kg of milk)			
	Desi cow	H F crossbred	Jersey Crossbred	Overall
Feed Cost	872.63 ± 7.21 (66.12)	720.40 ± 5.02 (65.45)	684.12 ± 5.87 (66.78)	758.39 ± 6.22 (65.82)
Labour Cost	191.10 ± 4.21 (14.48)	163.56 ± 4.22 (14.86)	151.10 ± 3.87 (14.75)	163.84 ± 1.40 (14.22)
Depreciation	56.48 ± 1.35 (4.28)	55.91 ± 1.25 (5.08)	50.81 ± 1.27 (4.96)	67.57 ± 1.89 (5.86)
Veterinary and A.I. cost	29.30±7.50 (2.22)	42.49 ± 1.25 (3.86)	30.32 ± 1.44 (2.96)	36.18 ± 1.32 (3.14)
Interest on fixed capital	134.88 ± 3.45 (10.22)	108.08 ± 3.87 (9.82)	96.81 ± 4.02 (9.45)	109.23 ± 5.57 (9.48)
Miscellaneous cost	35.37 ± 3.20 (2.68)	10.24 ± 2.25 (0.93)	11.27 ± 3.57 (1.10)	17.05 ± 3.25 (1.48)
Gross Cost of production(A)	1319.77 ± 3.73 (100.00)	1100.69±4.23 (100.00)	1024.45 ± 3.57 (100.00)	1152.23 ± 2.87 (100.00)
Income from dung (B)	35.95 ±1.48 (2.80)	42.13 ±1.92 (3.98)	34.36 ±1.80 (3.47)	41.32 ±1.04 (3.72)
Net cost of milk production (A-B)	1283.82 ± 35.25	1058.56 ± 28.67	990.69 ± 30.02	1110.90 ± 2036

Figure in parentheses indicate percentage of respective cost components.

(iv) Periodical change in degree of demand of milk from place to place influencing price of milk, and

(v) Variation in the genetic constitution of the animals included in different studies.

4.10.1 CONTRIBUTION OF DIFFERENT COST COMPONENTS TO THE COST OF MILK PRODUCTION :

4.10.1.1 Unorganized Co-operative Sector

The relative contribution of the different cost components to the gross cost of milk production for Desi and their crosses with HF and Jersey under co-operative sector in and around Pusa have been presented in Table-4.19. The estimate of overall gross cost per kg milk production was estimated to be 989.86±1.77 paise. The highest and lowest gross cost per kg of milk production were calculated to be 1108.31±1.73 and 818.77±1.93 paise in Desi and HF crossbred cows respectively. The estimates of income from cow dung were found to be 29.98, 28.15 and 28.92 paise in Desi, HF crossbred and Jersey crossbred cows respectively. After deducting the income from cow dung from the gross cost for the respective genetic groups, the estimates of per kg of milk production were observed to be 1078.33±12.78, 790±17.13 and 892.69±12.03 paise in Desi, HF crossbred and Jersey crossbred cows respectively. Feed alone contributed the maximum towards the gross cost of milk production followed by Labour cost, Interest on fixed capital, Depreciation on housing and utensils, Veterinary aids and A.I. and the lowest by the expenditure on miscellaneous items. The overall relative contributions of different cost components such as Feed, Labour, Interest on fixed capital, Depreciation on housing and Utensils, Veterinary aids and A.I. and miscellaneous items were observed to be 64.68, 14.48, 9.89, 5.18, 2.98 and 2.85 percentage respectively. The similar trend was also observed in Desi, HF crossbreds and Jersey crossbreds. The relative contribution to the gross cost of milk production in three genetic groups was observed to be ranging from 63.20 to 66.24 percent by the feed, 14.50 to 14.56 percent in labour cost, 4.11 to 6.12 percent in depreciation charges, 2.08 to 3.38 percent towards Veterinary aids and A.I. 9.14 to 10.28 percent for the interest on fixed capital and 2.78 to 3.09 percent due to expenditure by the miscellaneous items.

4.10.1.2 Unorganized Co-operative Sector

The relative contribution of different cost components to the gross cost of milk production under unorganized non-cooperative sector in and around Pusa, Samastipur has been presented in table-4.20. It revealed that overall gross cost per kg of milk production was estimated to be 1152.52±2.87 paise. The estimates of cost per kg of milk production for Desi was found to be 1319.77 paise which was more by 219.08 and 295.32 paise than the cost of milk produced by HF crossbred and Jersey crossbred cows respectively. It also observed that feed alone was the major cost component followed by Labour cost, Interest on fixed capital, Depreciation charges, Cost of Veterinary aids and A.I. and the expenditure on the miscellaneous items. The overall estimates of relative contribution of different cost components such as Feed, Labour cost, Depreciation charges, cost on Veterinary aids and A.I., Interest on fixed capital and the expenditure on miscellaneous items to the gross cost of milk production were reckoned to be 65.82, 14.22, 5.86, 3.14, 9.48 and 1.48 percent respectively and the corresponding ranges were 65.45 to 66.78, 14.48 to 14.86, 4.28 to 5.08, 2.22 to 3.86, 9.45 to 10.22 and 0.93 to 2.68 percentages. The overall income from cow dung was calculated to be 41.32

Table - 4.21 : Least squares analysis of variance for the effect of genetic and non-genetic factors on cost of milk production in co-operative and non-cooperative sectors in and around Pusa.

Source of Variation	Unorganised Cooperative Sector				Unorganised Non-Cooperative Sector			
	DF	MSS	F	R^2 (%)	DF	MSS	F	R^2 (%)
Genetic Group	2	665418.10	52.5920**	88.59	2	778304.00	3.157*	4.07
Herd size	2	10395.23	0.8216	1.38	2	16755.27	0.6797	8.76
Season of calving	1	32317.10	2.5542	4.30	1	32624.83	1.3234	17.07
Parity	3	30318.46	2.3963	4.04	3	109289.90	4.4333**	57.18
Error	253	12652.46		1.68	129	24652.11		12.90

* = P<0.05, ** = P<0.01

Table – 4.22 : Least squares mean ± S.E. of cost of milk production of cows managed in Private sector under unorganized co-operative and non-cooperative sectors in and around Pusa.

Particulars	Unorganised Co-operative Sector	Unorganised Non-cooperative Sector
Population Mean	959.07±8.10	1110.90±20.26
Genetic Group		
Desi	1078.33^{a} ±12.78	1283.82^{a} ±35.25
Friesian x B	790.62^{b} ±17.13	1058^{b} ±28.67
Jersey x B	892.69^{b} ±12.03	990.09^{b} ±30.02
Herd size		
3-5	955.56±14.20	1396.05±19.04
6-8	971.49±13.15	1245.97±30.01
9-above	950.17±11.42	1194.26 ± 53.01
Season of calving		
Hot - Humid	945.81±11.85	952.50±24.60
Cold - Comfort	972.33±11.34	1271.68±24.50
Parity		
1^{st}	926.87 ±13.19	722.06^{a} ±28.64
2^{nd}	967.35 ±12.67	874.59^{b} ±28.50
3^{rd}	966.15 ±14.74	947.84^{b} ±33.01
4^{th}	975.91 ±20.89	903.89^{b} ±39.52

Values with different superscripts (column wise) differed significantly (P<0.05) from each other.

paise and the estimates of income from cow dung of Desi, HF crossbred and Jersey crossbred cows were 39.95, 42.13 and 34.36 paise respectively. After reducing the income due to cow dung, the overall net cost per kg of milk production was estimated to be 1110.90±20.36 paise. For Desi, HF crossbred and Jersey crossbred cows the corresponding estimates were 1283.82±35.25, 1058.560±28.67 and 990.69±30.02 paise respectively.

4.10.2 FACTORS AFFECTING NET COST OF MILK PRODUCTION

4.10.2.1 Genetic group

The least squares analysis of variance revealed that the genetic constitution had highly significant (P<0.01) effect on cost of milk production in co-operative sector but did not show its influence in non-cooperative sector (Table-4.21). The contribution of genetic group to the total variation was calculated to be 88.59 and 4.07 percent in co-operative and non-cooperative sectors respectively.

The estimates of least squares means of the cost of per kg of milk produced by the cows of different genetic groups ranged from 790.62 ± 17.13 to 1078.33 ± 12.78 paise in co-operative sector and 990.09 ± 30.02 to 1283.82 ± 35.25 paise in non-cooperative sector (Table-4.22). In co-operative sector the cost of per kg of milk produced by the Friesian crosses was found to be the lowest (790.62 ± 17.13 paise) which was significantly (P<0.05) lower by 287.71 paise than the Desi but did not differ significantly from the cost of production in Jersey crosses. However, in non-cooperative sector though the cost of milk production was found to be the lowest in Jersey crosses but it did not differ significantly from those in Friesian cross and Desi. Non-significant in cost of milk production between HF crossbred and Desi cows in non-cooperative sector may be due to the only reason that investment on milch animals was done according to production. Besides that even HF crossbred cows might not be provided with environment proper to express its producing potency. The results obtained in the present study were in well agreement with the findings of Priya Raj (2002) who observed the net cost/ kg. of milk production of HF crossbreds to be significantly lower than Jersey crossbred cows under farmers' management system. Kumar[1] (2004) also reported the lowest net cost/kg of milk production in HF crossbreds. In non-cooperative sector though the cost per kg of milk production was higher than the co-operative sector yet the relative efficiency was similar. The cost per kg of milk production was estimated to be the lowest in HF crossbreds (Rs 10.59±2.86) followed by Jersey crossbred (Rs. 9.90±3.01) and Desi (Rs. 12.84±3.52). Kumar (2005) found the lowest average net cost/kg of milk production in HF crossbred followed by Jersey crossbred and Desi cows. The trend obtained in the present study is in close agreement with the results obtained by the above mentioned authors.

4.10.2.2 Herd Size

The effect of herd size on the cost of milk production in both co-operative and non-cooperative sectors was not significant (Table-4.21). The magnitudes of contribution of herd size to the total variation in cost of milk production were 1.38 and 8.76 percent in co-operative and non-cooperative sectors respectively. The least squares means along with their SE of cost of milk production (Table-4.22) revealed that the cost of milk production was found to be independent to the herd size and it ranged from 950.17 ± 11.42 paise in the herd of 9 & above animals to 971.49 ± 13.15paise in the herd of 6-8 animals in co-operative sector. However, no definite trend could also be established in non-cooperative sector but the average estimates of net cost per kg of milk produced in the different herds were much higher than in co-operative sector, the estimates ranging between 1194.26 ± 53.01 and 1396.05 ± 19.04 paise. The relatively lower cost of milk production observed in co-operative sector might be due to better feeding, disease control and input as well as expertise support from the milk unions. Priya Raj (2002), Kumar (2005) and Kumar (2006) observed that the cows maintained in the herd size of 7 & above had significantly ($P<0.05$) lower net cost/kg milk production. Kumar[1] (2004) also observed the herd size of 11-14 to be optimum for relative cheaper milk production.

4.10.2.3 Season of Calving

The season of calving had no significant influence on cost of milk production in both co-operative and non-cooperative sectors and the amount of variation contributed by this factor to the total variation were reckoned to be 4.30 percent in co-operative sector and 17.07 percent in non-cooperative sector (Table-4.21). The least squares means (Table-4.22) revealed that the cost of milk production was lower in the cows calved in hot-humid season than the milk produced by the cows calved during cold-comfort season in both the sectors but the mean values did not differ significantly. Singh (1984) and Kuamr[1] (2004) reported significant effect of season of calving on net cost/kg of milk production. Availability of more green fodders during rainy season might be responsible for lower net cost/kg of milk production. Priya Raj (2002) in HF crossbreds and Jersey crossbred cows and Kumar (2005) in Desi, HF crossbreds and Jersey crossbred cows reported non-significant effect of season of calving on net cost/kg of milk production which is similar to the findings in the present study.

4.10.2.4 Parity

The analysis of variance revealed that the order of lactation had highly significant ($P<0.01$) effect on cost of milk production in non-cooperative sector but did not show its influence on this trait in co-operative sector (Table-4.21). The estimates of variation contributed by the parity to the total variation in cost were reckoned to be 4.04 and 57.18 percent in co-operative and non-cooperative sectors respectively.

Parity wise the estimates of least squares means of cost of milk production have been presented in table-4.22. The cost of milk production was the lowest (722.06 $\pm$28.64 paise per kg) in 1^{st} parity under non-cooperative sector and then increased significantly ($P<0.05$) with the increase in order of lactation. However, the mean values of the cost of milk production in 2^{nd}, 3^{rd} and 4^{th} lactation did not differ significantly from each other. In co-operative sector the cost of milk production per kg of milk was found to be ranging from 926.87 paise in 1^{st} parity to 975.91 $\pm$ 13.19 paise in 4^{th} parity but did not differ significantly. The non-significant difference in cost of milk production under co-operative sector might be due to better and uniform management under farmer's management condition due to support of the milk unions. Priya Raj (2002), Kumar[1] (2004) and Kumar (2005) reported significant effect of lactation order on the net cost/kg of milk production which was similar to the findings in the present study under non-cooperative sector.

SUMMARY AND CONCLUSION

5. SUMMARY AND CONCLUSION

5.1 SUMMARY :

The present investigation was conducted for genetic studies on milk production efficiency of various crossbreds cattle both in organized and unorganized sectors in and around Pusa in terms of estimation of Phenotypic parameters of some economic traits including cost of milk production. The magnitudes of variation in milk production efficiency traits due to genetic and some non-genetic factors were also determined. Finally a suitable package of practices was suggested for economic milk production in the study area.

The study was conducted both in organized and unorganised farms. The RAU Cattle Farm, Pusa constituted the organized farm whereas the private dairy units popularly known as "Khatals" were classified into unorganized co-operative and unorganized non-cooperative sectors located in a radius of 10 km in and Pusa (Samastipur), Bihar.

The study was conducted on 262 cows from co-operative sector and 138 cows from non-cooperative sector consisting of Desi and its crosses with HF and Jersey. Accordingly data were recorded on 400 animals for relevant characters from private dairy units. 452 lactation records of the cows in organised sector were also included in this study. The data collected from the private dairy units were classified on the basis of Herd-size, genetic group of the animal, their season of calving and lactation order. Whereas, the data on animals from the organised herd where classified on the basis of genetic group, season of calving and lactation order of the animals. The khatals were of three sizes i.e. having 3-5, 6-8 and 9 & above milch animals. The year was divided into four seasons namely hot-humid (Rainy), cold-comfort (Winter), Spring and Summer. However, only two seasons namely hot-humid (rainy) and cold-comfort (winter) were considered in case of organized farm. The performance data were recorded upto 4th lactation in private dairy units and 5th lactation in organized herds.

Lactation length (LL), Lactation milk yield (LMY), Peak yield (PY), Days to attain peak yield (DAPY), Milk yield per day of lactation length (MY/LL) and Milk yield per day of calving interval (MY/CI) were taken as the measures of milk production efficiency to the animals of both organised and unorganized sectors. In addition life time milk production ($LTMP_3$) based on 3 lactations was also taken as one of the milk production efficiency traits in organized farms. Cost of milk production was taken as a measure of economic efficiency for the animals of private dairy units only.

The data were subjected to least squares analysis of variance procedure utilizing appropriate mathematical model and DMRT was utilized for pair-wise comparison of the least squares means.

5.1.1 Production traits :

The genetic group was found to have significant (P<01.05) effect all the milk production traits except days to attain peak milk yield in organized sector and non-cooperative units under unorganized sector. In general, Jersey crossbred had significantly (P<0.05) higher lactation milk yield, peak milk yield and longer lactation length than Desi and Friesian crosses both in organized and unorganized non-cooperative sectors whereas Friesian crossbreds had significantly (P<0.05) higher lactation milk yield in co-operative sector.

Herd-size had significant (P<0.05) influence on lactation milk yield, peak milk yield and days to attain peak milk yield in co-operative sector whereas it has significant (P<0.05) influence on lactation length in non-cooperative sector.

A Herd of 6-8 animals was found to have highest lactation milk yield & peak milk yield and lowest days to attain peak milk yield which was significantly higher than the herds of sizes of 3-5 and 9 & above animals.

Season of calving had significant (P<0.05) influence on lactation milk yield, lactation length & peak milk yield in organized sector and on lactation length and peak milk yield in unorganized non-cooperative sector only. Spring calvers had significantly (P<0.05) higher lactation yield, lactation length & peak milk yield than the rainy calvers but did not differ significantly from winter & summer calvers.

Parity had significant (P<0.05) influence on lactation milk yield in both organized & unorganized sectors where as the lactation length was significantly (P<0.01) influenced by the parity in organized sector & co-operative under unorganized co-operative sector. Peak yield and Days to attain peak yield were significantly influenced by parity in unorganized non-cooperative and organized sectors respectively. The highest lactation yield is recorded to be in 1st parity under organized sector which declined gradually with the increase in order of lactation. Under unorganised sector, the lactation milk yield increased with the increase in order of lactation. The highest lactation milk yield was recorded in 3rd and 4th lactations in co-operative and non-cooperative sectors respectively.

5.1.2 Production efficiency traits :

All the milk production efficiency traits were found to be significantly (P<0.05) influence by the genetic group in both organized and unorganized sectors.

The Jersey crossbred had significantly (P<0.05) higher milk yield per day of lactation length (MY/LL) and milk yield per day of C.I. (MY/CI) and life time milk production as compared to Desi and Friesian crosses under organized sector.

The Jersey crossbred though found to have the highest MY/LL and MY/CI both in unorganized co-operative and non-cooperative sectors but did not differ significantly from the Friesian crossbreds.

Herd-size had significant (P<0.05) effect on MY/CI in co-operative sector. The herd of 6-9 animals had significantly (P<0.05) higher milk yield per day of C.I. than the herd of 3-5 and 9- above animals.

The parity significantly (P<0.05) influenced the milk yield per day of lactation length (MY/LL) and milk yield per day of calving interval (MY/CI) in both organized and unorganized sectors except in co-operative unorganized sector. The 1st parity had the highest milk yield per day of lactation length & milk yield per day of C.I. under organized sector whereas the corresponding values were higher in unorganized non-cooperative sector.

5.1.3 Reproduction traits :

The genetic group was found to have significant (P<0.05) effect on Dry periods and Calving interval (CI) in unorganized and organized sectors respectively.

Among the crossbreds the Friesian crosses had the shortest C.I. both in organized sector and unorganized co-operative sector.

Herd size had significant influence on Dry period and C.I. only in cooperative dairy units under unorganized sector. The herds of 6-8 animals and 9 and above groups had the shorter dry period and C.I. as compared to the herd of 3-5 animals.

Season-effect contributed significantly to the variation in dry period & C.I. in organized sector but it had significant influence on only dry period in unorganized non-cooperative sector. The shortest Dry period and C.I. were observed in winter calvers in organized sector.

The parity had significant (P<0.05) effect on dry period and C.I. in organized sector whereas it was significant effect only on C.I. in unorganized non-cooperative. The C.I. decreased gradually with the increase in order of lactation under organized sector whereas it was reversed in non-cooperative organization under unorganized sector. However, no definite trend could be observed for Dry period.

The life time milk production ($LTMP_3$) was found to be significantly ($P<0.01$) influenced by the genetic group and Jersey crossbred cows had significantly ($P<0.01$) higher $LTMP_3$ than HF x_B and Desi. The HF x_B had significantly ($P<0.01$) higher $LTMP_3$ than the Desi cows.

The relative contribution of different cost components to the gross cost of milk production revealed that feed cost alone contributed the highest to the gross cost of milk production which comes to about two-third (about 65%) followed by labour charges, interest on fixed capital, depreciation charges, Veterinary aid and AI cost and expenditure on miscellaneous items.

The overall estimates of net cost of each kg of milk production ranged between Rs. 9.59 and Rs. 11.11 in co-operative and non-cooperative sectors respectively.

The net cost of milk production was significantly ($P<0.05$) influenced by the genetic group both in co-operative and non-cooperative sectors and crossbreds had significantly ($P<0.05$) lower net cost of milk production. Among the crossbreds HF crossbred and Jersey crossbred had the lower net cost of milk production in co-operative and non-cooperative sectors respectively.

5.2 CONCLUSION :

On the basis of findings of this study it could be concluded that the Jersey & HF crossbreds cows in 1st - 3rd lactations, managed in group of 6 - 8 animals and registered to milk co-operatives would be the best proposition for economical milk production in and around Pusa (Samastipur).

BIBLIOGRAPHY

BIBLIOGRAPHY

Ahir, N.J. and Singh, P.K. (1994). Production and marketing decisions of milk producers of heavy rainfall zone of Gujrat. Indian J.dairy Sc.47 (8): 658-662.

Akhter, F; Roy, T.C. and Das, B. (2003). Studies on some production and reproductive traits in Holstein – Friesian cattle, Indian Vet, J. 80: 453 – 454.

Akhter, J.Singh, H; Kumar, D. and Sharma, K. (2003). Factors affecting economic traits in crossbred cattle. Indian J. Anim. Sci 73 (4): 464 – 465.

Ayub (2005). M.V.Sc. Thesis entitled "Genetic studies on efficiency of milk production of cattle in and around Muzaffarpur (Bihar)" submitted to RAU, Pusa, Samastipur (Bihar).

Badal, P.S. and Dhaka, J.P. (1998). An analysis of feeding pattern and cost of milk production in Gopalganj district in Bihar. Indian J.Dairy Sc.51 (2): 121-126.

Bardhan, D.; SrivastavaR.S.L. and Dabas, Y.P.S. (2004).An economic analysis of milk production from indigenous cow in Udham singh Nagar district of Uttranchal.: Indian Dairyman. 56 (30).: 31-38.

Baruah, D.K.; Sarkar, A.B. and Bora, N.N.(1996).A study on milk production in Assam. Indian J.Dairy Sc49 (1): 17-23.

Becerril Parvez, C.M.; Roman ponce, H.and Castilo Rajas, H. (1981). Performance of H.F and B.S cows and their F1 crosses with Zebu in a tropical Climate. Tecnica Pecuria in Mexico (1981) No.40, pp.16-24. Cited from Anim.Breed. Abstr. (1983), 51:79.

Bhadauria, S.S. and Katpatal, B.G. (2003). Effect of genetic and non – genetic factors on 300 days of milk yield of first lactation in Friesian x Sahiwal corsses, Indian Vet, J. 80:1251 – 1254.

Bhaskar, B.V.; Reddy, A.O.and Rao, M.K. (1994). Constraints in the performance of crossbred cattle some field experiences. Indian Dairyman.46 (9): 416-419.

Bhattacharya, T.K.; Das, K.S. and Joshi, J.D. (1999). Lactation wise comparision of dairy performance in Hriana cattle. . Indian J. Anim Prod. Mgmt. 15 (3) : 118 – 119.

Bhattacharya, T.K.; Patil, V.K; Joshi, J.D; mahapatra, A.S. and Badola, S. (2002). Dairy performance of tharparkar, Holstein – Friesian and their crosses. Indian J. Anim. Sci 72 (2) : 154 – 156.

Bhoite, H.S. and Shinde, S.B. (1987). A Constraints analysis is relation to different components of dairy animal management practices. Indian J. Anim. Prod.&management.3 (4): 166-170.

Chandra, A.and Agarwal, S.B. (2000). Cost and return from milk production in farrukhabad district of U.P.. Indian J.Dairy Sc 53 (4): 310-316.

Chaudhary, A.L.; Mehra, S.C.and Sri Ram (1997). Factors affecting service period and dry period of Friesian x Sahiwal crosses. Indian J. Dairy Sc. 30: 274-278.

Chaudhary, K.B.;Deshmukh, D.P. and Deshpandey, K.S.(1995). Genetic studies on reproductive traits in Jersey, sahiwal and Jersey x Sahiwal crossbreds. Indian J. Dairy Sc. 48 (2) P:172-173.

Chauhan, R.S.; Mishra, R.R. and Bhatnagar, D.S. (1974). Peak yield in Brown-Swiss cows. Indian J.Dairy Sc. 30: 274-278.

Chopra, S.C. (1990). S.C. (1990). Comparative performance of half breds of Holstein – Friesian, Brown Swiss and Jersey with Hariana in semi – aride tropics.Indian. J. Anim. Sci. 60 (1) : 93 – 96.

Dalal, D.S; Rathi, S.S. and Raheja, K.L. (2002). Estimates of genetic and phenotypic parameters for first lactation and lifetime performance in Hariana cattle.. Indian J. Anim 72 (5) : 398 – 401.

Deshmukh, D.P.; Chaudhary, K.B. and Deshpande, K.S. (1995). Genetic Studies on some economic traits of jersey, Sahiwal and Jarsey x Sahiwal crossbred cows. Indian J. Dairy sc. 48 (2): 129-133.

Dev Raj and Gupta, J.N. (1994). An economic analysis of milk production in Churu district in Rajasthan. *Indian J. Dairy Sc.* 47(4) : 294-301.

Dhirendra Kumar (2004). Influence of genetic and non-genetic factors on some economic traits in Hariana and its crosses. M.V.Sc. Thesis submitted to Rajendra Agricultural University, Pusa (Bihar).

Duc, V.N. and Taneja, V.K. (1994). Comparative performance of pure bred and crossbreds grades in Indian. J. Anim. Sci. 54 (11) : 1023 – 1028.

Dutt,T.and Bhushan, B. (2001). Peak yield and its association with production and reproduction traits in crossbred. Indian J.Anim. Sc 71 (9) : 872-873.

Garett, H.E. and Woodworth. R.S. (1969).statistics in psychology and Education, Bombay, Fenner and Simons Pvt.Ltd.,329.

Gill,G.S.(1985). Breeding crossbreds in rural area Livestock Advisor 10 (1): 3-4

Grover, D.K.; Sankhayan, P.L. and Mehta, S.K. (1992). An economic analysis of milk production in Bhatinda district of Punjab. Indian J. Dairy Sc. 45 (8): 409-415.

Gupta. K.K. and De, D. (1889). A comparative study on constraints perceived by adopters and non-adopters in rearing crossbred cows in Jaipur district in Rajastan. Indian J. Dairy Sc. 42 (3): 456-463.

Harvey, W.R.(1966). Least Square Analysis of data with unequal sub-class numbers. U.S. Deptt. of Agriculture, A.R.S.

Hayatnagarkar, D.D; Yeotikar, S.S.; Deshpande, K.S. and Auradkar, S.K. (1990). Non – genetic and genetic factors affecting some production traits in rural crossbred cows. Indian J. Dairy Sci., 43 (4) : 515 – 520.

Hemalatha, b.: Prasanth, Y.V.R. (2003). Economics of milk production of different breeds of bovines in Ahmednagar district of Maharastra. Indian Dairyman. 55 (10):41-44.

India (2005), A reference Annual, Publication division, Ministry of Information and Broadcasting, Government of India, pg. 81.

Indian Dairy – Perspective 2010 (2004). Paper presented at state lever seminar on meeting challenges in dairy development through credit (NABARD) held on 27th Feb. 2004 at Patna Dairy Project. Phulwarisharif.: 118-120.

Jadhav, K.L; Tripathi, V.N.; Taneja, V.K. and Kale, M.M. (1991). Performance of various Holstein x Sahiwal grades for first lactation reproduction traits. Indian J. Dairy Sci., 44 (3) : 209 – 216.

Jahagir, A.; Akteruzzaman, M.; Rahman, A. and Ahmad, Z. (1994). Comparative performance of local and crossbred cows in Bangladesh. Indian J. Dairy Sc. 47 (2): 112-117.

Kalra, K.K.; Singh, R. and Chauhan, A.K. (1994). Comarative economics of milk production in rural and urban areas of Haryana. Indian Dairyman. 46 (12): 751-756.

Kalra, K.K.; Singh, R. and Chauhan, A.K. (1995). Economics analysis of milk production and disposal in rural areas of Hariyana. Indian J. Dairy Sc. 48 (9): 546-550.

Kaul. G.L.; Kaushik, S.N. and Kathpal, B.G. (1997). Studies on peak yield and days to attain peak yield in crossbred cows. Indian J. Dairy Sc. 30: 151-153.

Khanna, R.S.; Bhat, P.N. and Raheja, K.L. (1980). Inheritance of relative efficiency of milk production and its relationship with life time production in Sahiwal and Its Crosses with Friesian. Indian J. Dairy Sci. 33: 332-335.

Kramer, C.Y. (1957). Extension of Multiple Range Test to Group correlated adjusted means. Biometrics.13: 13-17.

Kumar, (2005). Studies on genetic and non-genetic factors affecting milk production efficiency of cattle in and around Patna (Bihar). M.V.Sc. Thesis, RAU, Pusa (Bihar).

Kumar[1], (2004). Genetic analysis of milk production efficiency in cattle and buffalo in and around Dharbhanga, Bihar. M.V.Sc. thesis, R.A.U., Pusa (Bihar)

Kumar[2], (2004). Influence of genetic and non-genetic factors on some economic traits in Hariana and its crosses. M.V.Sc. Thesis, RAU, Pusa (Bihar).

Kumar, P. and Balishter (1996). Economics of crossbred and Murrah buffalo – A study in Firozabad district in U.P..Indian J. Dairy Sc. 49 (6): 371-375.

Kumar, P. and Gupta, J.N. (1992). Economics of buffalo milk production in Muzaffarnagar district (U.P) Indian Dairyman. 44 (2): 67-69.

Kumar, S. (2006). Genetic and non-genetic factors affecting efficiency of milk production in and around Biharsharif of Nalanda (Bihar). M.V.Sc. Thesis, RAU, Pusa (Bihar).

Kurlakar, S.V. and Raheja, K.L. (2000). Factors affecting first lactation and life time traits in Murrah buffaloes. Indian J. Dairy Sc. 53 (4): 273- 277.

Mishra, A.K. and Prasad, R.B. (1998). Comparison of selection indices and milk production function in selecting dairy cattle. Indian J. Dairy Sc. 51 (4): 221- 225.

Mishra, R.K and Pal, P.K. (2003). Prospects and constraints of dairying in rural Bengal: A case study Indian Dairyman. 55 (12) 55-60.

Nayak, S.K. and Raheja, K.L. (1996). Performance of half breds and three breed crosses of Hariana with exotic dairy breeds. Indian J. Anim. Sci. 66: 154.

Panda, B.P. and Sadhu, D.P. (1983). Some genetic and non – genetic factors affecting milk production in crossbreds of Holstein and Jersey with Hariana and Deshi Bengal cows. Indian Vet. J. anim. 60 : 99 – 106.

Pander, B.L. and Chopra, S.C. (1986). Factors affecting milk flow rate, average daily yield and first 100 days lactation yield in crossbred dairy cattle. *Indian J. Dairy.*, 39(2) : 133-136.

Parmar , O.. ; Dev, D.S. and Dhar , N.L. (1986) . Effect of interse mating among Holstein, Friesian x Hariana Crossbred cattle. Indian J.Dairy Schi. 19 (1) : 86-88

Patel, A.K. and Tripathi, V.N.(1994). Effect of certain non-genetic factors affecting production traits in Surti buffaloes. Indian J. Dairy Sc. 47 (12): 1038-1042.

Patel, J.M. and Trivedi, M.M. (1989). Production profile of Jersey X Kankrej F., half breds. Indian J. Anim. Sci. 59 (6) 733 – 735

Pramanik, A.K., Samanta, A.K., Pyne, A.K. and Samanta, M.K. (2000). Effect of breed, lactation order and season of calving on 300-days lactation yield and peak yield in crossbred cows in West Bengal. *Indian Vet. J.*, 77(12) : 1091-1092.

Priya Raj (2002) Studies on milk production and its economics in crossbred cows under farmer's manage mental Condition of Patna (Bihar).

Pundir. R.K. and Raheja , K.L. (1997). Genetic Parameters estimation for first lactation and life time traits in Sahiwal and Hariana using multitrait maximum livelihood. Indian J. Dairy Sci. 50 (5) : 359-366

Pyne, A.K., Maitra, D.N. Sinha, R., Duttagupta, R., Roy, S.R. and Roy, S.K. (1987). Studies on the effects of season of birth of the Jersey-Hariana and Holstein Friesian - Hariana halfbreds on their calving intervals in humid tropics. *Indian J.,* 64(10) : 858-861.

Raheja K.L. (1982) . Peak yield and its relationship with other economic traits in Hariana and its halfbreds with temperate breeds. Indian J. Dairy Sci. 35: 213- 215

Raheja, K.L. (1982). Note on days to attain peak yield in Haryana and its half-bred. Indian J. Anim . Sc .52 565-566.

Raheja, K.L. (1997). Factors affecting first lactation and lifetime production traits in Sahiwal and Hariana halfbreds. Indian J.Dairy Sci.; 50 (2): 152 – 155

Raheja, K.L. and Balaine, D.S. (1982). Peak yield and its relationship with other economic traits in Hariana pure breds and its crosses with some elite exotic breeds. Indian Vet. J.59 : 790 – 793

Raheja, K.L. and Bhat P.N. (1982). Notes on the comparative performance of three Zebu Breeds and their F1 crosses with Holstein-Friesian for certain economics traits. Indian J. Anim. Sc. 52: 333-335.

Raheja, K.L. and Bhat, P.N. (1982). Notes on the comparative performance of three Zebu breeds and their F_1 crosses with Holstein - Friesian for certain economic traits. *Indian J. Anim. Sc.,* 52 : 333-335.

Raj Kumar (1985) M.V.Sc. thesis entitled" studies on performance of crossbred cattle and inheritance of some traits connected with adaptations" submitted to Rajendra Agricultural University, Pusa , Samastipur, Bihar.

Rajendra, K. and Prabaharan, R. (1993).. Factor affecting the choice of milch animals and problems in the management of milch animals. Indian J. Dairy Sc. 46 (9): 406-409.

Raju, D.T.; Pochaiah, M. and Reddy, G.V.K. (1993). Factor affecting the choice of milch animals and problems in the management of milch animals. Indian J. Dairy Sc. 46 (9): 415-419.

Ram, K.; Sharma, A.K. and Rathore, A.R. (1993). Economic analysis of milk production on weaker section households in sugagcane tract of western U.P..Indian J. Dairy Sc . 46 (11) : 500-504.

Rao, B.D. and singh, C.B. (1995). (1995). Impact of O.F.P. on economic of the buffalo milk production in Guntur district, Andhra Pradesh. Indian Dairyman 7 (4) : 47-50.

Rao, S.J.; Rao, B.V.R. and Rao, G.N. (2000). Performance of crossbred cows and buffaloes under village condition of Visakhapattanam district of Andhara Pradesh. Indian J. Dairy Sc. 53 (3) 222-226.

Rathi, S.S. (1975). A study on growth , reproduction and production in haryana cattle and their crosses with exotic breeds. H.A.U. Thesis Abstract 1: 37-39.

Reddy, P.V.N.R. (1999). Problems and prospects of dairying in Prakasam district of A.P., M.V.Sc. thesis submitted to Acharya N.G. Ranga Agril. Univ., Hyderabad.

Reddy, V.V.; Rastogi,B.K. and Singh, B. (1972). Cost of milk production with crossbred. Indian J. Animal Sci.50: 74-76.

Reddy,Y.V.R.; Venkatraman, T.G. and Sampath, S.R.(1980). Note on the cost of milk production in dairy animals in and around Bangalore city. Indian J. Anim. Sc. 50:74-76.

Sangu, K.P.S. (1995). Comparative Economics of milk production for buffalo, desi cow and crossbred cow in village and town conditions. Indian J. Dairy Sc. 48 (4): 266-270.

Sawarkar, S.W.; Borkar, M.M; Upadhyae, S.V. and Jadhao, S.B. (2001). Characteristics of dairy owners, their awareness, adoption and constraints in adoption of A.I. practices in Vidarva region. *Indian J. Dairy Sc.* 54(4) : 194-202.

Sethi , C.P. ; Khan , F.H. and Singh, Ashok (2000) . Factors affecting lactation length in Sahiwal cows. Indian Vet. Med. Jour., 24: 309-310.

Shah, D. and Sharma , K.N.S. (1994[a]). Economics of milk production in Bulanshar district of U.P. Indian J.Dairy Sc. 47 (11): 937-944.

Shah, D. and Sharma, K.N.S. (1994). Determinants of profit in milk production enterprise. *Indian J. Dairy Sc.* 47(12) : 1016-1021.

Shah, D. and Sharma , K.N.S. (1994[b]).Determinants of profit in milk production enterprise. Indian J.Dairy Sc.47 (12) : 1061-1021.

Sharan, S. (2005). Genetic analysis of variation in some performance and Blood bio – chemical traits in Hariana and its crosses. M.V.Sc. Thesis , R.A.U. , Pusa (Bihar|)

Sharma, D.B. (1978). A study on growth and some production parameters in crossbred cattle and buffalo. M.V. Sc. Thesis, Rajendra Agricultural University, Bihar.

Sharma, R.K. (1988). Constraints-oriented management system for cattle development Livestock Advisor 13: 28-32.

Sharma, V.P. and Singh, R.V. (1994). An Economics analysis of milk production by different breeds of milch animals in Humid-Temperature zone of H.P.. Indian J.Dairy Sc. 47 (9): 749-755.

Shettar, V.B. and Govndaiah, M.G.(1999) .Effect of genetic and non – genetic factors on production performance of crossbred cattle. Indian Vet. J. 76 : 515 – 517.

Shiv Prasad , A.K. and Singh C.S.P. (2000) . Factors accecting efficiency of milk production in Friesian x Zebu crossbreds in Un – organized herds. Indian Vet. Med. J.,24(1) : 11 -14.

Shiyani, R.L. and Singh , R.V. (1995). Economics of milk production - A comparative study. Indian J.Dairy Sc. 48 (1): 21-26.

Shrivastava, A.K. and Singh, C.S.P. (2000). Factors effecting efficiency of milk production in Friesian x zebu crossbred in un-organized herds. Indian Vet. Med. J. 24 (1); 11-14.

Shrivastava, A.K.; Singh, C.S.P. and Verma, S.K. (1998). A study on the effects of various factors on production traits in Zebu x Friesian crossbred cows maintained under un-organized farming system. Indian Vet. Med. J. 22 (1): 19-22.

Shrivastava, A.K.; Singh, C.S.P. and Verma, S.K. and Singh, R.A. (1996). Effect of various factors on dry-period and calving-interval in Zebu x Friesian crossbred cows maintained under farmers managemental conditions. Indian Vet. Med. J. 20 (3): 202-206.

Shrivastava, D.K.; Verma, D.N. and Singh, S.P. (2001). Effects of shower on milk production and its composition in crossbred cows. Indian Vet. Med. J. 25 (1): 81-82.

Shrivastava,A.K. ; Sigh, C.S.P.; Verma , S.K. and Singh, R.A. (1996). Effect of various factors on dry – period and calving – interval in Zebu x Friesian crossbred cows maintained under farmers managemental conditions. Indian Vet. Med. J. 20(3) :202 – 206.

Sil, B.K., Jana, D.N. and Tripathi, A.K. (2001). Effect of calving pattern on total lactation milk yield of crossbred cow. *Journal of Inter acacdemicia,* 5(3) : 384-387.

Singh, K.; Khanna, A.S. and Kanaudia, A.S. (2000). Factor effecting lactation performance and persistency in crossbred cattle. Indian J. Dairy. Sc.53 (5): 354-360.

Singh, L. and Prasad, R. (1998). Constraints perceived by the dairy beneficiaries during the execution of IRDP. J. Dairying, Food and Home Sc. 17 (3) 223-227.

Singh, L. and Thomas, C.K. (1992). Knowledge and adoption in technology of dairy farming and iis constrains. Indian Dairyman. 44 (9): 446-450.

Singh, S,; Raut, K.C. and Jain, J.P. (1986). Performance of crossbred cows vis-à-vis non-descript in a hilly area of Himachal Pradesh. . Indian J.Dairy Sc. 56: 442-445.

Singh, S.K. and Nagarcenkar, R. (1997). Factors affecting milk yield and lactation length in Sahiwal Cows. Indian J. Anim. Sci. 67 (11): 989 – 992.

Singh, S.R. (1984). Studies on genetic and phenotypic parameters of some economic traits in different grades of crossbred (Friesian x Zebu) cattle. Ph. D. Thesis. B. A. U. Ranchi (bihar).

Singh, S.R. (1995). Variation in some performance traits in Friesian x Zebu cows. Indian J.Dairy Sc.48 (1):27-30.

Singh, S.R., Mishra, H.F.; Singh, C.S.P. and Singh, S.K. (1989). Genetic analysis of milk production efficiency in crossbred cattle. Indian Vet. Med. J., 13: 253 – 258.

Singh, S.R., Mishra, H.R. and Pandey, R.S. (1996[a]). Economics of milk Production of crossbred cows in the plateau of Chotanagpur.Indian J. Animal Sci.56 (1) : 1175 – 1179.

Singh, S.R., Mishra, H.R. and Pandey, R.S. (1996[b]). Variation in some economic traits in Friesian x Local cows of private sector. Indian J. Animal Sci.56 (5) 617 – 619.

Singh, S.R.; Mishra, H.R. and Pandey, R.S. (1986[a]). Economics of milk production of crossbred cows in the plateau of Chotanagpur, Indian J. Animal Sci. 56 (1): 1175-1179.

Singh, S.R.; Mishra, H.R. and Pandey, R.S. (1986[b]). variation in some economic traits in Friesian x local cows of private sector, Indian J. Animal Sci. 56 (5): 617-619.

Singh, S.R.; Mishra, H.R.; Singh C.S.P. and Singh, S.K. (1987). Genetic analysis of milk production efficiency in crossbred cattle – MPEK & MPEKD. Indian Vet. Med. J. 13: 253-258.

Singh, S.R.; Mishra, H.R.; Singh C.S.P. and Singh, S.K. (1988). Genetic analysis of milk production efficiency in crossbred cattle . Indian Vet. Med. J. 13: 253-258.

Singh, U.P.; Singh, R.V.and Singh, C.V. (1993[b]). Genetic and non – genetic factor affecting milk production efficiency traits in Sahiwal and its crossbred with Jersey and Red Dane. Indian J. Dairy Sci.46 (1) : 5-8.

Singh, V.K.; Nautiyal, L.P.: Singh, A.K. and Singh, J.P. (2004). Studies on peak yield and days to attain peak yield in crossbred cattle. Indian Vet. Med. J. 28 : 105- 108.

Singh, V.P.; Singh, R.V. and Singh, C.V. (1993[b]). Genetic and non-genetic factors affecting milk production efficiency traits in Sahiwal and its crosses with Jersey and Red-Dane, Indian J. Dairy Sc. 46 (5): 5-8.

Singh,P.K. (2002). Genetic analysis of economic traits of murrah buffaloes maintained at livestock farm of U.P.. Indian Vet. Med. J.26 (1): 1-4.

Snendecor, G.W. and Cochran. W.G. (1967). Statical methods, Lowa State Univ. Press, Ames. Lowa. USA.

Tailor, S.P.; Banerjee, A.K.; Patodia, O.P. and Singh B, (1998(. Genetic studies of traits up to peak yield in Surti buffaloes. Indian J. Dairy Sci. 51 (1): 36-39.

Thakur, Y.P., Singh, B.P. and Singh, P.K. (1999). Effect of genetic group and non-genetic factors on first lactation performance of different Jersey crossbreds. *Indian Vet. Med. J.*, 23 : 259-264.

Thakur, Y.P.; Singh, P.K. and Singh, B.P. (2000). Phenotypic time trend for milk yield and production efficiency traits in jersey crossbred. Indian Vet. Med. J. 24 (20): 147-148.

Tomar, A.K.S.; Joshi, J.D.; Sidhu, N.S. and Bisht, G.S. (1998). Crossbreeding effects on performance traits oh Holstein x Sahiwal half – bred in Indian Tarai belt. Indian Vet. Med. J. 22 (1): 23-26.

Tripathi, V.N.; Singhal, S.P. and Pal, R.N. (1978). Crossbred cows and buffaloes their economic of milk production . Livestock Advisor. 3; 18-20.

Varde, P.K.; Khir, D.W., Ali, S.Z. and Kuralkar, S.V. (2004). Reproduction and productive performance of Jersey crossbred cows .Indian Vet. J., 81(12): 1415 – 1461.

Velmurugan, K.S. (1998). Land and credit constraints in the farm house holds. Indian Dairyman. 50 (11) 43-45.

Venkatasubramanian, V. and Fulzele, R.M. (1996). Factors affecting the production performance of Crossbred and indigenous cattle under field condition. Indian J. Dairy Sc. 49 (5): 301-306.

Verma, O.P. and Kherde, R.L. (1995). Productive and reproducing performance of buffaloes in upper Gangatic plain. Indian J. Dairy Sci. 48 (5): 330-335.

Vij, P.K.; Nivsarkar, A.E.; Balain, D.S. and Des Raj (1992). Factors sffecting production performance of Tharparkar cattle. Indian J. Anim. Sci. 62 (8) : 772 – 774.

Yadav, A.S. and Rathi, S.S.(1992). Factors influencing some performance traits in Hariana cattle. Indian J. Dairy Sci., 45 (10): 511 – 516.

Yadav, A.S.; Rathi, S.S.; Dahiya, S.P. and Arora, D.N. (1992). Factors affecting some performance traits in Sahiwal cattle. Indian J. Dairy Sci,; 45 (10): 522 – 527.

Yadav, B.S. Yadav, M.C.; Singh, A. and Khan, F.H. (2003a). Studies on first lactation milk yield and cumulative yield for first two and first three lactation milk in Murrah buffalo. Indian Vet. Med. J. 27: 109-112.

Yadav, B.S. Yadav, M.C.; Singh, A. and Khan, F.H. (2003b). Factors affecting calving interval and dry period in Murrah buffalo. . Indian Vet. Med. J. 27: 145-146.

Yedukondalu, R.; Rao, B.V.R. and Rao, K.S. (2000). Problems and Prospectes of dairying in Medak district of Andhra Pradesh. Indian J. Dairy Sc. 53 (6): 434-440.