"INFLUENCE OF GENETIC AND NON-GENETIC FACTORS ON MILK PRODUCTION EFFICIENCY AND MORPHOMETRIES OF BUFFALOES IN AND AROUND DANAPUR (BIHAR)"



# THESIS

SUBMITTED TO THE

# 'RAJENDRA AGRICULTURAL UNIVERSITY

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

84

# Dr. Kishor Kundan Azad

Registration No. - M/VBG/15/2006-2007

In Partial fulfillment of the requirements

FOR THE DEGREE OF

Master of Veterinary Science

(Animal Breeding & Genetics)

DEPARTMENT OF ANIMAL BREEDING & GENETICS

BIHAR VETERINARY COLLEGE

PATNA - 800 014 (BIHAR)

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2009

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# CERTIFICATE - I

This is to certify that the thesis entitled "Influence of genetic and non-genetic factors on milk production efficiency and Morphometrics of Buffaloes in and around Danapur (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. Kishor Kundan Azad, Registration No. M/VBG/15/2006-07, 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** 

Chairman of the Department

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# CERTIFICATE - II

We, the undersigned members of the Advisory Committee of Dr. Kishor Kundan Azad, Registration No. M/VBG/15/2006-2007, a candidate for the Degree of Master of Veterinary Science with major in Animal Breeding & Genetics have gone through the manuscript of the thesis and agree that the thesis entitled "Influence of genetic and non-genetic factors on milk production efficiency and Morphometrics of Buffaloes in and around Danapur (Bihar)" may be submitted by Dr. Kishor Kundan Azad in partial fulfilment of the requirements for the degree.

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# CERTIFICATE - III

This is to certify that the thesis entitled "Influence of genetic and nongenetic factors on milk production efficiency and Morphometrics of Buffaloes in and around Danapur (Bihar)" submitted by Dr. Kishor Kundan Azad, Registration No. M/VBG/15/2006-07 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, 

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# INTRODUCTION

The wide variation in agro-ecological zones in our country has helped to develop a large number of breeds in different species of livestock and birds. Resultantly 30 breeds of cattle, 10 breeds of buffalo, 42 breeds of sheep, 20 breeds of goat, 8 breeds of camel, 6 breeds of horse and 18 breeds of poultry have been developed in India from time to time in addition to other species like pig, donkey, mithun, yak, turkey, duck, fowl etc. Livestock have been providing the man with nature's most precious and nutritious food in the form of milk, meat and eggs as well as their manure in addition to draft power for rural transport and agricultural operations. Livestock also plays an important role in poverty alleviation for all sectors of the society through providing employment opportunity and generation of income.

Since last few years India continues to be the largest milk producer in the world, milk production in India has gone to the level of 100.9 million tones during the year 2006-07 (India, 2009). Although the per capita availability of milk has been estimated to be 230 gm per day, yet there is a big gap between availability and requirement of milk mainly due to steep rise in human population of the country. Thus, intensive effort are being made to increase milk production through scientific breeding, feeding, health care and better management of milch animals. Cattle and buffalo are the main milk producing animals in our country. Buffalo forms the back bone of India's dairy industry and is rightly considered as the 'bearer cheque' of the rural folk. Being less than one third of the total bovine population, it contributes more than 50% of the total milk production in the country. According to 17th Livestock census-2003, Govt. of India, India alone has a population of 97 million buffaloes which comes to about 46.5 percent of the world buffalo population. The Indian buffaloes are popularly known as riverine buffalo or river buffalo as they derived their name from their usual habitat, the river valley, and majority of them are non-descript. Out of the ten descripted breeds majority of them are confined in the North and Central Western parts of the country.

India has not only the best breeds of buffalo in the world but also possess a good genetic diversity in the form of non-accredited populations spread out in different parts of the country. Some of these populations have sufficient number with different characteristics to be conserved as distinct population. These populations are well adapted to the local agro-climatic conditions and thrive in adverse conditions. They have strong disease resistance power, less health and reproduction problems, besides optimum profitable production of milk, meat and generation of draft power. They can efficiently produce milk on prevalent feeds and fodder without any external supports.

Buffaloes are also important milk producing animal in Bihar. Bihar has 5.75million buffaloes which comes to about 34.86 percent of the total bovine population of the state (17th Livestock census, Govt. India 2003). Being one-third of the total bovine population, buffaloes are contributing more than 55% to the state milk pool. Although small buffalo herds are distributed through out the length and breadth of the state but the area under South and North Gangetic plains of Bihar is densely populated with clusters of buffalo. Majority of them are Non-descript type, some are Graded Murrah and rest of the population is phenotypically homogenous in certain distinguishable characteristics. These phenotypically homogenous buffalo population are almost true to the breed and have acquired full adaptation to the socio-agro-climatic and ecological conditions of Gangetic plains, particularly in the "Tal and Diara" area of the rivers Ganges, Gandak and Sone in the division of Patna, Bhagalpur and Magadh. These true breeding buffalo populations are particularly called as "Diara" by the farmers. It is pertinent to mention here that true breeding buffalo population (about 1.3 million of the total buffalo population of the state) locally known as Diara/Deshila, contributing about 32% of the state milk pool, is almost untouched, so far as their breeding and development programmes are concerned. These three groups of population are phenotypically different among-themselves and Diara buffalo are genetically different from Murrah. These clusters of buffaloes including Diara buffaloes are managed by the farmers in the Tal and Diara area of the state extending from Buxar in the west to Raj Mahal in the east.

Milk population in Bihar is predominantly a domain of small and marginal households. The dairy farmers maintain the small dairy units popularly known as 'Khatal' consisting of Desi and crossbred cows as well as buffalo managed under sub-optimal feeding and management system with sole objective of profitable milk production. But these units produce about 65% of the total milk production which is almost double in quantity that is produced by the organized farms.

Danapur, a subdivision of Patna district, is situated in the South Gangetic plain of Bihar adjacent to western part of Patna, the Capital of Bihar. Danapur has been stretched from Patna on its east to Maner in its west. Danapur is generally known for the presence of Danapur Cantonment and Military air base at Bihta.

Danapur is thickly populated with buffalo including clusters of 'Diara Buffalo' which are being maintained by the farmers of this area. To meet the demands of ever growing population of Danapur as well as of Patna for milk and milk products, a large number of private dairy units popularly known as 'Khatal' are being maintained by the farmers. Due to close proximity of Patna, the dairy farmers sell their milk and milk products in the city without much difficulty. Buffaloes are preferred by the farmers of this area probably due to high fat and S.N.F. content in their milk, the most desirable character for 'khoa' production. Farmers of this

area are getting remunerative price through selling raw milk as well as buffalo khoa to the city. Therefore, it is imperative to evaluate the milk production efficiency of these three groups of buffalo population namely Graded Murrah, Diara and Non-descript types under farmers' management system so that a suitable breeding pogramme and a package of practice may be developed for improvement of these buffaloes in general and Diara buffaloes in particular.

Like other economic traits, the milk production efficiency of buffalo is dependent upon various genetic and non-genetic factors. Although some information on milk production efficiency of buffalo in organized farms are available yet the information on buffaloes managed under unorganised farms is very scanty. Besides, the dairy farmers also perceive many constraints in maintaining the dairy units in different socio-economic and agro-climatic zones. Therefore, keeping in view the above facts, the present research work was undertaken with the following objectives.

#### **Objectives:**

- 1. To estimate the phenotypic parameters of some of the milk production efficiency measures of buffaloes in unorganized farms in and around Danapur.
- 2. To estimate the nature and magnitude of variation in various measures of milk production efficiency traits under consideration due to genetic and non-genetic factors in buffaloes in and around Danapur.
- 3. To study the variation in morphometric traits due to genetic and non-genetic factors in buffaloes of unorganized farms in and around Danapur.
- 4. To study the different constraints perceived by the dairy farmers in rearing buffaloes in and around Danapur.

# REVIEW OF LITERATURE

# **REVIEW OF LITERATURE**

The indigenous breeds of buffalo are very efficient milk producing livestock species in India. Thus it has become an important subject of investigation for animal scientists since long. A large number of publications are available in the literature on different physical and physiological parameters of different morphometrics as well as production and reproduction traits of buffalo maintained in organized farms. However, the findings of these parameters in organized farms may not be quite comparable with the findings based on the data on buffaloes maintained at farmers' door and collected by field survey methods. Studies on buffaloes maintained in their native tract under farmers management systems have been indicated very recently and sporadic reports are available from different parts of the country. Except a few no systematic studies have been conducted on the buffalo genetic resources under organized as well as in unorganized sectors of Bihar. However, some of the relevant research findings of the studies conducted on buffaloes managed in different argoecological and socio-economic conditions of the country as well as in Bihar, particularly managed under farmers' management system, have been reviewed here.

#### **MORPHOMETRIC TRAITS**

Association of morphometric traits with the productivity of the animals have been reported in literature. Morphometric traits play important role on input and output relationship of the animals.

Randhawa (1958) reported the average height at wither, body length and heart girth in adult Mehsana she buffaloes to be 132.1, 154.9 and 208.3 cm respectively.

Jawarkar and Johar (1975) reported morphometric traits of 289 Murrah buffalo cows in the organized herd and reported the average height at wither, body length and heart girth to be 133.3±0.4, 154.1±0.6 and 203.1±0.7cm respectively.

Sreedharan (1976) estimated the body measurements of Murrah buffaloes and reported the average height at wither, body length and chest girth of the adult animals to be 133.8±0.3, 162.7±0.6 and 207.0±1.1 cm respectively.

Manik and Iqbalnath (1981) studied the morphological traits of Murrah buffalo cows in an organized farm. The average measurements of height at wither, body length and heart girth were reported to be 133.3±0.4, 154.8±0.6 and 208.5±1.8 cm respectively.

Prajapati (1988) reported the average height at wither, body length and heart girth of adult Mehsana buffaloes in its native tract to be  $125\pm0.8$ ,  $146.5\pm0.4$  and  $203.3\pm0.6$  cm respectively.

Jogi and Patel (1990) studied the morphological traits of Surti buffaloes in an organized farm and reported the average estimates of height at wither, body length and chest girth to be 124.9±0.9, 148.8±1.1 and 184.1±2.0 cm respectively.

Singh *et al.* (1995<sup>a</sup>) made an attempt to record the various body measurement traits in Mehsana she buffaloes in their native tract and recorded thirteen body measurements. In adult buffaloes, the estimates for height at wither, body length and heart girth based on 441 observations were reported to be 125.87±0.86, 146.18±0.86 and 220.72±1.76 cm respectively.

Singh and Singh (1998) reported the average height at wither, body length and chest girth of Bhadawari buffaloes in UP to be 125.9±0.20cm, 122.6±0.4 cm and 192.0±0.5 cm respectively.

Singh et al. (2006) reported the mean height at wither, body length and heart girth of Diara buffaloes to be 130.75, 138.55 and 193.15 cm respectively.

Sinha (2006) studied the morphometric traits of Diara, Graded Murrah and Non-descript buffaloes in Barh a subdivision of Patna district in Bihar, and reported the population mean for height at wither, body length and heart girth to be 129.36±0.29, 135.64±0.31 and 193.68±0.65 cm respectively. The corresponding values for Diara buffalo reported to be 128.34±0.49, 134.39±0.56, and 188.95±1.08 cm respectively. The respective values for Graded Murrah reported to be 131.17±0.53, 137.59±0.56 and 196.75±1.19 cm respectively and for Non-descript buffalo to be 128.55±0.49, 134.93±0.51 and 195.34±1.09 cm respectively.

Nandedkar *et al.* (2006) studied the morphological traits of Nagpuri buffaloes under field conditions in its native tract and reported the average height at wither, body length and chest girth of the adults to be 125.66±0.42 cm, 134.96±0.63 cm and 172.00±0.75 cm respectively.

Kushwaha *et al.* (2006) studied the morphological traits of Bhadawari buffaloes under field conditions in its native tract. The average height at wither, body length and heart girth of the adult buffaloes were reported to be 123.90±0.65 cm, 134.38±0.92cm and 184.21±1.28 cm respectively.

Shankar (2007) studied the morphological traits of Diara, Graded Murrah and Non-descript buffaloes under field conditions in and around

Patna and reported the population mean for height at wither, body length and chest girth of buffaloes to be 130.25±0.11, 136.48±0.14 and 195.69±0.38 cm respectively. The corresponding values for Graded Murrah reported to be 132.11±0.19, 138.60±0.24 and 199.15±0.65 cm respectively. The respective values for Diara buffalo reported to be 129.82±0.19, 135.51±0.23 and 191.28±0.65 cm respectively and for Non-descript buffalo the corresponding values reported to be 128.81±0.18, 135.33±0.23 and 196.64±0.64 cm respectively.

#### Body weight

Randhawa (1958) reported the average body weight of Surti buffalo cows at first, second and third parities to be 383.1±8.9 kg, 439.4±16.3 kg and 468.9±19.4 kg respectively.

Jawarkar and Johar (1975) reported the average estimates of body weight of Murrah buffalo cows in an organized farm to be 497.0±5.0 kg and 510.2±4.2 kg at first and third parities respectively. The average adult body weight is reported to be 513.4±1.7 kg.

Sreedharan (1976) reported the average body weight of adult Murrah buffalo cows to be 561.8±7.6 kg. The mean body weight at first, second and third parities reported to be 483.2±1.6, 499.0±1.7 and 513.0±2.1 kg respectively.

Jogi and Patel (1990) reported the average body weight of adult Surti buffalo cows to be 382.6±12.1 kg.

Saini and Gill (1987) estimated the body weight of adult Murrah buffalo cows to be 509.0±6.8 kg.

Singh *et al.* (1995<sup>a</sup>) reported the average body weight of adult she buffaloes based on 382, 92 and 64 observations in first, second and third parities to be 446.3±0.4 kg, 474.8±12.7 kg and 542.2±11.7 kg respectively.

Taneja (1999) reported the average estimates of body weight at maturity in Murrah and Nili-Ravi buffaloes to be 461 and 533 kg respectively. The average body weight at maturity in Surti, Bhadawari and Mehsana buffaloes reported to be ranged from 319-413 kg, 346-467 kg and 335-567 kg respectively.

ICAR (2002) reported the average body weight at first calving in Murrah, Murrah grade, Nili-Ravi and Bhadawari buffaloes to be 446.4, 461.9, 531.1 and 425 kg respectively.

Sinha (2006) reported that average body weight of Graded Murrah, Diara and Non-descript buffaloes in their native tract i.e. Tal and Diara areas of the river Ganges in and around Barh, a subdivisional town of Bihar, to be 497.95±6.79, 447.50±6.35 and 473.23±6.12 kg respectively.

Shankar (2007) reported the average body weight of Graded Murrah, Diara and Non-descript buffaloes to be 508.97±3.36, 461.80±3.32 and 483.86±3.30 kg respectively.

# Effect of genetic and non-genetic factors on morphological traits Morphometric traits

Jawarkar and Johar (1975) reported significant influence of parity on height at wither, body length and heart girth in Murrah buffaloes. Mean values for all these traits were reported to be significantly lower in the first parity and then significantly increased upto third parity. The average height at wither at first, second and third parities were reported to be 132.3±0.5, 134.8±0.7 and 139.5±0.7 cm respectively. The corresponding values for body length were 137.5±1.4, 140.9±0.9 and 144.1±0.8 cm respectively. For chest girth the respective values at first, second and third parities were reported to be 186.5±1.2, 195.1±1.3 and 197.3±1.2 cms.

Saini and Gill (1987) reported significant effect of parity on morphometric traits in Murrah buffaloes.

Jogi and Patel (1990) reported significant effect of parity on morphometric traits in Murrah buffaloes. The average height at wither, body length and heart girth were reported to be significantly lower at the first parity and continued to be increased upto 3rd parity.

Singh et al. (1995<sup>a</sup>) reported significant influence of parity on morphometric traits in Mehsana buffaloes. Values for these traits were lower for primiparous animals and continued to increase significantly from first to third parity. They also reported the significant effect of farming system on some morphometric traits. The mean values of these traits in landless farms were the lowest.

Singh et al. (2000) reported significant effect of parity on height at wither, body length and chest girth in Mehsana buffaloes. The lowest average estimates of these traits were reported to be in the first parity and continued to increase significantly upto third parity.

Shankar (2007) reported significant (P<0.01) effect of genetic group, farming system and lactation order on morphometric traits. The worker reported significantly (P<0.05) larger morphometric traits in Graded Murrah followed by Diara and Non-descript. He also reported significantly higher morphometric traits of the animals maintained under mixed farming system than the animals maintained in the units involved dairying alone. Morphometric traits were reported to be increased significantly (P<0.05) from first to third parity.

## **Body weight**

Johari and Bhat (1979) analysed the data of four genetic groups of buffaloes viz. Murrah, Murrah grades, Nili-Ravi and Nili grades from 11 Military Dairy Farms over 30 years to investigate the effect of genetic and non-genetic factors on body weight. They reported significant effect of genetic and non-genetic factors on body weight. Nili-Ravi and Nili grades reported to have significantly higher body weight at 2 years of age and at the age of first calving than the Murrah and Murrah grades. The farms and periods reported to be significantly influenced all the body weights.

Nautiyal and Bhat (1979) reported the effect of farms and periods on body weight of female buffaloes to be highly significant at all the age groups from birth.

Singh *et al.* (2000) reported significant influence of some non-genetic factors like village, farming system and parity on body weight of adult Mehsana buffalo cows. The higher estimates of average body weight in compact villages suggesting the influence of better management practices on body weight than the non-compact villages. The average body weight was reported to be significantly lowered at first parity than the second and third parity. Size of land holding also had significant effect on body weight. Buffaloes maintained by the landless farmers had the lowest body weight.

Sinha (2006) reported significant influence of genetic group on body weight, Graded Murrah is reported to be significantly heavier than the Diara and Non-descript types.

Shankar (2007) reported significant (P<0.01) effect of genetic group, farming system and lactation order on body weight of buffaloes native to Patna. The worker reported significantly (P<0.05) higher body weight in graded Murrah followed by Non-descript and Diara. Animals maintained under mixed farming system were reported to be heavier than those maintained in the units involved dairying alone. Body weight of the animals reported to be increased significantly (P<0.05) upto third lactation.

#### PRODUCTION AND REPRODUCTION TRAITS

#### Lactation Milk Yield (LMY)

Lactation milk yield is the most important economic character of dairy animals because it is the major source of income to the dairy farmers. The expression of this trait is under the control of physiological and biochemical processes governed by both the hereditary and environmental factors. The first lactation milk yield provides the most efficient measure to assess the inherent capacity of an individual and helps in predicting breeding value of a dairy cow or a buffalo accurately.

Patro and Bhat (1979) reported the average first lactation yield of Indian buffaloes to be 1578.39±22.21 kg based on 7362 lactation records.

Tajane and Siddiquee (1985) reported overall means for first lactation milk yield (FLMY) as 1195.00±60.00 kg and pooled estimate of overall lactation milk yield as 1160.00±34.00 kg in Mehsana Buffaloes.

Kumar and Gupta (1992) reported the mean lactation yield of buffaloes maintained in different categories of households in Muzaffarnagar district of UP to be 1648.38 kg.

Singh (1992) reported overall means for FLMY in UNION and LRS herds of Mehsana buffaloes to be 1960.45±110.63 and 1684.54±49.58 kg

respectively. The overall estimates of lactation milk yield pooled over first four parities in UNION and LRS herds were reported to be 2025.73±26.20 and 1630.24±49.92 kg respectively.

Paliwal (1994) reported the overall average lactation milk yield of Mehsana buffaloes to be 1436±20 kg.

Rao and Singh (1995) reported the average estimates for lactation yield in graded Murrah buffaloes to be 1528 kg.

Yadav (1995-96) reported the overall average lactation milk yield in Surti buffaloes to be 1436 kg.

Chawla (1996-97) reported the overall average lactation milk yield in Nili-Ravi buffaloes to be 2092±72 kg.

Sethi (1996-97) reported the overall average lactation milk yield of Murrah buffaloes to be 1879±51 kg.

Taneja (1999) reported the average estimates of lactation milk yield in Murrah, Nili-Ravi, Surti, Bhadawari and Mehsana buffaloes to be 1805, 1833, 1278, 1009 and 1610 kg respectively.

Pundir *et al.* (2000) reported the weighted mean for first lactation milk yield based on 758 records in Mehsana buffaloes as 1896.19±47.69 kg and pooled estimate of overall lactation milk yield as 1822.03±33.93 kg based on 1737 records. The weighted mean for LMY upto fourth parity reported to be 1877.23±69.36 kg based on 1525 records. The corresponding estimates of LMY from 1st to 4th parity were reported to be 1896.19, 1820.82, 1874.89 and 1883.23 kg respectively.

Rao et al. (2000) conducted the study in 15 villages covered under Milk Producer Co-operative Society (MPCS) and another 10 villages not covered under Milk Producer Co-operative Society (Non-MPCS) for evaluation of performance traits in graded buffaloes in Vishakapathanam

district of Andhra Pradesh. The average estimates of LMY in graded buffaloes under MPCS and Non-MPCS were reported to be 1734.20±35.98 kg and 1703.84±56.57 kg respectively.

Sashidhar *et al.* (2000) reported the average lactation yield in Murrah buffaloes to be 1820.30 kg.

Singh (2002) reported the overall mean for LMY of Murrah buffaloes in U.P. as 1400.05±19.25 kg.

Yadav et al. (2003a) reported the least squares means of LMY in Murrah buffaloes pooled over three lactations to be 1646.09±36.02 kg.

Kumar (2004) reported the average lactation milk yield of graded buffaloes under field condition in and around Darbhanga (Bihar) to be 1369.88±18.91 kg.

Sinha (2006) reported the average LMY of Diara, Graded Murrah and Non-descript buffaloes native to Bihar as 1313.82±28.08 kg 1355.87±30.84 kg and 1005.04±28.08 kg respectively. The least squares mean of LMY pooled over three genetic groups and over all lactations was reported to be 1224.91±16.76 kg.

Shankar (2007) reported least squares means of lactation milk yield in graded Murrah, Diara and Non-descript buffaloes to be 1395.82±9.13, 1347.44±9.02 and 1106.85±8.97 kg respectively.

# Factors affecting lactation milk yield

Johari and Bhat (1979<sup>b</sup>) reported significant effect of period & non-significant effect of season on LMY in Murrah buffaloes.

Patro and Bhat (1979) reported significant effect of farms and season on lactation milk yield in buffaloes. They have also reported the significant influence of parity on lactation milk yield. Milk yield is reported to be



increased steadily from the first lactation onwards and was at the peak in the fourth lactation. Thereby it maintained at the same level till the ninth lactation. However, breed had no significant influence on LMY.

Gajbhiye ((1987) reported significant influence of parity on LMY in Murrah.

Jain and Kothari (1983) reported significant influence of parity on LMY in Surti buffaloes.

Biradar (1991) reported significant influence of parity on LMY in Surti buffalos.

Singh (1992) reported significant effect of farms on LMY in Murrah buffaloes. They maintained that significant difference at field and farm levels may be due to the difference in availability of feeds and fodder during different seasons.

Shankar (2007) reported significant (P<0.01) effect of genetic group, location of the herd, farming system and lactation order on lactation milk yield. He reported significantly (P<0.05) higher lactation milk yield in graded murrah, followed by Diara and Non-descript. Animals maintained under mixed farming system reported to have significantly (P<0.05) higher lactation milk yield than those maintained in the units involved dairying alone. Lactation milk yield reported to be increased significantly (P<0.05) upto third lactation and then started declining.

#### Lactation Length (LL)

Tajane and Siddiquee (1985) reported the average lactation length pooled over first four parities in Mehsana buffaloes to be 256.00 days. The estimates of LL from 1st to 4th parity were reported to be 264.00±9.00, 263.00±8.00, 250.00±9.00 and 250.00±14.00 days respectively.

Singh et al. (1986) reported the overall lactation length in Mehsana buffaloes based on 206 records to be 267.00±5.00 days.

Kumar and Gupta (1992) reported the mean lactation length of buffaloes maintained by different categories of households in Muzaffarnagar district of UP to be 331 days.

Singh (1992) reported the average first lactation length of Mehsana buffaloes in UNION and LRS (Livestock Research Station) herds to be 306.89±6.11 and 328.71±7.74 days respectively. The overall estimates of LL pooled over first four parities in UNION and LRS herds based on 1080 and 272 records were reported to be 317.35±2.06 and 314.08±7.14 days respectively.

Dev Raj and Gupta (1994) recorded the average lactation length of buffaloes native to Churu district of Rajasthan to be 310 days.

Paliwal (1994<sup>b</sup>) reported the overall average lactation length in Mehsana buffaloes to be 262±3 days.

Shah and Sharma (1994<sup>b</sup>) estimated the lactation length in Murrah buffaloes managed by co-operative and non-cooperative sectors to be 362±7.32 and 343±7.68 days respectively and for local buffaloes the LL in the respective sectors to be 354±5.58 and 334±6.30 days.

Rao et al. (1995) reported the average estimate of lactation length in graded Murrah buffaloes to be 341 days.

Verma and Kherde (1995) studied the production and reproduction performance of local buffaloes in upper Gangetic plain in U.P. The average lactation length was reported to be 329 days.

Yadav (1995-96) reported the average lactation length pooled over all the lactations in Surti buffaloes to be 305 days at Vallabhnagar research station.

Chawla (1996-97) reported the average lactation length pooled over all the lactations in Nili-Ravi buffaloes to be 392±9 days.

Sethi (1996-97) reported the average lactation length pooled over all the lactations in Murrah buffaloes to be 313±7 days.

Rao et al. (2000) evaluated the production performance traits of graded buffaloes in the villages of Vishakhapathanam district in Andhra Pradesh both under Milk Producer Cooperative Society (MPCS) and districts not covered under MPCS. The average estimates of LL in graded buffaloes under MPCS and non-MPCS were reported to be 371.45±3.34 and 378±5.25 days respectively.

Sashidhar *et al.* (2000) recorded the average lactation length in Murrah buffaloes to be 289.6 days.

Singh (2002) reported the average first lactation length of Murrah buffaloes in U.P. to be 348.59±4.80 days.

Hemalatha *et al.* (2003) made an attempt to work out economics of milk production of different breeds of bovine in Ahmadanagar district of Maharastra and reported the average lactation length in graded buffaloes to be 278 days.

Kumar (2004) reported the average lactation length in graded buffaloes to be 321.43±1.82 days in and around Darbhanga (Bihar).

Sinha (2006) reported the average lactation length of Diara, graded Murrah and Non-descript buffaloes along the diara areas of the river Ganges in Barh a subdivision of Patna district to be 307.71 ±5.10, 296.5±5.6 and 314.87±5.1 days respectively and the lactation length pooled over all the genetic groups to be 306.36±3.05 days.

Shankar (2007) reported the least squares means of lactation length in graded Murrah, Diara and Non-descript buffaloes to be 293.92±2.19, 312.59±2.16 and 312.11±2.15 days respectively.

#### Factors affecting lactation length

Patro and Bhat (1979) reported the significant effect of farms, seasons and parity on lactation length and the highest lactation length was reported to be in the second lactation. However, they did not observe the significant effect of breed on lactation length.

Jain and Kothari (1983) reported significant effect of parity on lactation length in Surti and Mehsana buffaloes.

Singh (1992) reported the non-significant effect of parity and age at first calving on lactation length in Mehsana buffaloes in UNION herd while age at first calving was not significant in LRS herd. The LL was the longest in the first parity of buffaloes maintained in LRS and in the 4<sup>th</sup> parity of the buffaloes in UNION herd. In LRS herd, there was a decreasing trend in LL after first lactation.

Kumar (2004) studied the effect of farming system on lactation length in dairy animals, consisting of cattle and buffalo both, in the district town of Darbhanga (Bihar) and observed the effect of farming system on lactation length to be non-significant.

Shankar (2007) reported significant (P<0.01) effect of genetic group and lactation order on lactation length in buffaloes. He reported the longest lactation length in Diara buffalo followed by Non-descript and graded Murrah. The worker also reported significantly (P<0.05) shorter lactation length in third and fourth parity than the first and second parity.

#### Peak Yield

Peak yield is an important production trait which expresses the milk producing ability of a cow in the early period of lactation and could be an important criterion for selection of dairy animals at an early age. Choudhary and Choudhary (1981) studied the peak yield in Mehsana buffaloes based on 133 lactation records, maintained under the AICRP on buffaloes at Vallabhnagar Research Station. The least squares means for peak yield in Mehsana and Surti breeds of buffaloes were reported to be 7.85±0.16 kg and 7.39±0.18 kg respectively.

Biradar (1990) reported the average peak yield in Surti buffaloes to be 6.50±0.115 kg based on 550 observations.

Singh (1992) estimated the peak yield in Mehsana buffaloes to be 5.57±0.07 kg in first lactation.

Paliwal *et al.* (1998) analysed the performance records of Surti buffaloes maintained at Livestock Research Station, Vallbahnagar (Rajasthan) and in Central Cattle Breeding Farm, Dhamrod (Gujarat) and reported the average peak yield in Surti buffaloes to be ranged from 6.89±0.08 kg in first lactation to 8.96±0.22 kg in sixth lactation with overall average as 8.37±0.08 kg.

Paliwal (1994) reported the overall average peak yield in Mehsana buffaloes to be 8.4±0.08 kg.

Yadav (1995-96) reported the overall average peak yield in Surti buffaloes to be 8.5 kg at Vallabhnagar Research Station.

Chawla (1996-97) reported peak yield of Nili-Ravi buffaloes to be 9.5±3 kg at Nabha.

Sethi (1996-97) reported the average peak yield of Murrah buffaloes pooled over all the lactations to be 9.1±0.2 kg.

Kumar (2004) reported the average peak yield in graded buffaloes under field condition to be 7.72±0.19 kg in Darbhanga district of Bihar.

Sinha (2006) reported the average peak yield of Diara, Graded Murrah and Non-descript buffaloes in diara area of the river Gangas under Barh subdivision in Bihar to be 7.5±0.20, 8.05±0.21 and 6.07±0.20 kg respectively.

Shankar (2007) reported the least squares means of peak yield to be 8.45±0.11, 7.51±0.11 and 6.80±0.11 kg of Graded Murrah, Diara and Non-descript buffaloes respectively.

# Factors affecting peak yield

Choudhary and Choudhary (1981) studied the effect of factors on peak yield in Mehsana buffaloes and reported non-significant influence of parity on peak yield.

Singh (1992<sup>a</sup>) reported significant (P<0.01) influence of order of lactation, year and season of calving on peak yield. The peak yield is reported to be increased significantly from 5.57±0.07 kg in first lactation to 7.31±0.26 kg in the fifth lactation.

Singh and Singh (1998) reported the average peak yield pooled over five lactations in Bhadawari buffaloes in UP under farm and field conditions to be 4.44±0.33 and 4.34±0.36 kg respectively. The peak yield is reported to be increased upto 5th lactation in field condition and then started declining from 6th lactation onwards whereas in farm condition the peak yield decreased from third lactation onward.

Kumar (2004) reported significant influence of parity on peak yield but did not observe significant role of farming system on this trait. The peak yield is reported to be increased significantly from first to third lactation and then decreased from fourth lactation onwards.

Shankar (2007) reported significant (P<0.01) effect of genetic group, farming system and lactation order on peak yield. Graded Murrah is reported to have significantly (P<0.05) higher peak yield than the Diara and non-descript buffaloes. Animals maintained under mixed farming system is reported to have significantly (P<0.05) higher peak yield than those maintained in the units involved dairying alone. Peak yield is reported to be increased significantly (P<0.05) upto third parity.

# Days to attain Peak yield (DAPY)

A milch animal is supposed to be economical if she attains peak yield shortly after calving and has higher persistency of peak milk yield. Choudhary and Choudhary (1981) reported the average number of days to attain peak yield in Mehsana buffaloes based on 133 observation to be 49.57±3.44 days. The corresponding value in Surti buffaloes was reported to be 57.11±3.86 days.

Biradar (1990) reported the average number of days to attain peak yield in Surti buffaloes to be 36.04±1.75 days based on 550 records.

Kumar (2004) estimated the average number of days to attain peak yield in Graded buffaloes under farmers' management system in Dharbhanga district of Bihar to be 39.00±0.48 days.

Sinha (2006) reported the average number of days to attain peak yield in Diara, graded Murrah and Non-descript buffaloes in Tal & Diara areas of Barh, a subdivision of Patna district in Bihar, to be 42.00±0.47,

 $28.00\pm0.52$  and  $44.00\pm0.47$  days respectively and the overall estimate of days to attain peak yield to be  $41.83\pm0.28$  days.

Shankar (2007) reported the least squares means for days to attain peak yield in graded Murrah, Diara and Non-descript buffaloes to be 37.81±0.36, 42.37±0.36 and 45.53±0.36 days respectively.

### Factors affecting days to attain peak yield

Choudhary and Choudhary (1981) reported significant effect of breeds on Days to attain peak yield in buffaloes. The average number of days to attain peak milk yield was reported to be significantly higher in Surti buffaloes (57.11±3.86 days) than the Mehsana (49.57±3.44 days). However, the effects of season and parity were non-significant.

Singh (1992) reported significant effect of parity on days to attain peak yield in Mehsana buffaloes whereas period and season were nonsignificant.

Kumar (2004) reported significant effect of genetic constitution of animals, order of lactation and season of calving on average number of days to attain peak yield in dairy animals i.e. cows and buffaloes. However, the effect of zone and farming system is reported to be non-significant.

Shankar (2007) reported significant (P<0.01) effect of genetic group on days to attain peak yield. The author reported significantly (P<0.05) shorter days to attain peak yield in graded Murrah followed by Diara and Non-descript buffaloes.

# Milk Yield per day of Lactation Length (MY/LL)

Lactation milk yield is generally used as selection criterion in dairy animal. This is not necessarily the most efficient one because of presence of production-reproduction antagonism. Therefore, a better approach would be if selection is based on production efficiency traits viz. Milk Yield per day of Lactation Length (MY/LL) and Milk Yield per day of Calving Interval (MY/CI).

Dev Raj and Gupta (1994) reported the average daily milk yield in desi buffaloes native to Churu district of Rajasthan to be 4.47 kg.

Singh and Singh (1998) reported the average daily milk yield pooled over six lactations of Bhadawari buffaloes in U.P. under farm and field conditions to be 2.88±0.29 and 2.57±0.32 kg respectively.

Tailor et al. (1998) reported the overall least squares mean for MY/LL of Surti buffaloes to be 3.68±0.05 kg which was lower than the estimates reported by Vij and Tiwana (1988) in Murrah and Singh et al. (1989) in Nili-Ravi buffaloes, indicating breed differences. Tailor et al. (1998) have also reported the significant influence of season of calving on MY/LL.

Sashidhar *et al.* (2000) reported the average daily milk yield in Murrah buffaloes to be 3.18 kg.

Singh (2002) analyzed the first lactation performance record of Murrah buffaloes in U.P. and recorded the average MY/LL to be 3.78±0.05 kg.

Hemalatha *et al.* (2003) made an attempt to work out economics of milk production of different breeds of bovine in Ahmadnagar district of Mahrashtra and reported the average daily milk yield in graded buffaloes to be 6.5 litres.

Kumar (2004) estimated the average MY/LL in graded buffaloes native to Dharbhanga district of Bihar to be 4.32±0.06 kg under farmers' management system.

Sinha (2006) reported the average daily milk yield in Diara, graded Murrah and Non-descript buffaloes in Tal and Diara areas of river Ganges at Barh, a sub-divisional town of Bihar, to be 4.28±0.11, 4.60±0.12 and 3.34±0.11 kg respectively. The least squares mean pooled over three genetic groups to be 4.87±0.06 kg.

Shankar (2007) reported the least squares means of milk yield per day of lactation length of graded Murrah, Diara and Non-descript buffaloes native to Patna to be 4.76±0.04, 4.31±0.04 and 3.60±0.04 kg respectively.

# Milk yield per day of Calving Interval (MY/CI)

Tailor *et al.* (1998) reported the overall least squares mean for milk yield per day of calving interval in Surti buffaloes to be 2.04±0.05 kg which was lower than the values reported by Vij and Tiwana (1987) and Kandasamy *et al.* (1991) in Murrah buffaloes and by Singh *et al.* (1989) in Nili-Ravi buffaloes, indicating the breed differences.

Kumar (2004) estimated the average MY/CI in graded buffaloes in and around Dharbhanga (Bihar) to be 3.10±0.05 kg and reported significant influence of genetic group, season of calving and parity on MY/CI in dairy animals which includes both cows and buffaloes. Buffaloes calved during winter had significantly more MY/CI than the summer and rainy calvers. Milk yield per day of calving internal is reported to be increased gradually from first to third parity and then declined from fourth parity onwards.

Shankar (2007) reported the least squares means of milk yield per day of calving interval in graded Murrah, Diara and Non-descript buffaloes to be 3.28±0.02, 2.86±0.02, and 2.93±0.02 kg respectively.

# Milk production efficiency per kg of Body weight (MPEK)

Choudhary and Barhat (1979) estimated milk production efficiency per kg body weight at calving (MPEK) and milk production efficiency per kg body weight per day of lactation length (MPEKD). The mean MPEK was reported to be 3.06±0.09 kg and 2.77±0.09 kg for Mehsana and Surti buffaloes, respectively. The average estimates of MPEKD for the respective breeds were 11.46±0.28 g and 10.46±0.31 g. It is reported that Mehsana buffaloes had higher efficiency of milk production with respect to body weight. Further, the animals with lower body weight were comparatively more efficient than the heavier.

Shankar (2007) reported the MPEK in graded Murrah, Diara and Non-descript buffaloes to be 2.72±0.02, 2.90±0.02 and 2.24±0.02 kg respectively, whereas the corresponding values for MPEKD were 9.20±0.093, 9.30±0.092 and 7.20±0.092 g respectively..

## Factors affecting MPEK and MPEKD

Sharma (1978), Khanna et al. (1980) and Singh et al. (1987) reported significant effect of genetic grade on MPEK and MPEKD in crossbred cows.

Choudhary and Barhat (1979) studied the milk production efficiency traits in buffaloes with respect to their body weights i.e. MPEK and MPEKD. They observed significant effect of year and season of calving on both MPEK and MPEKD. However, parity did not have significant effect on these two traits. Effect of breed was reported to be significant and Mehsana buffaloes were reported to have higher efficiency for both MPEK and MPEKD in comparison to that of Surti buffaloes. Buffaloes, within a

breed, with lower body weight had higher efficiency of milk production per kg of metabolic body weight.

Kumar (2004) studied the milk production efficiency of graded buffaloes with respect to their body weight in and around Dharbhanga of Bihar. The average estimates of milk production efficiency/kg body weight/lactation (MPEK) and milk production efficiency/kg body weight/day of lactation length (MPEKD) were reported to be 3.85±0.06 kg and 16.0±0.20 g respectively. Buffaloes had significantly more MPEK and MPEKD than the Desi cows but lower than the crossbreds. Parities had significant effect on both these traits, being highest estimates at third lactation. However, zone and farming system did not have significant influence on these traits.

Shankar (2007) reported significant (P<0.01) effect of genetic group, location of herd and lactation order on MPEK. The worker reported significantly (P<0.05) higher MPEK of Diara buffaloes followed by graded Murrah and Non-descript. He had also reported that MPEK increased significantly (P<0.05) with the increase in sequence of lactation and MPEK was reported to be highest in 3<sup>rd</sup> lactation.

Shankar (2007) reported the least squares means of MPEKD in graded Murrah, Diara and Non-descript buffaloes to be 9.20±0.09, 9.30±0.09 and 7.20±0.09 g respectively.

### Dry Period (DP)

Siddiquee *et al.* (1984) reported first dry period and overall dry period in Mehsana buffaloes to be 200.30±13.00 and 191.00±7.00 days respectively.

Singh (1992) studied the production and reproduction performance of Mehsana buffaloes in UNION and LRS herds. The estimates of first dry

period were reported to be 167.45±8.87 and 226.31±15.55 days in UNION and LRS respectively and the dry periods pooled over four parities were reported to be 161.47±5.76 and 185.78±9.74 days in UNIION and LRS herds respectively.

Dev Raj and Gupta (1994) reported the average dry period of local buffaloes of Churu district in Rajasthan to be 125 days.

Rao et al. (1995) reported the average dry period in graded Murrah buffaloes to be 194 days.

Verma and Kherde (1995) studied the production and reproduction performance of buffaloes in upper Gangetic plain of U.P. and estimated the average dry period of local buffaloes to be 184 days.

Pathodiya *et al.* (1998) reported the average estimate of dry period in Surti buffaloes to be 203±5.8 days.

Pundir et al. (2000) reported the pooled estimate of dry period based on 1410 records of some breeds of buffaloes to be 170.02±6.83 days.

Yadav et al. (2003b) reported overall least squares mean for dry period in Murrah buffaloes to be 174.06±9.5 days.

Kumar (2004) reported the average estimate of dry period in graded buffaloes in and around Dharbhanga, a district town of Bihar, to be 128.96±3.24 days.

Sinha (2006) reported the average estimates of dry period in three genetic groups of buffaloes viz. Diara, graded Murrah and Non-descript types in Tal and Diara area of the Ganges in and around Barh (Bihar) to be 115.26±1.95, 118.73±2.14 and 122.76±1.95 days respectively and the overall mean irrespective of genetic groups to be 118.66±1.17 days.

Shankar (2007) reported the least squares means of dry period in graded Murrah, Diara and Non-descript buffaloes to be 130.48±1.32, 151.60±1.30 and 150.90±1.30 days respectively.

### Factors affecting dry period

Singh (1992) reported the significant influence of period of calving on first dry period in UNION and LRS herds. The first dry period reported to be decreased significantly over the periods in both the herds, indicating the role of improved management during the period 3 over periods 1 and 2. However, the worker has observed non-significant effect of parity on dry period in both the herds.

Kumar (2004) studied the effect of genetic and non-genetic factors on dry period in cows and buffaloes in and around Dharbhanga (Bihar) and reported significant effect of parity on dry period. The longest dry period was reported to be in second calvers followed by first, fifth, fourth and third calvers.

Shankar (2007) reported significant effect of genetic group and lactation order on dry period. The worker reported significantly (P<0.05) shorter dry period in graded Murrah than the Diara and Non-descript buffaloes but did not observe significant difference between Diara and Non-descript type in respect to this trait. He also reported that the dry period decreased significantly (P<0.05) with the increase in sequence of lactation and it was lowest in 3<sup>rd</sup> lactation.

# Calving Interval (CI)

Johari and Bhat (1979) reported the average first calving interval pooled over four genetic groups of buffaloes viz. Murrah, Murrah grades, Nili-Ravi and Nili grades to be 479.5±2.41 days.

Siddiquee *et al.* (1984) estimated the average First Calving Interval (FCI) and overall calving interval in Mehsana buffaloes to be 485.00±9.00 and 466.00±8.00 days respectively.

Kumar and Gupta (1992) reported the average calving interval in buffaloes maintained by different categories of households in Muzaffarnagar district of U.P. to be 484 days.

Singh (1992) reported the mean FCI in Mehsana buffaloes for UNION and LRS herds as 476.23±9.00 and 558.26±17.96 days respectively and the pooled FCI based on 621 observations as 492.02±11.24 days. The overall average estimates of calving interval in the respective herds were reported to be 468.23±5.85 and 502.12±11.25 days. These estimates are within the range as reported by Gajbhiye (1987) and Raheja (1992) in Murrah and by Tailor *et al.* (1990a) in Surti buffaloes.

Dev Raj and Gupta (1994) recorded the average calving interval in buffaloes local to the Churu district of Rajasthan to be 435 days.

Rao and Singh (1995) reported the average estimate for calving interval in Graded Murrah buffaloes to be 566 days.

Verma and Kherde (1995) estimated the average calving interval of buffaloes in upper Gangetic plain of U.P. to be 513 days.

Pathodiya et al. (1998) reported the average calving interval in Surti buffaloes to be 469.9±6.4 days.

Pundir et al. (2000) reported the overall calving interval in buffaloes over four parities as 478.81±13.41 days based on 1300 records.

Yadav et al. (2003<sup>a</sup>) reported the average calving interval in Murrah buffalo to be 477.08±13.73 days.

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Kumar (2004) estimated the average calving interval in graded buffaloes in and around Drabhanga of Bihar to be 449.87±4.15 days.

Sinha (2006) reported the average calving interval of three genetic groups of buffaloes i.e. Diara, Graded Murrah and Non-descript type in and around Barh, a subdivisonal town of Patna district in Bihar, to be 426.53±2.43, 416.35±2.67 and 430.86±2.43 days respectively and overall mean to be 424.58±1.45 days.

Shankar (2007) reported the least squares mean of calving interval in graded Murrah, Diara and Non-descript buffaloes native to Patna to be 424.32±2.60, 464.21±2.57 and 462.19±2.55 days respectively.

# Factors affecting calving interval

Johari and Bhat (1979) reported significant effect of farm and period on calving interval in buffaloes pertaining to Murrah, Murrah grades, Niliravi and Nili grades while effects of breed and season were non-significant.

Siddiquee et al. (1984) reported significant effect of period of calving on C.I. in both UNION and LRS herds while they have reported non-significant effect of parity on C.I. Non-significant effect of parity on C.I. was also reported by Tailor et al. (1998) in Surti and Mehsana and by Raheja (1992) in Murrah buffalo.

Singh (1992) observed the effects of parity on calving interval to be non-significant in both UNION and LRS herds of Mehsana buffaloes. However, the longest calving interval was reported to be in first parity in both the herds and then gradually decreased with the advancement of parity upto fourth lactation. Similar results were also reported by Pundir *et al.* (2000).

Kumar (2004) reported significant effect of parity on Calving Interval in dairy animals maintained in private Khatals of Dharbhanga (Bihar). The longest and the shortest calving intervals were reported to be in second and first parity respectively.

Shankar (2007) reported significant (P<0.01) effect of genetic group and lactation order on calving interval. He reported significantly (P<0.05) shorter calving interval in graded Murrah than Diara and Non-descript buffaloes, but did not observe significant difference between them. Calving interval is reported to be decreased significantly (P<0.05) with the increase in sequence of lactation and it was lowest in 3<sup>rd</sup> lactation.

### **Constraints in Livestock Farming**

Since the reports on constraints in livestock farming pertaining to buffaloes are very scanty, therefore, some relevant reports pertaining to cows are also mentioned here.

Bhoite and Shinde (1987) studied the constraints perceived by the farmers in adoption of scientific animal husbandry technology and reported that the major constraints in respect to animal breeding was non-availability of crossbred cattle in local market followed by 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 knowledge of scientific animal management (65.66%), shortage of capital (90.0%) and low price of milk (99.0%) were the serious constraints to successful dairy farming. In respect to animal health, unavailability 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 centres and Veterinary hospitals, and lack of finance were the common constraints in rearing high yielding cows.

Raju et al. (1993) reported that 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 in rearing of crossbred cattle.

Bhaskar et al. (1994) reported that in and around Bangalore, Friesian crossbreds were the animals of choice. High cost of feed stuffs was the major problem in rearing high yielding crossbred cows.

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 dairy development and the constraints perceived by dairy farmers in randomly selected two Mandals in Medak district of Andhra Pradesh. Majority of the farmers reported that non-remunerative price of 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 crossbred animals, non-availability of Veterinary services, distant location of A.I. centers, non-availability of good breeding bulls, lack of 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.

Sawarkar 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 resources (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%), nonavailability of stockmen on A.I. centre (5.2%) and non-availability of A.I. facility (5.2%) were the major constraints. Besides that, some social 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%).

Shankar (2007) made a comprehensive study on constraints in buffalo farming in and around Patna and reported that among the various constraints perceived by the farmers on the order of their ranking were the high cost of buffaloes, lack of proper housing due to costly land, non-availability of high yielding buffaloes in the locality, high incidence of repeat breeding, non-availability of green fodder throughout the year, high cost of feeds, fodder and feed supplements and high cost of veterinary medicine. Poor results of A.I., lack of finance/ credit facilities, uneconomical male calves and non-remunerative price of milk were also the constraints.

# MATERIALS AND METHODS

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### Source of Data

Three genetic groups of buffaloes namely Graded Murrah, Diara and Non-descript type maintained in unorganized private dairy units at farmer's door located in a radius of 15 km in and around Danapur (Bihar) were the experimental animals for the present study.

### Study area

The present study was conducted at Danapur which is a subdivision of Patna district adjacent to western part of Patna, the capital of Bihar. Since Danapur is extended longitudinally from east to west along the south Gangetic plane adjacent to the river Ganges, therefore, the whole study area was divided into three distinct zones, viz. East, West and Central Danapur. The villages covered under each zone were as follows:

Zone - 1 (East)

: Rukunpura, Rupaspur, Dhanaut,
Mahuabag, Jalalpur, Bhagwan bigha,
Sorangpur, Bishnupur.

Zone - 2 (Central)

: Hatikhana, Chandwari, Nagradha,
Sahpur, Rahmanpur, Pendapur, Amba,
Purandar chak.

Zone – 3 (West)

: Kotma, Golapur, Naya bigha, Garbhu chack, Manpura, Kheman bigha, Lodipur, Dariyachack, Lalbigha

### Geography

Danapur is located about 25°36' North latitude and 85°06' East longitude at an alttitude of 60 m. from mean sea level. Danapur is famous for having a Military Cantonment in its East and a Military air base at Bihta which is situated in western part of Danapur. On the basis of records for last 30 years, the month wise average of air temperature, relative humidity and rainfall obtained from meteorological centre, Patna have been mentioned in the following table.

Months	Particulars							
	Air temp. (°C)		Mean relative	humidity (%)	Rain fall (mm)			
	Max.	Min.	Morning	Evening	Average	Heaviest in a day		
January	23.3	9.2	76.0	57.0	18.9	104.9		
February	26.5	11.6	66.0	45.0	10.7	62.5		
March	32.6	16.4	50.0	30.0	11.4	52.0		
April	37.7	22.3	44.0	23.0	7.6	38.9		
May	38.9	25.2	56.0	32.0	33.3	132.3		
June	36.7	26.7	70.0	54.0	134.2	343.3		
July	33.0	26.2	83.0	74.0	305.8	664.7		
August	32.4	26.1	84.0	77.0	274.4	474.7		
September	32.3	25.4	82.0	76.0	226.9	636.3		
October	31.5	21.8	75.0	68.0	93.0	388.6		
November	28.8	14.7	70.0	60.0	8.9	70.4		
December	24.7	9.9	75.0	60.0	4.1	20.9		
Mean	31.5	19.6	69.0	55.0	-	-		

### **Primary Survey**

The primary survey was conducted in unorganized private dairy units popularly known as "khatal" located in a radius of 15 km in and around Danapur. A "door to door survey" method was utilized for enumeration of buffaloes from those khatals which had atleast two or more buffaloes consisting of Graded Murrah, Diara and Non-descript (Desi) types either alone or in combination. A "Khatal" may be described as small dairy units

managed in unorganized private sector with cows and /or buffaloes as the milk producing animal with prime objective of profitable milk production. Altogether 1295 buffaloes consisting of 479 Graded Murrah, 298 Diara and 518 Non-descript buffaloes were enumerated from 215 private dairy units located in and around Danapur. The details of zone-wise distribution of buffaloes are depicted in the following table:

Zone-wise distribution of enumerated dairy units and buffaloes of different genetic groups.

Zones	Dairy units enumerated		I		
		Graded Murrah	Diara	Non-descript	Total
I	71	158	98	171	427
II	86	192	119	207	518
III	58	129	81	140	350
Total	215	479	298	518	1295

# General Managerial Practices in Dairy units

The managerial practices in all the khatals were not quite the same and the approved scientific practices, particularly pertaining to feeding and physical as well as sexual health disease control measures, were not properly adopted by khatal owners. The animals were generally managed in sub-optimal conditions of housing and sanitation. But in order to fulfill the sole objective of profitable milk production, milch buffaloes were supplied with high quality concentrate mixture to challenge the animals to produce milk to their maximum. The roughages fed to the animals were generally of poor quality. In general, the animals were maintained on grazing and one time stall feeding in the evening was in common practice. Individual feeding was in practice. Physical and physiological status of the animals like body size, level of milk production, stage of lactation and gestation as well as dry period were the basis of quantum of concentrate mixture fed to

a particular animal. Barring a few exceptions of feeding branded ready made concentrate mixture like Sudha dana, Kapila Pashu Aahar etc, home made concentrate mixtures were fed to the animals. Lineseed or mustered cake along with cereals (Maize, broken wheat etc.), Pulses-chunni and wheat-bran were the chief ingredients of concentrate mixtures. Besan (flour gram), Molasses/gur and common salt were also fed to new calver buffaloes.

Wheat bhusa and dry maize straw were the common items of dry fodder. Seasonal cultivated green fodders like maize and jwar along with uncultivated green grasses were recorded to be the main source of green fodder. Mineral mixture and calcium preparation were not in common feeding practices in the study area.

Natural breeding with the available bull was the common practice to breed the animals.

In majority of cases buffaloes were maintained either in ½ Kutcha, 3/4<sup>th</sup> Pucca or even complete pucca houses. However, the housing pattern was not in accordance with the scientific norms. Thus, 4 types of houses were provided to the buffaloes under the study area in different units which are as follows:

Type A - Full Kutcha house

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

Type C - 3/4<sup>th</sup> Pucca house (wall, floors and feeding through pucca)

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

However, in some cases housing was provided only during night hours in the shed with kutcha floor and kutcha drain.

### Genetic groups of the animals

On the basis of physical attributes, the farmers were classifying buffaloes in the following three distinct groups viz. Punjabiya (Graded Murrah), Deshila (Diara) and Non-descript (other than above two types). In fact, the Punjabiya type of buffaloes were those having Murrah germ plasm in their ancestry. Buffaloes of this type were possessing some of the phenotypic characters of Murrah buffalo particularly spiral orientation of the horn, relatively lesser clearance of the body from the ground, small and typical face cut and jet black skin colour. The Deshila/Diara were true breeding population evolved in Tal and Diara area of North and South Gangatic plain. These buffaloes were medium in size having a different horn orientation and light black skin colour. The buffaloes which could not be described within the boundaries of any defined breed including the above two categories, were categorized as Non-descript.

### **Respondent Units**

The dairy units whose owners have provided the relevant information in connection with the present study were called as respondent units. Out of 215 enumerated units, only 180 units were the respondent units which provided the relevant information. The zone wise distribution of the respondent units along with number of buffaloes of different genetic groups are presented in table-1. The respondent units had 1180 buffaloes consisting of 436 graded Murrah, 283 Diara, 461 Non-descript buffaloes.

Table -1 Zone-wise distribution of dairy units and buffaloes of different genetic groups in respondent units.

Zones	Respondent Dairy Units				
		Graded Murrah	Diara types	Non-descript types	Total
I	64	144	93	153	390
II	70	174	113	185	472
III	46	118	77	123	318
Total	180	436	283	461	1180

### Sampling of respondent units

Out of the total 180 respondent units, 50% i.e. 90 diary units consisting of 670 buffaloes of different genetic groups were randomly selected utilizing the procedures of "Stratified random sampling with proportional allocation" (Snedecor and Cochran, 1967). Finally 540 buffaloes of different age and genetic groups were sorted out from these 90 respondent units for collection of information in the light of objective of this investigation. The zone-wise distribution of selected respondent units along with the number of buffaloes in three genetic groups namely Graded Murrah, Diara and Non-descript types and the number of discarded buffaloes have been presented in the table-2.

Table-2 Zone-wise distribution of buffaloes of different genetic groups in selected respondent units.

Particulars / Genetic	c Zones				
group	East	West	Central	Total	
No. of units selected	31	34	25	90	
No. of buffaloes studied					
Graded Murrah	64	77	54	198	
Diara	38	49	46	126	
Non-descript types	75	88	49	216	
Sub-total (A)	177	214	149	540	
Discarded buffalo					
Graded Murrah	13	18	17	48	
Diara	08	11	10	28	
Non-descript	15	20	18	54	
Sub-Total (B)	36	49	45	130	
Total (A+B)					
Graded Murrah	102	95	71	246	
Diara	46	60	56	154	
Non-descript	90	108	67	270	
Graded Total	213	263	194	670	

A total of 130 buffaloes were discarded due to their non-completion of one calving interval during the period of this study.

### Collection of Data

Data were recorded from the buffaloes of defined genetic groups which have completed at least one calving interval.

The information with respect to zone, genetic architecture of the animals, measures of production, reproduction, economic efficiencies and morphometric traits were recorded.

## Information of the unit:

- (a) Zone / Location
- (b) Farming System

### Information on the Buffaloes:

### (A) General:

- (a) Genetic architecture
  - (i) Graded Murrah
  - (ii) Diara
  - (iii) Non-descript
- (b) Herd size
- (c) Lactation order

# (B) Measures of production efficiency:

- (a) Lactation milk yield (kg)
- (b) Lactation length (days)
- (c) Peak yield (kg)
- (d) Days to attain peak yield (days)

- (e) Milk yield per day of lactation length (MY/LL) (kg)
- (f) Milk yield per day of calving interval kg (MY/CI) (kg)
- (g) Milk Production Efficiency per kg of body weight (MPEK) (kg)
- (h) Milk Production Efficiency per kg of body weight per day of lactation length (MPEKD) (g)

# (C) Measures of Reproduction efficiency:

- (a) Age at first calving (days)
- (b) Dry Period (days)
- (c) Calving interval (days)

### (D) Morphometric traits:

- (a) Height at withers (cm)
- (b) Body length (cm)
- (c) Heart girth (cm)

### (E) Body weight:

Schedule and questionnaires were prepared and given to the selected respondent units to record the relevant information as per the objectives of the present investigation. Frequent approaches were made to the selected respondent units to collect the data and monitor the data recording. Information obtained through personal interview was also included in the study.

### Classification of Data

The data were classified on the basis of genetic group of the buffaloes, location of herd (zone), herd size, farming system and lactation order to study the effect of various genetic and non-genetic factors on the

economic and morphometric traits. The various factors affecting the traits under study were classified in the following way:

### (1) Genetic groups:

The experimental animals under study were classified into three genetic groups such as :

- (i) Graded Murrah
- (ii) Diara
- (iii) Non-descript

# (2) Location of herd:

- (i) East
- (ii) West
- (iii) Central Danapur

### (3) Herd size:

- (i) 3-4
- (ii) 5-6
- (iii) 7 & above

### (4) Farming system:

The enumerated dairy units were grouped according to the farming system adopted by the farmers which are as follows:

- (i) Mixed farming (Animal husbandry integrated with agriculture)
- (ii) Dairy alone (Only animal husbandry)

# (5) Lactation order:

Performance records of the buffaloes were classified into six groups on the basis of sequence of lactation

- (i) 1<sup>st</sup> parity
- (ii) 2<sup>nd</sup> parity
- (iii) 3<sup>rd</sup> parity
- (iv) 4<sup>th</sup> parity
- (v) 5<sup>th</sup> parity
- (vi) 6<sup>th</sup> parity

# Statistical Method

# Startified random sampling with proportional allocation:

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

$$K$$

$$\sum_{i=1}^{N} N_{i} = N$$

$$K$$

$$\sum_{i=1}^{N} N_{i} = N$$

Let 
$$n_i \propto N_i$$
  
or,  $n_i = C N_i$  .....(1)

Where,

C is the constant of proportionality.

After taking summation on both the sides, we get

$$\begin{array}{ll} K & K \\ \sum n_i & = C \ \sum n_i \\ i = 1 & i = 1 \end{array}$$

Or, n = CN

Hence, n/N = C (constant)

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

$$n_i = \frac{(n) N_1}{(N)}$$
 (i = 1, 2, 3 ....., 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<sub>i</sub> and  $y_{ij}$  be the corresponding sample observation (i=1,2,3,..... K and j=1,2,3,.... hen population mean  $\overline{Y}$  is given by:

$$K \qquad N_{i}$$

$$Y_{ij} = 1/N \qquad \sum \qquad \sum \overline{y}_{ij}$$

$$i = 1 \quad i = 1$$

$$K \qquad \qquad K$$

$$= 1/N \qquad \sum N_{i} \overline{y}_{ij}$$

$$i = 1$$

Where,

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

The population variance

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

$$N_i$$
  
= $\sum w_i^2 (1/n_i - 1/N_i) s_i^2$   
 $i = 1$ 

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

Similarly, the sample mean can be defined as:

Where, Y1 = 1/K 
$$\sum_{i=1}^{K} y_{ij}$$
 i.e. the sample mean of the i<sup>th</sup> strata and i = 1

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

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

$$Ni s_i^2 = 1/n1 - 1\sum_{i=1}^{N} w_i^2 (Y_{ij} - y_i)^2 i = 1$$

# Least squares analysis

To quantify the variation due to various genetic and non-genetic factors on morphometric, milk production efficiency and reproduction efficiency traits, the data were subjected to Least squares analysis (Harvey, 1966) for which the following mathematical model was utilized:

$$Y_{iiklmn} = \mu + G_i + Z_j + HS_k + F_l + P_x + e_{ijklmn}$$

Where  $Y_{ijklmn}$  = The value of  $m^{th}$  individual under  $i^{th}$  genetic group,  $j^{th}$  location,  $k^{th}$  herd size,  $l^{th}$  farming system and  $m^{th}$  parity

 $\mu$  = The overall population mean

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

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

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

 $F_1$  = The effect of  $l^{th}$  farming system (l = 1, 2,)

 $P_m$  = The effect of m<sup>th</sup> parity (m = 1, 2, 3, 4, 5, 6)

 $e_{ijklmn}$  = The random error associated with individual which is randomly and independently distributed with mean zero and variance  $\sigma_e^2$ 

The statistical significance of various fixed effects was tested by F test whereas DMRT, as modified by Kramer (1957), was applied to carry out the pair-wise comparisons among least squares means at 0.05 and 0.01 levels of probability.

# Estimation of body weight

Body weight of the animals was estimated by utilizing the following formula based on their body measurements

Weight of buffalo (in pound) =  $(L \times G^2) / 300$ 

L = Length of animal in inch

G = Heart girth of animal in inch

1 Kg = 2.2046 lbs

### Constraints in dairy farming

The respondents were requested to provide the important technological and managemental problems perceived by them in maintaining the dairy units in and around Danapur. Garett's ranking technique was used to rank the problems. The order of merit, thus given by the respondents, were converted into ranks by using the following formula (Garett & Woodworth, 1969).

Percent position =  $100 (R_{ij} - 0.5) / N_j$ 

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

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

The percent position of each rank was converted into scores by referring Garett's ranking table. 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.

 $e_{ijklmn}$  = The random error associated with individual which is randomly and independently distributed with mean zero and variance  $\sigma_e^2$ 

The statistical significance of various fixed effects was tested by F test whereas DMRT, as modified by Kramer (1957), was applied to carry out the pair-wise comparisons among least squares means at 0.05 and 0.01 levels of probability.

### Estimation of body weight

Body weight of the animals was estimated by utilizing the following formula based on their body measurements

Weight of buffalo (in pound) =  $(L \times G^2) / 300$ 

L = Length of animal in inch

G = Heart girth of animal in inch

1 Kg = 2.2046 lbs

### Constraints in dairy farming

The respondents were requested to provide the important technological and managemental problems perceived by them in maintaining the dairy units in and around Danapur. Garett's ranking technique was used to rank the problems. The order of merit, thus given by the respondents, were converted into ranks by using the following formula (Garett & Woodworth, 1969).

Percent position =  $100 (R_{ij} - 0.5) / N_j$ 

Where  $R_{ij} = Rank$  given for i<sup>th</sup> constraints by j<sup>th</sup> individual

 $N_i = Number of factors ranked by j<sup>th</sup> individual$ 

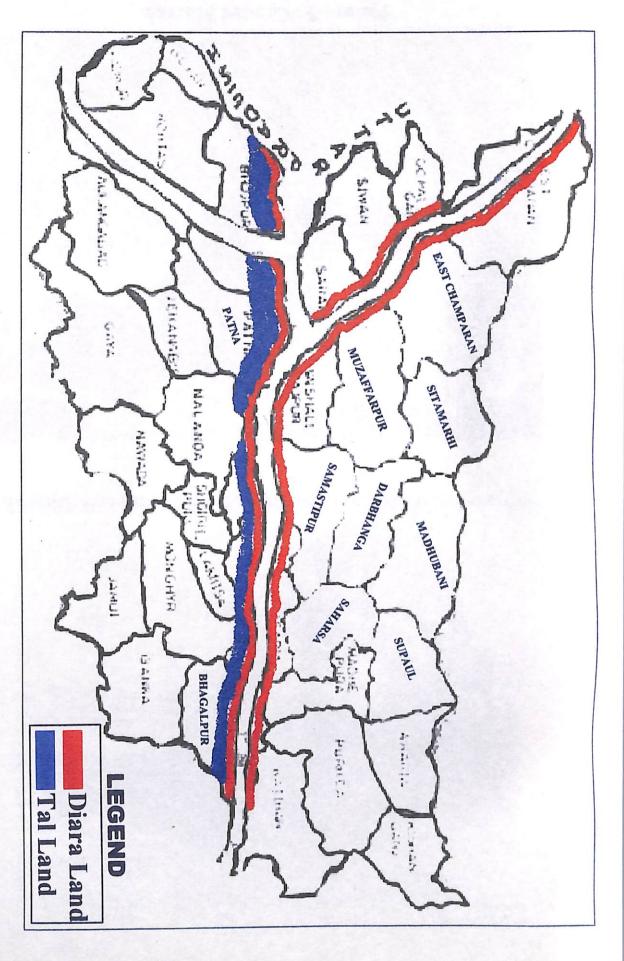
The percent position of each rank was converted into scores by referring Garett's ranking table. Then for each factor the scores of individual respondents were added. The mean scores for all the factors were arranged in descending order and ranked.

# RESULTS AND DISCUSSION

# RESULTS AND DISCUSSION

The area under South and North Gangetic planes of Bihar is densely populated with clusters of Buffalo. However, small buffalo herds are distributed throughout the length and breadth of the State. Majority of them are Non-descript, some are Graded Murrah and rest of the population is "true breeding" type which are locally known as Diara / Deshila / Bhuria. As a state Breeding Policy, Murrah males had been used to breed Non-descript buffaloes in Bihar since long under the different breed improvement programmes like Intensive Rural Development Programme (IRDP), Intensive Cattle Development Programme (ICDP), Key Village Scheme (KVS) etc. Resultantly, clusters of buffalo populations consisting of Graded Murrah has grown up and inter-se-mating followed by natural and artificial selection for several generations might have resulted into evolution of Diara buffalo. The breeding tract of Diara buffalo has been extended from Buxar in the west to Rajmahal in the east of North and South Gangetic planes of Bihar (Picture-1).

From the study it could be revealed that phenotypically Diara buffaloes are light black to brown or silver gray (Bhuria) in colour (Picture-2) whereas Graded Murrah (Picture-3) and Non-descript (Picture-4) types are jet black in colour. Switch of the tail is either black or brown in Diara buffalo whereas black or white in Graded Murrah and Non-descript types. Sometimes there is white marking on the forehead and feet below the fetlock joint in Non-descript type. Muzzle, hoofs and horn are usually black in colour in all the genetic groups. In Diara buffalo, horns are dorso-ventrally flat, loosely coiled and emerging from side of the head extended backward and inward direction. In case of Graded Murrah, the horns are short and tightly curved and in Non-descript types horns are generally large and of irregular in shape. The results of production, reproduction and



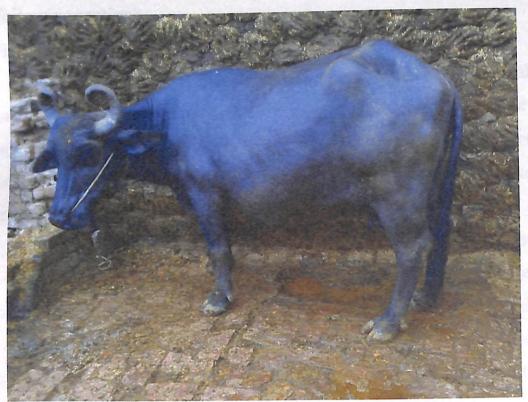
Picture-1: Breeding tract of Diara buffalo



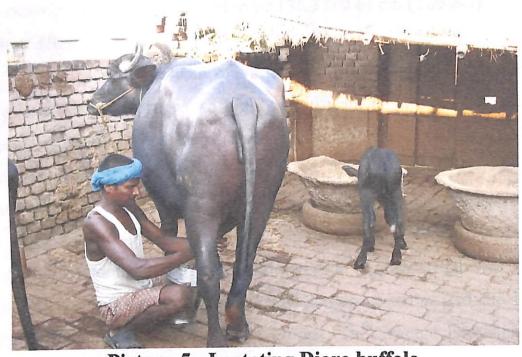
Picture-2: Adult female of Diara buffalo with calf (Bhura).



Picture-3: Graded Murrah.



Picture-4: Non-Descript buffalo.



Picture-5: Lactating Diara buffalo.

morphometric traits of these three genetic groups have been presented in the following sections.

#### MORPHOLOGICAL TRAITS

Body weight, size and body measurement traits of an animal are related with its productivity and they have important role in input and output relationship. In the present investigation three body measurement traits namely Body length, Heart girth and Height at wither were taken as morphometric traits. Body size of animal was measured in term of body weight. Since taking weight of a large animal under field condition is very difficult, therefore, the live body weight of buffaloes were estimated by utilizing formula based on their body measurements. In the light of objective of this study the data were subjected to Least squares analysis utilizing relevant mathematical models and accordingly the results are presents in tables 3-23.

#### **BODY LENGTH**

The overall least squares mean for Body Length (BL) of buffaloes consisting of three different genetic groups viz. Graded Murrah, Diara and Non-descript type was estimated to be 136.37±0.61 cm (Table-3).

## Factors affecting body length

Least squares analysis of variance (Table-4) revealed that genetic group and lactation order had highly significant (P<0.01) effect on body length. Location of herd, herd size and farming system had no significant influence on this trait.

## Genetic group

The genetic group had highly significant (P<0.01) effect on body length and its contribution to the total variation in body length was 39.43% (Table-4). As evident from table-3, the Graded Murrah had the longest body length among all the genetic groups. The average body length of Graded Murrah was found to be 139.16±0.63 cm, which was significantly (P<0.05) longer than the Diara and Non-descript buffaloes by 3.63 and 4.78 cm respectively. Although Diara buffaloes were little bit longer than the

Non-descript type but did not differ significantly. The overall population mean and the mean values obtained in three genetic groups viz. Graded Murrah, Diara and Non-descript buffaloes included in this study were very much comparable to the findings available in the literature. The average estimates for body length in all the three genetic groups obtained in the

Table 3: Least squares mean±S.E. and CV% of Body Length (BL), Heart Girth (HG) and Height at Wither (HAW) of buffaloes in and around Danapur (Patna).

(Tama).	Mean±SE				
Particulars	BL (cm) (CV%)	HG (cm) (CV%)	HAW (cm) (CV%)		
Population mean	136.37 <u>+</u> 0.61 (1.77)	195.30 <u>+</u> 1.30 (3.43)	130.36 <u>+</u> 0.80 (1.47)		
Factors					
Genetic group					
Graded Murrah	139.16 <sup>a</sup> ±0.63 (1.70)	199.62 <sup>a</sup> ±1.34 (3.27)	132.77 <sup>a</sup> ±0.62 (1.41)		
Diara buffalo	135.53 <sup>b</sup> ±0.67 (1.71)	192.29 <sup>b</sup> ±1.42 (3.41)	$130.14^{b} \pm 0.66 (1.43)$		
Non-descript type	134.38 <sup>b</sup> ±0.65 (2.75)	194.00 <sup>b</sup> ±1.36 (2.34)	· 128.00°±0.63 (3.67)		
Location of herd					
East	136.26 <u>+</u> 0.66 (1.72)	195.00 <u>+</u> 1.39 (3.35)	130.11 <u>+</u> 0.64 (1.44)		
West	136.41±0.66 (1.72)	195.57 <u>+</u> 1.39 (3.35)	130.27 <u>+</u> 0.64 (1.44)		
Central	136.45±0.64 (1.72)	195.32 <u>+</u> 1.35 (3.35)	130.63 <u>+</u> 0.62 (1.44)		
Herd size					
3-4	136.26±0.62 (1.72)	195.61 <u>+</u> 1.31 (3.38)	130.15±0.60 (1.47)		
5-6	136.81±0.59 (1.72)	195.82 <u>+</u> 1.24 (3.39)	130.69 <u>+</u> 0.57 (1.48)		
7 & above	135.94±0.82 (1.72)	194.46 <u>+</u> 1.74 (3.33)	130.16±0.80 (1.47)		
Farming system					
Dairying alone	135.39 <u>+</u> 0.21 (1.73)	193.92 <u>+</u> 0.45 (1.92)	129.34 <u>+</u> 0.21 (1.45)		
Mixed farming	137.36±1.19 (1.74)	196.68 <u>+</u> 2.50 (1.94)	131.33±1.15 (1.46)		
Lactation order					
1 <sup>st</sup>	131.91 <sup>a</sup> ±0.78 (1.78)	187.93 <sup>a</sup> ±1.64 (1.99)	126.08 <sup>a</sup> ±0.75 (1.50)		
2 <sup>nd</sup>	132.09 <sup>a</sup> ±0.66 (1.77)	190.34 <sup>a</sup> ±1.39 (1.98)	128.13 <sup>b</sup> ±0.64 (1.51)		
3 <sup>rd</sup>	135.44 <sup>b</sup> ±0.66 (1.84)	196.47 <sup>b</sup> ±1.40 (1.96)	130.33°±0.64 (1.52)		
4 <sup>th</sup>	138.54°±0.69 (1.92)	200.20°±1.46 (2.00)	131.42 <sup>d</sup> ±0.67 (1.53)		
5 <sup>th</sup>	138.49°±0.68 (1.92)	200.01°±1.44 (2.00)	131.06 <sup>d</sup> ±0.67 (1.52)		
6 <sup>th</sup>	138.87°±0.68 (1.92)	200.14°±1.44 (2.00)	131.08 <sup>d</sup> ±0.67 (1.52)		

- Means with similar superscripts (column wise) did not differ significantly
- Values in parenthesis indicating CV%

present study were lower than the body length of Murrah breed of buffaloes as reported elsewhere by Jawarkar and Johar (1975), Sreedharan (1976) and Manik and Eqbalnath (1981). Mehsana buffaloes had also longer body length as reported by Randhawa (1958), Prajapati (1988) and Singh et al. (1995). However, comparatively shorter body length has been reported by Nandedkar et al. (2006) in Nagpuri buffaloes, Singh and Singh (1998) and Kushwaha et al. (2006) in Badhawari and Jogi and Patel (1990) in Surti buffaloes. The average estimates for body length in all the three genetic groups obtained in the present study were similar to the estimates reported by Shankar (2007). Significant (P<0.05) effect of genetic group on body length reported by Sinha (2006), Singh et al. (2006) and Shankar (2007) was in agreement with the findings of the present study. Thus it can be stated that the buffaloes in and around Danapur (Bihar) were shorter in length than the Murrah and Mehsana but longer than the Surti, Bhadawari and Nagpuri.

Table: 4 Least squares analysis of variance for the effect of genetic and non-genetic factors on Body Length (B.L.) of buffaloes in and around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	918.7876	101.128**	39.43
Location/zone	2	1.3522	0.149	0.58
Herd size	2	18.2838	2.012	0.78
Farming system	1	25.5099	2.809	1.09
Lactation order	5	1357.0940	149.371**	58.24
Error	527	9.0854		

<sup>\*\* =</sup> Significant at P<0.01

## Location of herd

As evident from table-3, the average estimate of body length was found to be ranged from 136.26±0.66 cm in the animals located in East Danapur to 136.45±0.64 cm in the animals located in Central Danapur. The

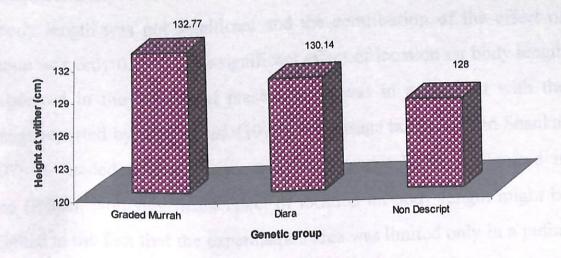


Fig. 1: Graph showing the average height at wither (cm) of buffaloes in and around Danapur.

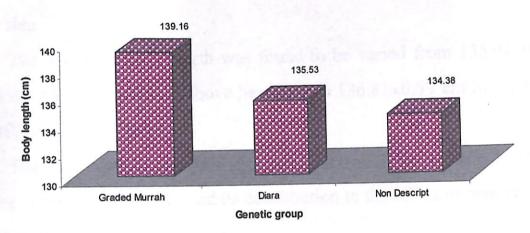


Fig. 2: Graph showing the average body length (cm) of buffaloes in and around Danapur.

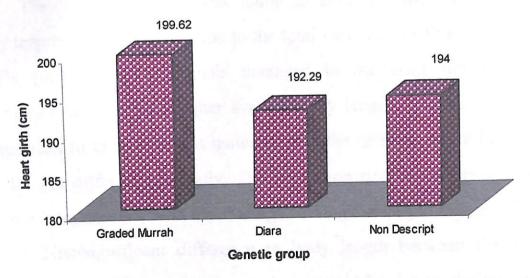


Fig. 3: Graph showing the average Heart girth (cm) of buffaloes in and around Danapur.

least squares analysis of variance revealed that the effect of location of herd on body length was not significant and the contribution of the effect of location was only 0.58%. Non-significant effect of location on body length as observed in the finding of present study was in agreement with the findings reported by Singh *et al.* (1995) in Mehsana buffaloes and Shankar (2007) in Graded Murrah, Diara and Non-descript buffaloes located in Patna (Bihar). Non-significant effect of location on body length might be attributed to the fact that the experimental area was limited only in a radius of 15 km which was divided into three zones and as such there was not much variation in agro-climatic condition between different zones.

#### Herd size

The average body length was found to be varied from 135.94±0.82 cm in the animals of 7 and above herd size to 136.81±0.59 cm in the herd size of 5-6 animals (Table-3).

The least squares analysis of variance revealed non-significant effect of herd size on body length and its contribution to the effect of herd size on body length was only 0.78%.

## **Farming system**

The farming system was found to have non-significant effect on body length and its contribution to the total variation for this trait was only 1.09% (table-4). The animals managed in the units integrated with agriculture farming had higher average body length (137.36±1.19 cm) in comparison to those animals maintained in the dairying alone by 1.97 cm but did not differ significantly. The results obtained in the present study was not in agreement with the findings of Singh *et al.* (1995<sup>a</sup>) and Shankar (2007). Non-significant difference in body length between the animals managed under different farming systems might be due to similar level of management practices prevailing in both the farming systems.

### **Parity**

As evident from table-4, the lactation order has highly significant (P<0.01) effect on body length and its contribution to the total variation was 58.24%. The body length was found to be the lowest in the animals of 1<sup>st</sup> parity and then increased significantly (P<0.05) upto 4<sup>th</sup> lactation. The body length was continued to be increased upto 6<sup>th</sup> lactation but did not differ significantly from those animals in 4<sup>th</sup> and 5<sup>th</sup> lactations. Significant (P<0.05) influence of parity on body length observed in the present study has also been reported by Jawarkar and Johar (1975), Saini and Gill (1987), Joggi and Patel (1990) in Murrah buffaloes and by Singh *et al.* (1995) and Singh *et al.* (2000) in Mehsana buffaloes and by Shankar (2007) in buffaloes of Patna. Shankar (2007) reported significant increase of body length upto 3<sup>rd</sup> parity. Significant (P<0.05) increase in body length upto 4<sup>th</sup> parity of the present study revealed that the skeletal maturity in buffaloes may be taken place upto the age at 4<sup>th</sup> parity.

#### **HEART GIRTH**

The overall least squares mean±SE for heart girth pooled over three genetic groups of buffaloes viz. Graded Murrah, Diara and Non-descript was estimated to be 195.30±1.30 cm (Table-3).

## Factors affecting heart girth

Least squares analysis of variance revealed significant (P<0.01) influence of genetic group and order of lactation on heart girth (Table-5). However the influence of location, herd size and farming system was not significant. Least squares means for heart girth of buffaloes under the influence of various factors have been presented in table-3.

## Genetic group

Genetic group had highly significant (P<0.01) influence on heart girth and its contribution to the total variation was reconed to be 30.30% (Table-5). As evident from table-3, the Graded Murrah had the largest heart

girth (199.62±1.34 cm) which was significantly (P<0.05) higher than the Diara and Non-descript buffaloes by 7.33 and 5.62 cm. The Diara buffalo had the lowest heart girth among all the genetic groups but did not differ significantly from the Non-descript. The overall population mean and the mean values for heart girth observed in the present study were very much comparable with the findings available in the literature. The findings of the present study were not in agreement with the findings of Jowarkar and Johar (1975), Sreedharan (1976) and Manik & Iqbalnath (1981) who reported higher estimates of heart girth in Murrah buffaloes. Higher estimates of heart girth were also reported by Randhawa (1958), Prazapati (1988) and Singh et. al. (1995) in Mehsana buffaloes. Comparatibly shorter heart girth is reported by Nandedkar et al. (2006) in Nagpuri buffaloes, by Singh and Singh (1998) and Kushwaha et al. (2006) in Bhadawari and Jogi & Patel (1990) in Surti buffaloes. However, the results obtained in the present study are in agreement with the findings of Sinha (2006) and Shankar (2007). Therefore, it can be concluded that the buffaloes in and around Danapur (Bihar) were shorter in heart girth than the Murrah and Mehsana buffaloes but larger than the Surti, Bhadawri and Nagpuri.

Table: 5 Least squares analysis of variance for the effect of genetic and non-genetic factors on Heart Girth (H.G) of buffaloes in and around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	1886.54.80	46.6503**	30.30
Location/zone	2	14.0010	0.3462	0.22
Herd size	2	24.1520	0.5972	0.39
Farming system	1	50.4032	1.2464	0.81
Lactation order	5	4210.5130	104.117**	67.62
Error	527	40.4402		

<sup>\*\* =</sup> Significant at P<0.01

#### Location

As evident from table-3, the average chest girth was found to be ranged from 195.00±1.39 cm in the animals located in East Danapur to 195.57±1.39 cm in the animals located in west Danapur. The least sqares analysis of variance (table-5) revealed non-significant effect of location on heart girth and contribution of location of the herd to the total variation was only 0.22%. The results obtained in the present study were in confirmation with the findings reported by Singh *et al.* (1995<sup>a</sup>) in Mehsana buffaloes and Shankar (2007) in buffaloes of Patna. Non-significant effect of location on heart girth observed in the present investigation might be attributed to the fact that the experimental area was limited in a radius of 15 km only, which was divided into three zones and as such there was not much variation in agro-climatic condition between different zones.

#### Herd size

The average heart girth was found to be varied from 194.46±1.74 cm in the herd of 7 and above group to 195.82±1.24 cm of the animals in the herd size of 5-6 (Table-3). The least squares analysis of variance (Table-5) revealed non-significant influence of herd size on heart girth and contribution of the effect herd size to the total variation was only 0.39%. The results obtained in the present study could not be compared due to non-availability of the report in the literature in respect to this trait.

# Farming system

The effect of farming system on heart girth was found to be non-significant and its contribution to the total variation for heart girth was only 0.81 (Table-5). The animals managed in the units integrated with agriculture farming had higher average heart girth (196.68±2.50 cm) than those animals involved in dairying alone by 2.76 cm but did not differ significantly. The results obtained in the present investigation were not in agreement with the findings of Singh *et al.* (1995) and Shankar (2007) who

observed significant difference in heart girth among all the age groups of Mehsana buffaloes and buffaloes in and around Patna respectively where animals were managed under farmers management system. Non-significant difference in heart girth between animals managed under different farming system might be due to almost similar level of management practices were given to the animals in and around Danapur.

## **Parity**

As evident from table-5, the lactation order had highly significant (P<0.01) effect on heart girth and its contribution to the total variation for this trait was 67.62%. The average heart girth pooled over all the three genetic groups was found to be the lowest (187.93±1.64 cm) at first parity.

The average estimates of heart girth at 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> parities were observed to be increased significantly (P<0.05) than the average heart girth at first parity by 8.54, 11.27, 12.08 and 12.9 cm respectively. The average heart girth at 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> parities were also significantly (P<0.05) larger than the animals of third parity by 2.73, 3.54 and 4.37 cm respectively. However, differences among 4th, 5th and 6th parities were nonsignificant. The trend of variation in heart girth was similar to the trend of variations as observed in body length. Significant effect of parity on heart girth was also reported by Jowarkar and Johar (1975), Saini and Gill (1987), Jogi and Patel (1990) in Murrah buffaloes, Singh et al. (1995) and Singh et al. (2000) in Mehsana buffalo and Shankar (2007) in buffaloes in and around Patna. Significantly (P<0.05) increased in heart girth upto 4th parity as observed in the present study was not in confirmation with the findings of those workers as mentioned above who reported significant increase of heart girth upto 3<sup>rd</sup> parity. Significant (P<0.01) increase in heart girth up to 4th parity as observed in the present investigation revealed that skeletal maturity of buffaloes pertaining to this study is attained upto 4th parity.

#### HEIGHT AT WITHER

The overall least squares means for height at wither of buffaloes consisting of Graded Murah, Diara and Non-descript types in and around Danapur was calculated to be 130.36±0.80 cm (Table-3).

# Factors affecting height at wither

Least squares analysis of variance (Table-6) revealed that effect of genetic group and lactation order was highly significant (P<0.01) on height at wither, while the location of the herd, herd size and farming system did not influence this trait.

## Genetic group

As evident from table-6, the genetic group had highly significant (P<0.01) influence on height at wither and its contribution to the total variation for height at wither was 38.59%. As evident from table-1, the Graded Murrah was the tallest (132.77±0.62 cm) among all the genetic groups. The Graded Murrah was significantly (P<0.05) taller than the Diara and Non-descript buffaloes by 2.63 and 4.77 cm respectively and Diara buffalo was significantly (P<0.05) taller than the Non-descript by 2.14 cm. The average estimates of height at wither obtained in the present study were very much comparable to the findings available in the literature for other breeds. The mean values obtained in the present study were lower than those reported elsewhere for Murrah by Jowarkar and Johar (1975); Sreedharan (1976) and Manik & Iqbal Nath (1981). Contrary to these mean values reported by Prazapati (1988) and Singh et al. (1995) in Nagpuri, by Jogi and Patel (1990) in Surti and by Singh and Singh (1988) and Kushwaha et al. (2006) in Bhadawari buffaloes were lower than the mean values observed in the present study. However, the mean values reported by Sinha (2006) and Shankar (2007) for Graded Murrah, Diara and Nondescript buffaloes in Barh and Patna respectively were in accordance with the results obtained in the present study. Thus, it may be concluded that Graded Murrah, Diara and Non-descript buffaloes in and around Danapur (Bihar) were observed to be smaller and lighter than Murrah but heavier than Mehsana, Surti, Bhadawari and Nagpuri buffaloes.

Table: 6 Least squares analysis of variance for the effect of genetic and non-genetic factors on height at wither (HAW) of buffaloes in and around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	856.7219	99.4696**	38.59
Location/zone	2	8.0986	0.9403	0.364
Herd size	2	19.2966	2.2404	0.87
Farming system	1	26.0295	3.0222	1.17
Lactation order	5	1301.2080	151.0766**	58.61
Error	527	8.6129		

<sup>\*\* =</sup> Significant at P<0.01

#### Location

As evident from table-3, the height at wither was found to be ranged from 130.11±0.64 cm in East to 130.63±0.62 cm in the central Danapur (Table-3). Least squares analysis of variance (Table-6) did not reveal significant influence of location of herd on this trait as the total study area was limited in a radius of 15 km and as such variation due to agro-climatic conditions did not observe on this trait.

#### Herd size

As evident from table-6, the effect of herd size on height at wither was not significant and its contributions to the total variation for this trait was only 0.87%. The height at wither was found to be ranged from 130.15±0.60 cm in the animals maintained in the group of 3 to 4 to 130.69±0.75 cm of those animals maintained in the herd size of 5-6 (Table-3). The findings observed in the present study could not be compared due to non-availability of reports in the literature.

### Farming system

As evident from table-6, the effect of farming system on height at wither was non-significant and it contribution to the total variation for this trait was only 1.17%. The average height at wither of the animals reared under mixed farming system integrated with agriculture had higher estimate of HAW than those animals managed in the units involved in dairying alone by 1.99 cm but did not differ significantly. Significantly (P<0.05) higher estimates of HAW for animals maintained under farmer's management system reported by Singh *et al.* (1995<sup>a</sup>) and Shankar (2007) were not in consonance with the findings of the present study.

### **Parity**

Least squares analysis of variance (Table-6) revealed significant (P<0.01) effect of lactation order on HAW and its contribution to the total variation was reckoned to be 58.61%. The least squares mean for HAW was lowest (126.08±0.75 cm) in first parity. The average HAW was found to be increased significantly (P<0.05) upto 4th parity and the difference between 1st and 4th parity was 5.34 cm. However, the difference in HAW from 4th to 6th lactation did not differ significantly. The average HAW at 4th parity was also significantly (P<0.05) higher than the 2<sup>nd</sup> and 3<sup>rd</sup> parity by 3.29 and 1.09 cm respectively. Significant (P<0.01) influence of parity on HAW as observed in the present study was in accordance with the findings of many workers viz. Jowarkar and Johar (1975), Saini and Gill (1987), Jogi and Patel (1990), Singh et al. (1995) and Shankar (2007). However, all the workers reported significant increase in HAW upto 3<sup>rd</sup> parity, which is not in consonant with the findings of the present study. Significant (P<0.05) increase in HAW upto 4th parity indicated the fact that skeletal maturity of buffaloes in and around Danapur attained at 4th parity which might be due to more influence of growth hormone upto that period.

#### **BODY WEIGHT**

The overall least squares mean for body weight of buffaloes consisting of three genetic groups namely Graded-Murrah, Diara and Nondescript types in and around Danapur was estimated to be 483.08±7.34 kg (Table-7). Jowarkar and Johar (1975), Sreedharan (1976) and Saini and Gill (1991) reported higher estimates of body weight at maturity in Murrah buffalo. Taneja (1999) also reported higher estimate of body weight at maturity in Mehsana buffalo. However, Taneja (1999) reported lower average body weight at maturity in Surti and Bhadawri buffalo.

### Factors affecting body weight

Least squares analysis of variance (Table-8) revealed significant (P<0.01) effect of genetic group and lactation order on body weight. The effect of location of herd, herd size and farming system was found to be non-significant. Least squares means for different levels of factors influencing body weight of buffaloes are presented in table-7.

### Genetic group

As evident from table-8, the genetic group had highly significant (P<0.01) effect on body weight and its contribution to the total variation was reckoned to be 31.88%. As evident from table-7, the Graded Murrah was the heaviest (514.48±7.59 kg) followed by Non-descript and Diara buffalo. Diara and Non-descript buffaloes were significantly (P<0.05) lighter than the Graded Murrah by 49.83 and 44.36 kg respectively but they did not differ among themselves in respect to this trait. Significant effect of genetic group on body weight as observed in the present study was also reported by Johari and Bhat (1979), Sinha (2006) and Shankar (2007). Significantly (P<0.05) lower body weight of Diara and Non-descript buffaloes in comparison to Graded Murrah reported by Shankar (2007) was in agreement with the findings of the present study. As the body size and weight of animals vary from breed to breed and environment to environment, therefore, the estimates obtained in the present study substantiates the findings of the other workers.

Table 7: Least squares mean + S.E. and CV% of Body weight (BW) of buffaloes in and around Danapur (Patna).

D4'1	Mean <u>+</u> SE
Particulars	Body weight (kg)
Population mean	483.08 <u>+</u> 7.34 (7.14)
Factors	
Genetic group	
Graded Murrah	514.48 <sup>a</sup> ±7.59 (6.63)
Diara buffalo	464.65 <sup>b</sup> ±8.06 (7.27)
Non-descript type	470.12 <sup>b</sup> ±7.74 (6.89)
Location of herd	
East	482.00 <u>+</u> 7.88 (6.95)
West	484.28 <u>+</u> 7.87 (9.66)
Central	482.97 <u>+</u> 7.63 (6.99)
Herd size	
3-4	484.30 <u>+</u> 7.42 (7.21)
5-6	487.67 <u>+</u> 7.05 (7.31)
7 & above	477.29 <u>+</u> 9.85 (7.24)
Farming system	
Dairying alone	474.57 <u>+</u> 2.54 (7.16)
Mixed farming	491.59 <u>+</u> 14.19 (6.89)
Lactation order	
1 st	421.38 <sup>a</sup> ±9.28 (7.93)
2 <sup>nd</sup>	442.37 <sup>a</sup> ±7.88 (7.87)
3 <sup>rd</sup>	475.28 <sup>b</sup> ±7.93 (7.92)
4 <sup>th</sup>	528.12°±8.27 (6.34)
5 <sup>th</sup>	527.93°±8.18 (6.33)
6 <sup>th</sup>	522.42°±8.19 (6.21)

- Means with similar superscripts (column wise) did not differ significantly.
- Values in parenthesis indicating CV%

#### Location

As evident from table-7, the average body weight of the animals varied from  $482.00 \pm 7.88$  Kg in the east to  $484.28 \pm 7.87$  Kg in the west. The least squares analysis of variance revealed non- significant effect of location on body weight and its contribution to the total variation for this trait was only 0.08% (Table-8). Non-significant effect of location on body weight observed in the present study was also reported by Shankar (2007). Non-significant effect of location on body weight observed in the present study might be attributed to the fact that the experimental area was limited in a radius of 15 Km which was divided into three zones as such there was not much variation in agro- climatic condition between the zones.

#### Herd size

The animals maintained in the herd size of 5-6 had the highest average body weight (487.67±7.05 kg) followed by those maintained in herd size of 3-4 and 7 & above groups (Table-7). However, the least squares analysis of variance (Table-8) did not reveal significant effect of herd size on body weight. The results obtained in the present study could not be compared due to non- avaibility of reports in the literature.

Table 8: Least squares analysis of variance for the effect of genetic and non-genetic factors on Body weight of buffaloes in and around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	99081.7800	76.138**	31.88
Location/zone	2	232.2345	0.1785	0.075
Herd size	2	1737.7500	1.3354	0.56
Farming system	1	1912.8760	1.4699	0.62
Lactation order	5	206552.9000	158.7228**	66.45
Error	527	1301.3440		

<sup>\*\* =</sup> Significant at P<0.01

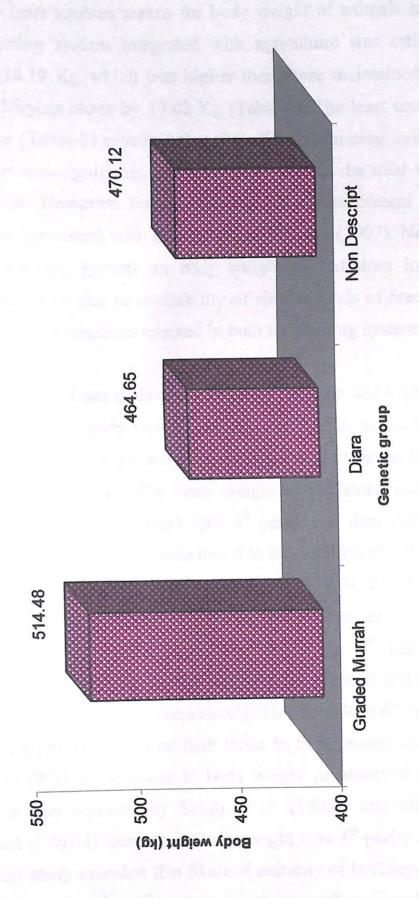


Fig. 4: Graph showing the average body weight (kg) of buffaloes in and around Danapur.

### Farming system

The least squares means for body weight of animals maintained in mixed farming system integrated with agriculture was estimated to be  $491.59 \pm 14.19$  Kg which was higher than those maintained in the units involved dairying alone by 17.02 Kg (Table-7). The least squares analysis of variance (Table-8) revealed that the effect of farming system on body weight was non-significant and its contribution to the total variation was only 0.62 %. However, the results obtained in the present investigation were not in agreement with the finding of Shankar (2007). Non-significant effect of farming system on body weight of buffaloes in and around Danapur might be due to availability of similar kinds of feeds and fodder and management practices adopted in both the farming systems.

### **Parity**

As evident from table-8, the order of lactation had highly significant (P<0.01) effect on body weight and its contribution to the total variation was 66.45%. The average body weight was found to be the lowest (421.38 ±9.28kg) in first parity. The body weight of buffaloes was found to be increased significantly(P<0.05) upto 4<sup>th</sup> parity and then started declining. The animals in 4<sup>th</sup> lactation were found to be significantly (P<0.05) heavier than those in first, second and third parity by 106.74, 85.75 and 52.84 Kg respectively. The differences in body weight between animals of 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> parity were non-significant. The animals in 5<sup>th</sup> parity were also significantly (P<0.05) heavier than those in first, second and third parity by 106.74, 85.75 and 52.84 kg respectively. The animals in 6<sup>th</sup> parity were also significantly (P<0.05) heavier than those in first, second and third parity. Significant (P<0.05) increase in body weight as observed in the present study was also reported by Singh et al. (1995a) and Shankar (2007). Significant (P<0.05) increase in body weight upto 4<sup>th</sup> parity as observed in the present study revealed that Skeletal maturity of buffaloes pertaining to this study is achieved at 4th parity when the animals are nearly 7-8 years of age.

### MEASURES OF MILK PRODUCTION

Lactation milk yield, Lactation length, Peak yield, Days to attain peak yield, Milk production efficiency traits in terms of Milk Yield per day of Lactation Length, Milk Yield per day of Calving Interval, Milk production efficiency per kg body weight and Milk production efficiency per kg body weight per day of lactation length were taken as measures of production. Out these traits, the Lactation milk yield, Lactation length, Peak yield and Days to attain peak yield were directly observed and recorded, while the later four milk production efficiency traits were derived. The results of different economic traits including least squares means and least squares analysis of variance have been presented in tables 9-20 accordingly.

### LACTATION MILK YIELD (LMY)

Lactation milk yield is the most important economic trait of a dairy animal. Milk given by an animal during her normal lactation period was taken as Lactation milk yield (LMY). The overall least squares mean for lactation milk yield of buffaloes consisting of three genetic groups namely Graded Murrah, Diara and Non-descript, included in the study in and around Danapur was found to be 1310.56±34.29 kg (Table-9).

# Factors affecting lactation milk yield

Least squares analysis of variance (Table-10) revealed significant (P<0.01) effect of genetic group, herd size and lactation order on lactation milk yield. Least squares means for different levels of factors affecting lactation milk yield are presented in table-9.

## Genetic group

Least squares analysis of variance (Table-10) revealed highly significant (P<0.01) effect of genetic group on lactation milk yield and its contribution to the total variation on lactation milk yield was 10.10%. As evident from table-9, the Graded-Murrah had the highest lactation milk yield (1431.02±35.22 kg) followed by Diara (1385.08±37.42 kg) and Nondescript type (1115.58±35.94 kg). The animals of three genetic groups

differed significantly (P<0.05) among themselves with respect to their milk yield. Graded Murrah yielded significantly (P<0.05) more milk than the Diara and Non-descript buffalo by 45.94 and 315.44 kg respectively. Diara buffalo also yielded significantly (P<0.05) more milk than the Non-descript by 269.50 kg. Significantly higher milk yield of Graded Murrah and Diara over Non-descript was also reported by Sinha (2006) and Shankar (2007) who conducted similar type of work in Bihar. The findings of the present study revealed that Diara buffaloes are almost equally efficient to that of Graded Murrah and more efficient than the Non-descript with respect to lactation milk yield.

Table 9: Least squares mean +S.E. and CV% of Lactation Length (days) and Lactation Milk Yield (kg) of buffaloes in and around Danapur (Patna).

Danapar (1 atma).						
Particulars	Lactation Milk Yield (kg) (Mean <u>+</u> S.E.) (CV%)	Lactation Length (days) (Mean±S.E.) (CV%)				
Population mean	1310.56 <u>+</u> 34.29 (7.21)	309.43 <u>+</u> 4.64 (7.36)				
Factors						
Genetic group						
Graded Murrah	1431.02 <sup>a</sup> ±35.22 (6.55)	297.84 <sup>a</sup> ±4.76 (7.44)				
Diara buffalo	1385.08 <sup>b</sup> ±37.42 (6.77)	316.59 <sup>b</sup> ±5.06 (6.92)				
Non-descript type	1115.58°±35.94 (8.31)	313.83 <sup>b</sup> ±4.86 (7.04)				
Location of herd						
East	1291.64 <u>+</u> 36.57 (7.29)	309.78 <u>+</u> 4.95 (7.13)				
West	1306.33+36.51 (7.31)	310.90 <u>+</u> 4.94 (7.14)				
Central	1333.71 <u>+</u> 35.43 (7.42)	307.59 <u>+</u> 4.79 (7.12)				
Herd size						
3-4	1276.01 <sup>a</sup> ±34.44 (7.25)	310.03 <u>+</u> 4.66 (7.11)				
5-6	1306.74 <sup>ab</sup> ±32.75 (7.76)	310.91 <u>+</u> 4.43 (7.12)				
7 & above	1348.93 <sup>b</sup> ±45.74 (7.47)	307.33 <u>+</u> 6.19 (7.01)				
Farming system						
Dairying alone	1295.75 <u>+</u> 11.78 (7.46)	306.23 <u>+</u> 1.59 (7.01)				
Mixed farming	1325.37 <u>+</u> 65.85 (7.21)	312.62 <u>+</u> 8.91 (7.12)				
Lactation order						
1 <sup>st</sup>	988.62 <sup>a</sup> ±43.06 (9.43)	308.43°±5.82 (7.20)				
2 <sup>nd</sup>	1169.55 <sup>b</sup> ±36.59 (7.54)	316.17 <sup>b</sup> ±4.95 (7.41)				
3 <sup>rd</sup>	1264.20°±36.79 (5.92)	310.27 <sup>a</sup> ±4.98 (7.10)				
4 <sup>th</sup>	1385.97 <sup>d</sup> ±38.40 (4.12)	312.48 <sup>ab</sup> ±5.19 (7.12)				
5 <sup>th</sup>	1320.03 <sup>d</sup> ±38.00 (4.72)	306.48 <sup>ac</sup> ±5.14 (7.11)				
6 <sup>th</sup>	1236.98°±38.02 (5.97)	302.73°±5.14 (6.89)				

- Means with similar superscripts (column wise) did not differ significantly.
- Values in parentheses indicating CV%

#### Location of herd

As evident from table-10, the location of herd did not influence lactation milk yield, however, its contribution to the total variation on LMY was 7.03%. The lactation milk yield was found to be highest in central region followed by West and East. The average lactation milk yield of the animals located in central Danapura was higher than the animals located in the East and West by 42.07 and 27.38 kg respectively but did not differ significantly among themselves. The result obtained in the present study does not substantiate the finding of Shankar (2007) who obsorbed significant (P<0.05) effect of location of herd on LMY. This might be due to the fact that the experimental area was limited in a radius of 15 km only, which was again divided into three different zones as such not much variation could be obsorbed in agro-climatic condition between different locations.

Table 10: Least squares analysis of variance for the effect of genetic and non-genetic factors on Lactation Milk Yield of buffaloes in and around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	47949.6900	17.1007**	10.10
Location/zone	2	52891.2100	1.8863	7.03
Herd size	2	99521.9800	3.5493*	13.22
Farming system	1	5795.7340	0.2067	0.77
Lactation order	5	518429.0000	18.489**	68.88
Error	527	28039.6500		

<sup>\* =</sup> Significant at P<0.05, \*\* = Significant at P<0.01

### Herd size

As evident from table-10, the herd size had significant (P<0.05) effect on LMY and its contribution to the total variation was 13.22%. The animals maintained in the herd of 7 & above group yielded more milk which was significantly (P<0.05) higher by 72.92 kg than the animals

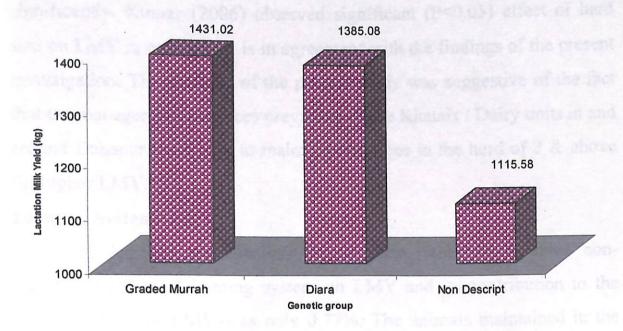


Fig. 5: Graph showing the average lactation milk yield (kg) of buffaloes in and around Danapur.

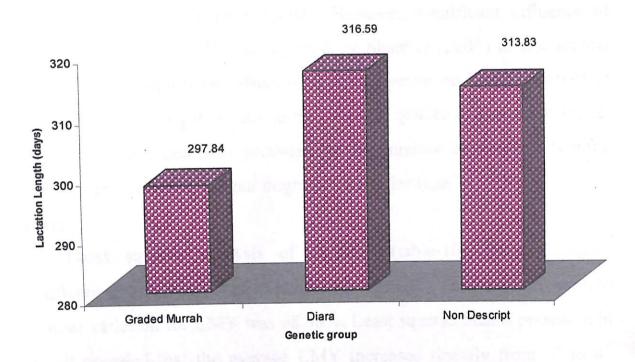


Fig. 6: Graph showing the average lactation length (days) of buffaloes in and around Danapur.

maintained in the herd of 3-4. The animals of 7 & above herd size group yielded more milk than the animals of 5-6 group but did not differ significantly. Kumar (2006) observed significant (P<0.05) effect of herd size on LMY in cow which is in agreement with the findings of the present investigation. The findings of the present study was suggestive of the fact that the management practices prevalling in the Khatals / Dairy units in and around Danapur were able to maintain buffaloes in the herd of 7 & above for higher LMY.

## **Farming System**

The least squares analysis of variance (table-10) revealed non-significant effect of farming system on LMY and its contribution to the total variation for LMY was only 0.77%. The animals maintained in the units integrated with agriculture farming though yielded more milk than the animals managed in the units involved dairying alone by 29.62 kg but did not differ significantly (table-9). The non-significant effect of farming system on LMY observed in the present investigation was in agreement with the findings of Kumar (2004). However, significant influence of farming system on LMY was reported by Shankar (2007) in and around Patna. The non-significant effect of farming system on LMY observed in the present study might be due to the fact that quality of feeds and fodder and management practices provided to the animals in different farming system in and around Danapur might be of similar type.

## **Parity**

Least squares analysis of variance (table-10) revealed highly significant (P<0.01) effect of lactation order on LMY and its contribution to the total variation for LMY was 68.88%. Least squares means presented in table-9 revealed that the average LMY increased linearly from 1<sup>st</sup> to 4<sup>th</sup> parity and there after declined gradually from 5<sup>th</sup> parity onwards. The lowest average LMY was found to be 988.62±43.06 kg in 1<sup>st</sup> lactation. The

average estimates of LMY in 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> parity were significantly (P<0.05) higher by 180.93, 275.58, 397.75, 331.41 and 248.36kg respectively than the animals in 1st parity. The average estimates of LMY in 4th and 5th parity were also significantly (P<0.05) higher by 216.42 and 150.48 kg than the animals in 2<sup>nd</sup> parity and by 131.77 and 55.83 kg than the animals in 3<sup>rd</sup> parity. The LMY in 4<sup>th</sup> parity was though higher by 65.94 kg than the 5<sup>th</sup> parity but did not differ significantly. The average LMY in 6th parity was lesser by 148.99 and 83.05 kg than the 4th and 5th parity respectively. Patro and Bhat (1979), Jain and Kothari (1983) and Gajbhaiye (1987) also observed significant influence of parity on LMY in Mehsana, Murrah and Surti buffalo respectively. Significant effect of parity on LMY was also reported by Shankar (2007) when worked on Graded Murrah, Diara and Non-Descript buffalo in and around Patna. The findings of the present study was indicative of the fact that the lactation maturity of buffaloes in and around Danapur attained during 4th lactation. It could be explained that with the advancement in sequence of lactation there would have been increased number of functional genes responsible for milk yield and their expression could reach maximum around 4th lactation. The another probable reason for increase in milk yield with the advancement of lactation sequence could be ascribed to the increased functional activities of the secretary tissues of mammary gland during later lactations, being maximum at the age coinsiding with 4th parity. The reports available in literature for average LMY in Murrah, Nili-Ravi, Surti and Mehsana buffaloes were higher than the estimates obtained in the present study (Paliwal, 1994, Yadav, 1995-96; Sethi, 1996-97; Chawla, 1996-97 and Taneja, 1999). However, the average estimate for LMY obtained in the present study were higher than those of Bhadawari as reported by Taneja (1999). The average estimates for LMY observed in the present investigation corroborate the findings of Shankar (2007) who studied on Graded Murrah, Diara and Non-descript buffaloes in and around Patna.

#### **LACTATION LENGTH**

Lactation length is one of the important traits affecting economics of dairy farming. Either too long or too short lactation length is not desirable. For buffaloes the ideal lactation length is regarded as 305 days.

The overall least squares mean for lactation length in buffaloes of three genetic groups namely graded Murrah, Diara and Non-descript included in this study in and around Danapur was estimated to be 309.43±4.64 days (Table-9). The population average of lactation length of buffaloes consisting of aforesaid three genetic groups obtained by Sinha (2006) and Shankar (2007) under farmers management system in Bihar corroborates the findings of the present investigation. Similar findings have also been reported by Devraj and Gupta (1994) in buffaloes native to Churu district of Rajsthan under farmers management system.

Table 11: Least squares analysis of variance for the effect of genetic and non-genetic factors on Lactation Length of buffaloes in and around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	13466.3200	26.2430**	78.28
Location/zone	2	389.6527	0.7594	2.27
Herd size	2	180.0505	0.3509	1.05
Farming system	1	269.6984	0.5256	1.57
Lactation order	5	2383.4970	4.6449**	13.86
Error	527	513.1386		

<sup>\*\* =</sup> Significant at P<0.01

# Factors affecting lactation length

Least squares analysis of variance (Table-11) revealed that genetic group and lactation order had significant (P<0.01) influence on lactation length. The effects of location of herd, herd size and farming system were non-significant.

### Genetic group

The genetic group had highly significant (P<0.01) influence on lactation length and its contribution to the total variation for lactation length was reckoned to be 78.28% (Table-11). As evident from table-9, the Diara buffalo had the longest lactation length (316.59±5.06 days) which was significantly (P<0.05) longer by 18.75 days than the Graded Murrah but did not differ significantly from Non-descript. Significant (P<0.05) effect of genetic group on average lactation length observed in the present study was in confirmation with the findings of Shankar (2007). However, Sinha (2006) reported the longest lactation length in Non-descript buffalo followed by Diara and Graded Murrah but the effect of genetic group was statistically non-significant. The average estimates of lactation length as obtained in the present study was close to the findings of Yadav (1995-96) and Devrai and Gupta (1994<sup>b</sup>). However, the higher estimates of lactation length have been reported by Singh (1992) in Mehsana, by Kumar and Gupta (1992) in Desi buffalo maintained under farmers management system in U.P. and by Shah and Sharma (1994), Rao et al. (1995) and Singh (2002) in Murrah buffaloes. Chawla (1996-97) reported the average lactation length pooled over all the lactations in Nili-Ravi buffalo to be 392±9 days which is much longer than the average lactation length observed in the present investigation. The average lactation length of Mehsana buffaloes reported by Tajane and Siddiquee (1985) and Singh et al. (1986) was shorter than the findings of the present study.

### Location of herd

As evident from table-11, the effect of location of herd on lactation length was not statistically significant and its contribution to the total variation was only 2.27%. The animals located in West had the longest lactation length (310.90±4.94 days) which was lengthier by 1.12 and 3.31 days than the animals located in East and Central Danapur respectively but

differences were non-significant. Non-significant effect of zones on lactation length might be attributed to the fact that the area under investigation was limited in a radius of 15 km only, which was divided into three zones, and as such there was not much variation in agro-climatic condition between different zones. Non-significant effect of location of herd on lactation length has also been reported by Shankar (2007).

#### Herd size

As evident from table-11, the herd size had no significant influence on lactation length and its contribution to the total variation for this trait was only 1.05%. The animals maintained in the herd size of 7 & above group had the shorter lactation length (307.59±6.19 days) than those maintained in the herd size of 3-4 and 5-6 but did not differ significantly (Table-9). Reports about the effect of herd size on lactation length in buffaloes were not available in the literature to substantiate the findings of the present study, however, the non-significant effect of herd size on lactation length in cattle has been reported by Priya Raj (2002) and Kumar (2005).

## Farming system

As evident from table-11, the effect of farming system on lactation length was not significant and its contribution to the total variation for this trait was only 1.57%. The animals managed in the units integrated with agriculture farming had the longer lactation length (312.62±8.91 days) than those maintained in the units involved dairying alone by 6.39 days but did not differ significantly. Non-significant effect of farming system on lactation length of buffaloes has also been reported by Kumar (2004) and Shankar (2007) under farmers management system. This might be attributed to the fact that the animals maintained under different farming system might have received similar kind of management practices in and around Danapur.

### **Parity**

Least squares analysis of variance (Table-11) revealed significant influence of lactation order on lactation length and its contribution to the total variation was 13.86%. The least squares means of lactation length in 1<sup>st</sup> parity was reckoned to be 308.43±5.8 days. The lactation length in 2<sup>nd</sup> parity was found to be increased significantly (P<0.05) by 7.74 days than the animals in 1st parity and then gradually decreased with the increase in sequence of lactation (Table-9). The lactation length was found to be the lowest (302.73±5.14 days) in 6<sup>th</sup> parity which was significantly shorter by 5.7, 13.44, 7.54 and 9.75 days than those  $1^{st}$ ,  $2^{nd}$ ,  $3^{rd}$  and  $4^{th}$  parity respectively but did not differ significantly from 5<sup>th</sup> parity. Significant effect of parity on lactation length as observed in the present study has also been reported by Patro and Bhat (1979), Jain and Kothari (1983), Singh (1992), Kumar (2004) and Shankar (2007). However, the trend observed in the present study was not similar to the findings of Singh (1992) who reported the longest and shortest lactation length in 1st and 4th parity respectively. The optimal reproductive function in buffaloes may be attained in 2<sup>nd</sup> parity and as such, the longest lactation length has been observed in the 2<sup>nd</sup> parity of this study.

## Peak yield

Peak milk yield is one of the important indicators in determining worth of milch animals. It is a directly observed economic trait of very high practical significance in dairy farming. The overall least squares mean for peak yield in buffaloes consisting of three genetic groups viz. Graded Murrah, Diara and Non-descript types included in this study in and around Danapur was estimated to be 6.96±0.25 kg (Table-12).

# Factors affecting peak yield

Least squares analysis of variance (Table-13) revealed that genetic make up of the animals, location of herd and sequence of lactation had

significant influence on peak milk yield, while the effect of herd size and farming system was non-significant. Least squares means for different levels of the factors affecting peak yield are presented in table-12.

### Genetic group

Genetic group had highly significant (P<0.01) influence on peak milk yield and its contribution to the total variation was calculated to be 46.05% (Table-13). As evident from table-12, the highest average peak milk yield (7.87±0.26 kg) was reported in graded Murrah followed by Diara and Non-descript. Peak yield of graded Murrah was significantly (P<0.05) higher by 2.13 kg than the peak yield of Non-descript animals but did not differ significantly from Diara buffalo. The trend observed in this study was in accordance with the expectation as graded Murrah in Bihar has been developed through up gradation of Non-descript type in crosses with Murrah, the highest milk producer among the buffalo breeds in the World and it is postulated that Diara buffaloes have been evolved from graded Murrah through the process of natural selection and their location over the generations under agro-socio-ecological conditions of Diara area in Bihar. As such the Diara buffaloes occupied the second position. Since the Non-descript buffalo has the lowest potency to produce milk among the animals of different genetic groups being occupied the lowest rank. The results observed in the present study were in accordance with the findings of Sinha (2006) and Shankar (2007). The results of this study substantiate the fact that peak yield was an indicator of lactation milk yield because the average lactation milk yield of these three genetic groups were also observed in the same order (Table-9).

### Location of herd

The analysis of variance (Table-13) revealed significant (P<0.05) effect of location of herd on peak milk yield and its contribution to the total variation was only 1.10%. As evident from table-12, the animals located in

central region of Danapur had the highest peak yield (7.18±0.26 kg) which was significantly (P<0.05) higher by 0.40 kg than those located in East Danapur, but did not differ significantly from those animals located in the West. However, Shankar (2007) reported the non-significant effect of location of herd on peak milk yield which is contrary to the findings of the present study.

Table 12: Least squares mean +S.E. and CV% of Peak Yield (PY) and Days to attain Peak Yield (DAPY) of buffaloes in and around Danapur (Patna)

Mean  $\pm$  SE (CV%) **Particulars** DAPY PY (kg) 40.23+0.72 (8.92) 6.96+0.25 (17.46) Population mean **Factors** Genetic group 37.67° ±0.74 (9.52)  $7.87^{a} \pm 0.26 (14.10)$ Graded Murrah 41.10<sup>b</sup>+0.78 (8.57)  $7.28^{a} \pm 0.28 (14.41)$ Diara buffalo 41.91<sup>b</sup>+0.75 (8.78)  $5.74^{b} \pm 0.27$  (18.27) Non-descript type Location of herd  $6.78^{a}\pm0.27$  (16.39) 40.55±0.77 (8.51) East  $6.94^{ab} + 0.27 (16.12)$ 40.14+0.76 (8.64) West  $7.18^{b} \pm 0.26 (15.87)$ 39.99+0.74 (8.62) Central Herd size 40.83±0.72 (8.52) 6.79+0.25 (1.72) 3-4 40.66+0.69 (8.60) 6.99±0.24 (1.67) 5-6 39.19+0.96 (8.62) 7.12+0.34 (1.57) 7 & above Farming system 40.88+0.25 (8.72) 7.11±0.09 (15.30) Dairying alone 39.57±1.38 (8.66) 6.82+0.49 (16.41) Mixed farming Lactation order 38.01°±0.90 (8.47)  $5.24^{a}+0.32$  (20.21) 1<sup>st</sup> 38.04<sup>a</sup>±0.77 (8.48)  $2^{\overline{nd}}$  $5.14^{a}+0.27$  (21.22) 40.84<sup>ab</sup>+0.77 (7.71)  $6.60^{ab} + 0.27 (17.36)$ 3rd 40.95<sup>ab</sup>+0.80 (7.20)  $7.56^{b} + 0.28 (14.24)$ 41.78<sup>b</sup>+0.79 (6.98) 5<sup>th</sup>  $7.12^{b}+0.28$  (14.26) 41.48<sup>b</sup>+0.80 (6.98)  $6.84^{b}+0.28$  (17.32)

Means with similar superscripts (column wise) did not differ significantly.

Value sin parentheses indicating CV%.

#### Herd size

The analysis of variance revealed that herd size had no significant influence on peak milk yield in buffaloes and its contribution to the total variation was only 0.70% (Table-13). As evident from table-12, the animals in the herd size of 7 & above group had the highest (7.12±0.34 kg) peak yield followed by those animals maintained in the herd size of 5-6 and 3-4 groups. However, the differences were non-significant. The non-significant effect of herd size on peak yield obtained in the present study was in confirmation with the findings of Kumar (2004). Significant effect of herd size on peak yield in cows has been reported by Kumar (2006). However, both the workers reported that the animals maintained in the herd size of 9 & above had the highest peak milk yield than those managed in the smaller herd size which supports the finding of the present study.

Table 13: Least squares analysis of variance for the effect of genetic and non-genetic factors on Peak Yield (PY) of buffaloes in and around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	199.9811	130.564**	46.05
Location/zone	2	4.7654	3.111*	1.10
Herd size	2	3.0273	1.977	0.70
Farming system	1	0.5483	0.358	0.13
Lactation order	5	224.3862	146.498**	51.67
Error	527	1.5317		

<sup>\* =</sup> Significant at P<0.05, \*\* = Significant at P<0.01

### Farming system

The least squares analysis of variance revealed non-significant effect of farming system on peak yield and its contribution to the total variation was only 0.13% (Table-13). As evident from table-12, the animals managed in the units integrated with mixed farming system had the lower peak yield than those animals maintained in the units involved in dairying alone by 0.29 kg but did not differ significantly. Kumar (2004) had also reported

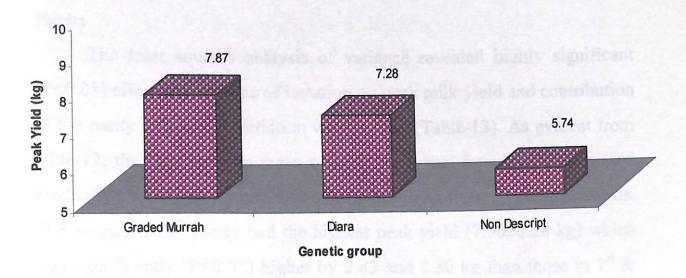


Fig. 7: Graph showing the average Peak milk yield (kg) of buffaloes in and around Danapur.

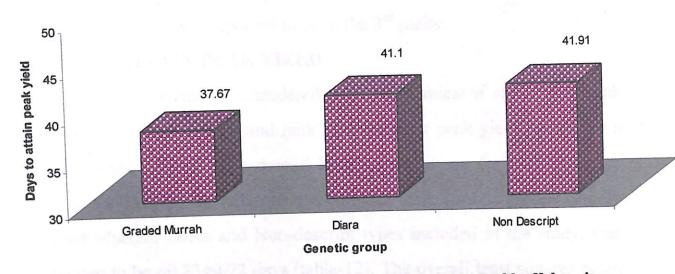


Fig. 8: Graph showing the average Days to attain peak yield of buffaloes in and around Danapur.



non-significant effect of farming system on peak yield. However, Shankar (2007) reported significant effect of farming system on peak yield of buffaloes in and around Patna.

#### **Parity**

The least squares analysis of variance revealed highly significant (P<0.01) effect of sequence of lactation on peak milk yield and contribution of the parity to the total variation was 51.67% (Table-13). As evident from table-12, the least squares mean of peak yield was found to be increased gradually from 3<sup>rd</sup> parity and then started declining from 5<sup>th</sup> parity onwards. The animals in 4<sup>th</sup> parity had the highest peak yield (7.56±0.28 kg) which was significantly (P<0.05) higher by 2.83 and 2.80 kg than those in 1<sup>st</sup> & 2<sup>nd</sup> parity respectively but did not differ significantly from those in 3<sup>rd</sup>, 5<sup>th</sup> and 6<sup>th</sup> parity. Singh (1992<sup>a</sup>), Singh and Singh (1998), Kumar (2004) and Shankar (2007) reported significant effect of parity on peak yield. However, Chaudhary and Chaudhary (1981) did not observe the significant influence of parity on peak yield. The trend of variation in peak yield observed in the present study was also reported by Shankar (2007) but highest peak yield was reported to be in the 3<sup>rd</sup> parity.

### DAYS TO ATTAIN PEAK YIELD

A milch animal is considered to be economical if she attains peak yield shortly after calving and milk production at peak yield persist for a longer period of time. The overall least squares mean for Days to attain peak yield (DAPY) in buffaloes consisting of three genetic groups namely Graded Murrah, Diara and Non-descript types included in the study, was estimated to be 40.23±0.72 days (table-12). The overall least squares mean for Days to attain peak yield in buffaloes consisting of these three genetic group has been reported to be 41.83±0.28 days and 42.02±0.21 days respectively by Sinha (2006) and Shankar (2007).

A. Walley

### Factors affecting days to attain peak yield

Least squares analysis of variance revealed significant (P<0.01) effect of genetic constitution of the animals and lactation order on DAPY (Table-14). Least squares means for different levels of factors affecting DAPY are presented in table-12.

Table 14: Least squares analysis of variance for the effect of genetic and non-genetic factors on Days to Attain Peak Yield (DAPY) of buffaloes in and around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	737.2483	59.899**	71.87
Location/zone	2	10.8367	0.8804	1.06
Herd size	2	33.2139	2.6985	3.24
Farming system	1	11.2684	0.9155	1.10
Lactation order	5	220.8921	17.9467**	21.53
Error	527	12.3082	·	

<sup>\*\* =</sup> Significant at P<0.01

### Genetic group

The genetic group had highly significant (P<0.01) influence on DAPY and its contribution to the total variation was 71.87% (Table-14). As evident from table-12, the Graded Murrah attained peak milk yield at the shortest period (37.67±0.74 days) which was significantly (P<0.05) shorter by 3.43 and 4.24 days than the Diara and Non-descript type. Diara buffalo though attained peak yield earlier than the Non-descript but the difference was statistically non-significant. The trend of DAPY as observed in the present study has also been reported by Sinha (2006) and Shankar (2007) but difference between Diara and Non-descript buffalo in respect to this trait was reported to be statistically significant.

#### Location of herd

The analysis of variance revealed non-significant influence of location of herd on DAPY and its contribution to the total variation in DAPY was only 1.06% (table-14). As evident from table-12, the animals

located in the central region of Danapur attained DAPY earlier than those animals located in East and West Danapur but did not differ significantly. Non-significant effect of location of herd on DAPY has also been reported by Kumar (2004) and Shankar (2007). The non-significant effect of zone on DAPY might be attributed to the fact that the present study was conducted in small area within 15 km radius which was divided into three zones and as such the variation in agro-ecological condition in different zones was absent.

#### **Herd Size**

Least squares analysis of variance revealed non-significant effect of herd size on DAPY and its contribution to the total variation for this trait was 3.24% (Table-14). As evident from table-12, the animals maintained in the herd size of 3-4 group had the longest DAPY (40.55±0.77 days) followed by those animals maintained in the herd size of 5-6 and 7 & above groups (Table-12). However, the differences among the groups in respect to DAPY were statistically non-significant. Kumar (2005) and Kumar (2006) reported shorter DAPY when the animals maintained in the shorter herd size than the larger herd size.

### Farming system

Least squares analysis of variance revealed that farming system had no significant influence on DAPY and its contribution to the total variation was only 1.10% (Table-14). As evident from table-12, the animals maintained in the units integrated with agriculture farming attained peak yield earlier than those animals managed in the units involved dairying alone but did not differ significantly (table-12). Non-significant effect of farming system on DAPY reported by Kumar (2004) and Shankar (2007) substantiate the findings of the present study.

#### **Parity**

The least squares analysis of variance revealed highly significant (P<0.01) effect of lactation order on DAPY and its contribution to the total variation was 21.53% (Table-14). As evident from table-12, the animals in the first lactation had the shortest DAPY which was found to be gradually increased over the sequence of lactation. The animals in 5<sup>th</sup> lactation had the longest DAPY (41.78±0.79 days) which was significantly (P<0.05) longer than those in 1<sup>st</sup> and 2<sup>nd</sup> parity by 3.77 and 3.74 days but did not differ significantly from those animals in 3<sup>rd</sup> and 4<sup>th</sup> parity as well as in 6<sup>th</sup> parity. Significant (P<0.05) effect of parity on DAPY observed in the present study confirmed the findings of Singh (1992) and Kumar (2004). However, Chaudhary and Chaudhary (1981) and Shankar (2007) reported non-significant effect of parity on DAPY.

#### MEASURES OF MILK PRODUCTION EFFICIENCY

In order to produce highly productive and efficient milk producing stock selection on the basis their relative efficiency of milk production seems to be much more advantageous as it includes selection for general adaptability, inheritance capacity to produce and resource utilization efficiency. Out of several derived measures of milk production efficiency, only four efficiency traits such as Milk Yield per day of Lactation Length (MY/LL), Milk Yield per day of Calving Interval (MY/CI), Milk yield per kg of body weight within first month of calving (MPED), and milk yield per kg body weight per day of lactation length (MPEKD) were included in this study.

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

In this study the average daily milk yield was taken as one of the measures of production efficiency. It was derived as the ratio of total milk yield (kg) during a lactation and total days in milk or total number of days in milk by an animal during a lactation. Abnormal lactation length i.e. less

than 200 days and more than 350 days were ignored. The overall least squares means for milk yield per day of lactation length (MY/LL) in buffaloes consisting of three genetic groups namely Graded Murrah, Diara and Non-descript types was estimated to be 4.28±0.14 kg (Table-15).

# Factors affecting milk yield per day of lactation length (MY/LL)

Least squares analysis of variance revealed that genetic makeup of the animals and lactation order had significant effect of MY/LL (Table-16). Least squares means for different levels of factors affecting MY/LL have been presented in table-15.

### Genetic group

As evident from table-16, the genetic group had highly significant (P<0.01) effect on MY/LL and its contribution to the total variation for MY/LL was 49.08%. The least squares mean revealed that the Graded Murrah had highest average MY/LL (4.83±0.14 kg) followed by Diara and Non-descript type. The Graded Murrah had significantly (P<0.05) 1.26 kg higher MY/LL than the Non-descript type but did not differ significantly from Diara buffalo. The significant (P<0.05) influence of genetic group on MY/LL observed in the present study had also been reported by Sinha (2006) and Shankar (2007), however, Shankar (2007) reported significant difference between Graded Murrah and Diara. Reports on the effect of genetic group on MY/LL under field conditions were very scanty in the literature. However, the higher average estimates for MY/LL have been reported by Vij and Tiwana (1986) in Murrah and by Singh et al. (1989) in Nili-Ravi buffaloes and lower estimates (2.88±0.29 kg) reported by Singh & Singh (1998) in Bhadawari buffaloes indicating breed differences for this trait. The trend in variation of this milk production efficiency trait was similar to that for variation in lactation milk yield (LMY), however, Diara buffaloes were equally efficient to Graded Murrah in respect to this trait.

Table 15: Least squares mean±S.E. and CV% of Milk Yield per day of Lactation Length (MY/LL) and Milk Yield per day of Calving Interval (MY/CI) of buffaloes in and around Danapur (Patna).

Doutionless	Mean ± SE (CV%)			
Particulars	MY/LL (kg)	MY/CI (kg)		
Population mean	4.28±0.14 (8.28)	2.85 <u>+</u> 0.08 (6.14)		
Factors				
Genetic group				
Graded Murrah	4.83 <sup>a</sup> ±0.14 (8.51)	3.31 <sup>a</sup> ±0.08 (6.04)		
Diara buffalo	4.37 <sup>a</sup> ±0.15 (9.32)	2.91 <sup>b</sup> ±0.09 (6.92)		
Non-descript type	3.60 <sup>b</sup> ±0.15 (11.3)	2.33°±0.09 (8.11)		
Location of herd				
East	4.22 <u>+</u> 0.15 (10.2)	2.81 <u>+</u> 0.09 (8.62)		
West	4.24 <u>+</u> 0.15 (9.12)	2.86 <u>+</u> 0.09 (7.01)		
Central	4.39 <u>+</u> 0.14 (9.05)	2.88 <u>+</u> 0.09 (7.07)		
Herd size				
3-4	4.16±0.14 (9.15)	2.75 <sup>a</sup> ±0.08 (8.11)		
5-6	4.24 <u>+</u> 0.13 (9.11)	2.83 <sup>ab</sup> ±0.08 (8.02)		
7 & above	4.44 <u>+</u> 0.18 (9.02)	2.96 <sup>b</sup> ±0.11 (7.96)		
Farming system				
Dairying alone	4.27 <u>+</u> 0.05 (9.12)	2.84 <u>+</u> 0.03 (9.11)		
Mixed farming	4.29 <u>+</u> 0.27 (9.02)	2.86 <u>+</u> 0.16 (9.05)		
Lactation order				
1 <sup>st</sup>	3.15 <sup>a</sup> ±0.17 (13.61)	2.13°±0.10 (11.41)		
2 <sup>nd</sup>	3.78 <sup>ab</sup> ±0.15 (13.26)	2.29 <sup>a</sup> ±0.09 (11.46)		
3 <sup>rd</sup>	4.03 <sup>bc</sup> ±0.15 (8.99)	2.97 <sup>b</sup> ±0.09 (9.87)		
4 <sup>th</sup>	4.51°±0.16 (7.62)	3.13 <sup>b</sup> ±0.09 (7.75)		
5 <sup>th</sup>	4.24 <sup>bc</sup> ±0.15 (7.60)	2.78 <sup>bc</sup> ±0.09 (10.11)		
6 <sup>th</sup>	3.98 <sup>b</sup> ±0.15 (12.91)	2.61°+0.09 (10.87)		

<sup>•</sup> Means with similar superscripts (column wise) did not differ significantly.

Values in parentheses indicating CV%.

# Location

The least squares analysis of variance revealed non-significant influence of location of herd on MY/LL and its contribution to the total variation was only 0.83% (Table-16). As evident from table-15, the least squares means for MY/LL were almost equal in different zones. Non-significant effect of zone on MY/LL observed in the present study was also reported by Kumar (2004) in dairy animals, however, Shankar (2007) reported significant effect of location of herd on MY/LL in and around Patna.

Table 16: Least squares analysis of variance for the effect of genetic and non-genetic factors on Milk Yield per day of Lactation length (MY/LL) of buffaloes in and around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	64.5552	140.8577**	49.08
Location/zone	2	1.0860	2.3695	0.83
Herd size	2	1.0866	2.3709	0.83
Farming system	1	0.0014	0.0030	00.10
Lactation order	5	64.3402	140.3886**	48.91
Error	527	0.4583		

<sup>\*\* =</sup> Significant at P<0.01

### Herd size

Least squares analysis of variance (Table-16) revealed non-significant effect of herd size on MY/LL and its contribution to the total variation was only 0.83%. As evident from table-15, The MY/LL was lowest in the herd size of 3-4 group followed by 5-6 and 7 & above groups but differences among the groups were non-significant. Results obtained in the present study were similar to the findings of Priya Raj (2002) and Kumar (2005) in dairy animals, however, Kumar (2005) reported significant (P<0.01) effect of herd size on this trait.

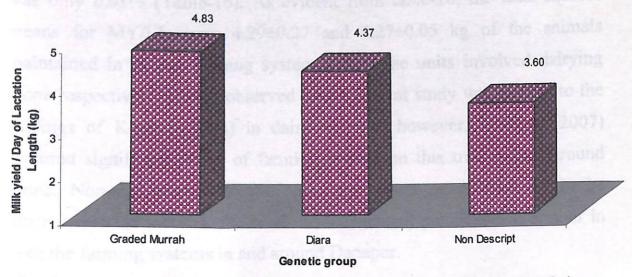


Fig. 9: Graph showing the average Milk yield / day of Lactation Length (kg) of buffaloes in and around Danapur.

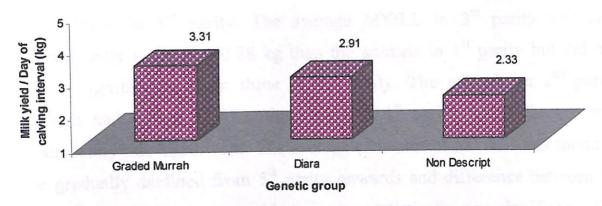


Fig. 10: Graph showing the average Milk yield / day of Calving Interval (kg) of buffaloes in and around Danapur.

# Farming system

Least squares analysis of variance revealed that farming system had no significant influence on MY/LL and its contribution to the total variation was only 0.01% (Table-16). As evident from table-16, the least squares means for MY/LL were 4.29±0.27 and 4.27±0.05 kg of the animals maintained in mixed farming system and in the units involved dairying alone respectively. Result observed in the present study was similar to the findings of Kumar (2004) in dairy animals, however, Shankar (2007) reported significant effect of farming system on this trait in and around Patna. Non-significant effect of farming system on MY/LL might be attributed to the fact that the level of management practices was similar in both the farming systems in and around Danapur.

# **Parity**

Least squares analysis of variance revealed highly significant (P<0.01) effect of parity on MY/LL and its contribution to the total variation was 48.91% (Table-16). As evident from table-15, the least squares mean for MY/LL was the lowest (3.15±0.17 kg) in the first parity and then it was increased gradually upto 4th parity. The least squares mean for MY/LL in 4th lactation was significantly (P<0.05) higher by 1.36 and 0.75 kg than the animals in 1st and 2nd parity but did not differ significantly from those in 3<sup>rd</sup> parity. The average MY/LL in 3<sup>rd</sup> parity was also significantly higher by 0.88 kg than the animals in 1st parity but did not differ significantly from those in 2<sup>nd</sup> parity. The animals in 2<sup>nd</sup> parity though had higher MY/LL than those in 1st parity but difference was statistically non-significant. The average estimates of MY/LL was found to be gradually declined from 5<sup>th</sup> parity onwards and difference between 5<sup>th</sup> and 6th parity in respect to this trait was statistically non-significant. The trend of variation in MY/LL was similar as recorded for lactation milk yield (LMY) in different parity. The reasons could be explained in the similar way as explained for LMY i.e. the lactation maturity in buffaloes of the study area was attained in 4th lactation. The reports about the effect of parity on MY/LL was very scanty in the literature. However, Shankar (2007) reported significant effect of parity on MY/LL which is in accordance with the findings of the present study.

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

Average daily milk yield given by a buffalo cow during one calving interval was taken as an another criterion to measure its milk production efficiency. Milk yield per day of calving interval (MY/CI) was derived as the ratio of total lactation milk yield and corresponding inter calving period. The overall least squares mean for MY/CI in buffaloes pooled over three genetic groups namely Graded Murrah, Diara and Non-descript was estimated to be 2.85±0.08 kg (Table-15). Tailor *et al.* (1998) reported the overall least squares mean of MY/CI in Surti buffaloes to be 2.04±0.05 kg. Kumar (2004) and Shankar (2007) reported the average MY/CI of buffaloes in and around Darbhanga and Patna to be 3.10±0.05 and 2.84±0.01 kg respectively.

# Factors affecting milk yield per day of calving interval

Least squares analysis of variance revealed significant effect of genetic constitution of the animals, herd size and lactation order on MY/CI (Table-17). Least squares means for different level of factors affecting MY/CI are presented in table-15.

Table 17: Least squares analysis of variance for the effect of genetic and non-genetic factors on Milk Yield per day of Calving Interval (MY/CI) of buffaloes in and around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	38.8350	238.2641**	58.04
Location/zone	2	0.1264	0.7753	0.19
Herd size	2	0.7532	4.6209*	1.13
Farming system	1	0.0028	0.0170	0.01
Lactation order	5	27.0348	165.8662**	40.40
Error	527	0.1630		

<sup>\* =</sup> Significant at P<0.05, \*\* = Significant at P<0.01

# Genetic group

Least squares analysis of variance (Table-17) revealed highly significant (P<0.01) effect of genetic group on MY/CI and its contribution to the total variation for this trait was found to be 58.04%. As shown in table-15, the Graded Murrah had the highest estimate of MY/CI (3.31±0.08 kg) which was significantly (P<0.05) higher than the Diara and Nondescript buffaloes by 0.40 and 0.98 kg respectively. Diara buffaloes also had significantly (P<0.05) higher average estimates of MY/CI than the Non-descript by 0.58 kg. The trend of variation in MY/CI among three genetic groups was similar to the trend of their lactation milk yield (Table-9) which was one of the components in its derivation. Reports on the effect of genetic group on MY/CI in buffaloes were very scanty in the literature. However, the higher estimates for MY/CI reported by Vij and Tiwana (1986) in Murrah and by Singh et al. (1989) in Nili-Ravi and lower estimates reported by Singh and Singh (1998) in Bhadawari buffaloes indicating breed differences for this trait. However, Shankar (2007) reported significant effect of genetic group on MY/CI in buffaloes (Graded Murrah, Diara and Non-descript) in and around Patna, the capital of Bihar.

# Location of herd

Least squares analysis of variance (Table-17) revealed non-significant effect of location of herd on MY/CI and its contribution to the total variation for this trait was only 0.19%. As evident from table-15, the animals located in East Danapur had the lowest MY/CI (2.81±0.09 kg) followed by those located in the West and Central part of Danapur. However, the differences between the zones were statistically non-significant. The non-significant effect of zone on MY/CI observed in the present study was also reported by Kumar (2004) in milch animals (cow & buffalo). However, Shankar (2007) reported significant effect of zone on this trait in buffaloes in and around Patna. Non-significant effect of location

of herd on MY/CI observed in the present study might be attributed to the fact that the area of the present study was confined in a radius of 15 km which was further divided into three zones. As such the variation in agroecological condition between the zones was non-significant.

# Herd size

Least squares analysis of variance (Table-17) revealed that the herd size had significant (P<0.05) influence on MY/CI and its contribution to the total variation was only 1.13%. As evident from table-15, the animals maintained in the herd size of 7 & above had the highest estimates (2.96±0.11 kg) of MY/CI than those maintained in the herd size of 3-4 by 0.21 kg. The average estimate of MY/CI of the buffaloes maintained in the herd size of 5-6 group did not differ significantly from those animals maintained in the groups of 3-4 and 7 & above. Reports about the effect of herd size on MY/CI in buffaloes were not available in the literature, however, Kumar (2006) reported significant (P<0.05) effect of herd size on MY/CI in dairy cow.

# Farming system

The least squares analysis of variance (Table-17) revealed non-significant influence of farming system on MY/CI and its contribution to the total variation for this trait was negligible. As evident from table-15, the least squares means for MY/CI of the animals maintained in the units integrated with mixed farming system was estimated to be 2.86±0.16 kg. and those animals maintained in the units involved dairying alone had the average estimate of 2.84±0.03 kg. The difference between the farming systems was statistically non-significant. The results obtained in the present study were similar to the findings of Kumar (2004), however, Shankar (2007) reported significant effect of farming system on MY/CI. The non-significant effect of farming system on MY/CI observed in the present study might be attributed to the fact that the feed and fodder resources and

level of management practices were similar under both the farming systems in and around Danapur.

# **Parity**

The least squares analysis of variance (Table-17) revealed highly significant (P<0.01) effect of parity on MY/CI and its contribution to the total variation for this trait was 40.40%. As evident from table-15, the average estimates of MY/CI was found to be the lowest (2.13±0.10 kg) in the 1st parity, which was observed to be increased in subsequent lactations. The average estimate of MY/CI was the highest (3.13±0.09 kg) in 4<sup>th</sup> parity which was higher by 1.00 and 0.84 kg than the animals in  $1^{st}$  &  $2^{nd}$  parity respectively. However, the average estimate of MY/CI in 4th parity did not differ significantly from those in the 3<sup>rd</sup> parity. The average estimate of MY/CI was found to be declined from 5<sup>th</sup> parity onwards and the difference between 4<sup>th</sup> and 6<sup>th</sup> parity was significant. The trend of variation in MY/CI was similar to the trend recorded for lactation milk yield (LMY) in different parities (Table-9). The reports about the effect of parity on MY/CI were very scanty in the literature, however, Shankar (2007) reported significant effect of parity on MY/CI in buffaloes in and around Patna which are similar to the findings of the present study.

# MILK PRODUCTION EFFICIENCY PER KG BODY WEIGHT (MPEK)

The average amount of milk given by an animal with respect to its per kg metabolic body weight was taken as one of the measures of milk production efficiency. It was derived as the ratio of total milk yield (kg) during a lactation period to the live body weight (kg) of the animals within 1<sup>st</sup> month of calving. The overall least squares mean for milk production efficiency per kg of body weight (MPEK) in buffaloes consisting of three genetic groups viz. Graded Murrah, Diara and Non-descript type was found to be 2.57±0.15 kg (Table-18).

# **Factors affecting MPEK**

The least squares analysis of variance revealed significant (P<0.01) effect of genetic group and lactation order on MPEK (Table-19). The effects of location of herd, herd size and farming system were found to be non-significant.

Table 18: Least squares mean±S.E. and CV% of Milk Production Efficiency per kg body weight (MPEK) & Milk Production Efficiency per kg body weight per day of lactation length (MPEKD) of buffaloes in and around Danapur (Patna).

Da.,4'	Mean ± SE (CV%)			
Particulars	MPEK (kg)	MPEKD (g)		
Population mean	2.57±0.15 (2.74)	8.47 <u>+</u> 0.22 (11.2)		
Factors				
Genetic group				
Graded Murrah	2.66°+±0.15 (7.35)	9.24 <sup>a</sup> ±0.23 (10.11)		
Diara buffalo	2.87 <sup>b</sup> ±0.17 (6.94)	8.98 <sup>a</sup> ±0.25 (12.11)		
Non-descript type	2.28°±0.16 (8.88)	7.12 <sup>b</sup> ±0.24 (13.14)		
Location of herd				
East	2.51 <u>+</u> 0.16 (8.26)	8.41 <u>+</u> 0.24 (11.2)		
West	2.62±0.16 (7.71)	8.36 <u>+</u> 0.24 (11.4)		
Central	2.59 <u>+</u> 0.16 (7.12)	8.64±0.23 (11.1)		
Herd size				
3-4	2.49 <u>+</u> 0.15 (4.80)	8.31 <u>+</u> 0.23 (11.0)		
5-6	2.59 <u>+</u> 0.15 (4.95)	8.37 <u>+</u> 0.21 (10.9)		
7 & above	2.63±0.21 (4.32)	8.74 <u>+</u> 0.30 (10.12)		
Farming system	·			
Dairying alone	2.59 <u>+</u> 0.05 (4.80)	8.52 <u>+</u> 0.08 (10.8)		
Mixed farming	2.55 <u>+</u> 0.29 (9.11)	8.42 <u>+</u> 0.43 (10.8)		
Lactation order				
1 <sup>st</sup>	2.12 <sup>a</sup> ±0.19 (8.74)	7.01 <sup>a</sup> ±0.28 (13.4)		
2 <sup>nd</sup>	2.33 <sup>a</sup> ±0.16 (7.72)	7.18 <sup>a</sup> ±0.24 (12.2)		
3 <sup>rd</sup>	2.54 <sup>b</sup> ±0.17 (6.03)	8.41 <sup>b</sup> ±0.24 (11.21)		
4 <sup>th</sup>	2.73 <sup>bc</sup> ±0.17 (6.05)	9.13° <u>+</u> 0.25 (8.87)		
5 <sup>th</sup>	2.80°±0.17 (6.81)	9.08°±0.25 (8.88)		
6 <sup>th</sup>	2.78°±0.17 (6.78)	9.02°±0.25 (8.65)		

<sup>•</sup> Means with similar superscripts (column wise) did not differ significantly.

Value sin parentheses indicating CV%

# Genetic group

The analysis of variance revealed significant (P<0.01) effect of genetic group on MPEK and contribution of the genetic groups to the total variation for this trait was calculated to be 57.25% (Table-19). As evident from table-18, the milk production efficiency per kg body weight was found to be the highest (2.87±0.17 kg) in Diara buffalo which was significantly (P<0.05) higher by 0.59 kg than that of Non-descript buffalo. The Diara buffalo was also found to have higher MPEK than the Graded Murrah by 0.21 kg but did not differ significantly. The Graded Murrah also had significantly (P<0.05) higher estimate of MPEK than the Non-descript by 0.38 kg. Chaudhary and Barhat (1979) also reported the significant effect of breed on MPEK and Mehsana buffaloes reported to have higher efficiency for MPEK in comparison to that of Surti. They have also reported that buffaloes within a breed with lower body weight had higher efficiency of milk production per kg of metabolic body weight. Diara buffaloes being smallest in size among all the three genetic groups, included in this study, also had higher milk production efficiency. The results observed in the present study were similar to the findings of earlier workers. The higher estimate of MPEK in Diara buffalo observed in the present investigation was similar to the findings of Shankar (2007) who has also reported significantly (P<0.05) higher MPEK in Diara buffaloes than the Graded Murrah and Non-descript type in and around Patna. The results were in accordance with the expectation because MPEK was derived on the basis of lactation milk yield, body weight within one month of calving and lactation length of the animal. The reason of lower milk production efficiency of Non-descript buffaloes was due to relatively lesser lactation milk yield in comparison to other genetic groups. Significant (P<0.01) effect of genetic group on MPEK as observed in the present study was also reported by Sharma (1978), Khanna et al. (1980) and Singh et al. (1987) in different genetic grades of crossbred cows and by Shankar (2007) in buffaloes in and around Patna.

# Location of herd

The analysis of variance (Table-19) revealed non-significant effect of location of herd on MPEK and its contribution to the total variation was reckoned to be 2.50% only. The least squares mean for MPEK was found to be the highest (2.62±0.16kg) in the animals located in the West of Danapur followed by those located in Central and East Danapur. However, the differences were not statistically significant. The non-significant effect of location of herd on MPEK as observed in the present study might be attributed to the fact the area of study was limited in a radius of 15 km which was further divided into three zones as such the variation in agroclimatic condition between the zones was found to be non-significant. The non-significant effect of location of herd on MPEK was also reported by Kumar (2004), however, Shankar (2007) reported significant effect of location of herd on MPEK in and around Patna.

Table 19: Least squares analysis of variance for the effect of genetic and non-genetic factors on (MPEK) of buffaloes in and around Danapur (Patna).

	• `	·		
Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	10.5690	18.7185**	57.25
Location/zone	2	0.4518	0.8178	2.50
Herd size	2	0.6467	1.1454	3.50
Farming system	1	0.0129	0.0299	0.70
Lactation order	5	6.2051	10.9897**	33.61
Error	527	0.5646		

<sup>\*\* =</sup> Significant at P<0.01

### Herd size

The analysis of variance revealed non-significant influence of herd size on MPEK and its contribution to the total variation for this trait was 3.05% (Table-19). As evident from table-18 the average estimate of MPEK was found to be highest (2.63±0.21 kg) of the animals maintained in the

90

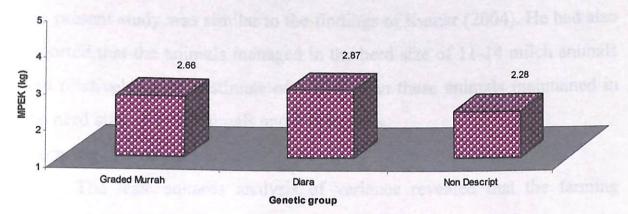


Fig. 11: Graph showing the average MPEK (kg) of buffaloes in and around Danapur.

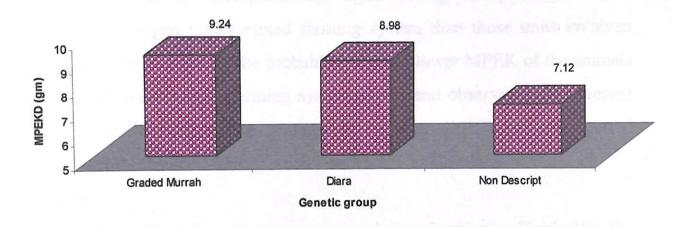


Fig. 12: Graph showing the average MPEKD (gm) of buffaloes in and around Danapur.

herd size of 7 and above. The animals maintained in the smallest herd size of 3-4 had the lowest MPEK which was lower than those animals maintained in the herd size of 5-6 and 7 & above groups but did not differ significantly. The non-significant effect of herd size on MPEK observed in the present study was similar to the findings of Kumar (2004). He had also reported that the animals managed in the herd size of 11-14 milch animals had relatively higher estimate of MPEK than those animals maintained in the herd size of 7-10 animals and 3-6 animals.

# Farming system

The least squares analysis of variance revealed that the farming system had no significant influence on MPEK and its contribution to the total variation was only 0.07% (Table-19). As evident from table-18, the animals managed in the units integrated with agriculture farming had the lowest average MPEK (2.55±0.29 kg) which was higher by 0.03 kg than those animals managed in the units involved dairying alone but did not differ significantly. Comparatively higher average body weight of the animals managed under mixed farming system than those units involved dairying alone might be the probable reason of lower MPEK of the animals managed under mixed farming system. The trend observed in the present study was similar to the findings of Shankar (2007) but he reported significant effect of farming system on MPEK in buffaloes.

# Parity

As evident from least squares analysis of variance (Table-19), the order of lactation had highly significant (P<0.01) effect on MPEK and its contribution to the total variation for this trait was 33.61% which is next to the contribution of the genetic groups. As evident from table-18, the milk production efficiency per kg body weight (MPEK) of buffaloes was found to be the lowest (2.12±0.19 kg) in animals of 1<sup>st</sup> parity. The average estimates of MPEK was found to be increased significantly (P<0.05) with

the increase in sequence of lactation and it was highest in 5<sup>th</sup> parity and then declined from 6th parity onwards. The average estimate of MPEK of the animals in 5th parity was found to be 2.80±0.17 kg which was significantly (P<0.05) higher by 0.68, 0.47 and 0.26 kg than those animals in 1st, 2nd and 3<sup>rd</sup> parity respectively. The animals in 4<sup>th</sup> and 6<sup>th</sup> parity also had the lower estimates of MPEK than those in 5<sup>th</sup> parity but did not differ significantly. The average estimate of MPEK of the animals in 4th parity had significantly (P<0.05) higher estimates of MPEK than those animals in 1st and 2nd parity by 0.61 and 0.40 kg respectively, but did not differ significantly from those animals in 3<sup>rd</sup> parity. The animals in 3<sup>rd</sup> parity also had significantly (P<0.05) higher estimate of MPEK than those in 1st and 2nd parity by 0.42 and 0.21 kg respectively. However, the animals in 2<sup>nd</sup> parity though had higher estimate of MPEK than those in 1st parity but did not differ significantly. The significant effect of lactation order on MPEK observed in the present study was in accordance with the findings of Kumar (2004) and Shankar (2007), however, Chaudhary and Barhat (1979) reported the nonsignificant effect of parity on MPEK in buffaloes. The results followed the similar trends recorded for the lactation milk yield in the present study (Table-9) which was logical as the lactation milk yield (LMY) was one of the components in deriving this milk production efficiency trait.

# MILK PRODUCTION EFFICIENCY PER KG BODY WEIGHT PER DAY OF LACTATION LENGTH (MPEKD)

The amount of milk produced by an animal with respect to its per kg metabolic body weight per day of lactation length was taken as another measure of its milk production efficiency. The milk production efficiency per kg body weight per day of lactation length (MPEKD) was derived as "the ratio of MPEK to the corresponding lactation length of the animals". The overall least squares mean for MPEKD in buffaloes consisting of three genetic groups viz. Graded Murrah, Diara and Non-descript types in and

around Danapur was calculated to be 8.47±0.22 gm (Table-18). Barhat and Chaudhary (1979) reported the average estimates of MPEKD in Mehsana and Surti buffaloes to be 11.46±0.28 and 10.46±0.31 gm respectively. Kumar (2004) reported the overall average estimate of MPEKD of milch animals consisting of cows & buffaloes in and around Darbhanga (Bihar) to be 16.0±0.20 gm. The higher estimate of MPEKD reported by him is very pertinent as the crossbred cow produced more amount of milk. However, Shankar (2007) reported the overall average estimate of MPEKD of buffaloes consisting of three genetic groups namely Graded Murrah, Diara and Non-descript types to be 8.60±0.055 gm which is very close to the findings of the present study.

# **Factors affecting MPEKD**

The least squares analysis of variance (Table-20) revealed that genetic group and lactation order had significant (P<0.01) influence on MPEKD. The effect of location of herd, herd size and farming system was found to be statistically non-significant. The least squares means for different levels of factors influencing MPEKD have been presented in table-18.

Table 20: Least squares analysis of variance for the effect of genetic and non-genetic factors on (M.P.E.K.D) of buffaloes in and around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	206.6018	171.771**	63.16
Location/zone	2	2.8551	2.3738	0.87
Herd size	2	2.3196	1.9286	0.70
Farming system	1	0.0636	0.0529	0.02
Lactation order	5	114.0915	94.8597**	34.88
Error	527	1.2027		

<sup>\*\* =</sup> Significant at P<0.01

# Genetic group

The least squares analysis of variance (Table-20) revealed that the genetic group had highly significant (P<0.01) influence on MPEKD and its contribution to the total variation was 63.16%. As evident from table-18, the average estimate of MPEKD was found to be the highest (9.24±0.23 gm) in Graded Murrah followed by Diara and Non-descript types. The Graded Murrah had significantly (P<0.05) higher estimates of MPEKD than the Non-descript buffalo by 2.12 gm, however, it did not differ significantly from Diara buffalo. The lower estimate of MPEKD in Diara buffalo than the Graded Murrah might be attributed to significantly (P<0.05) longer lactation length in Diara buffalo than the Graded Murrah. However, the Diara buffalo had significantly (P<0.05) higher estimate of MPEKD than the Non-descript by 1.86 gm. The reason for lower milk production efficiency of Non-descript buffaloes might be due to relatively lower lactation milk yield in comparison to Graded Murrah and Diara buffaloes. Chaudhary and Barhat (1979) also reported significant (P<0.05) effect of breed on MPEKD and Mehsana buffaloes reported to have higher efficiency for MPEKD in respect to Surti. Significant effect of genetic groups observed in the present study was also reported by Shankar (2007). Sharma (1978), Khanna et al. (1980) and Singh et al. (1987) also reported significant effect of genetic grades on MPEKD in crossbred cows.

# Location of herd

The analysis of variance revealed that the location of herd had no significant influence on MPEKD and its contribution to the total variation for this trait was only 0.87% (Table-20). As evident from table-18, the highest and lowest estimates of MPEKD were reckoned to be 8.36±0.24 gm and 8.64±0.23 gm of the animals located in the West and Central Danapur respectively. The reports on the effect of location of herd on MPEKD were very scanty in the literature, however, Shankar (2007) reported significant

effect of location of herd on MPEKD which is contrary to the findings of the present study. However, Kumar (2004) reported the effect of zone on this trait to be non-significant in dairy animals consisting of cattle and buffalo in and around Darbhanga (Bihar).

## Herd size

The least squares analysis of variance (Table-20) revealed non-significant influence of herd size on MPEKD and its contribution to the total variation was only 0.70%. As evident from table-18, the average estimates of MPEKD was found to be the lowest (8.31±0.23 gm) of the animals managed in the herd size of 3-4 and then increased gradually with the increase in herd size. However, the differences between the herds in respect to their size for this trait were statistically non-significant. The non-significant effect of herd size on MPEKD observed in the present investigation was similar to the findings of Kumar (2004).

# Farming system

Least squares analysis of variance (Table-20) revealed that the farming system had no significant influence on MPEKD and its contribution to the total variation was only 0.02%. The average estimate of MPEKD for the animals managed in mixed farming system was similar to those animals maintained in the units involved dairying alone. Non-significant effect of farming system on MPEKD observed in the present study was also reported by Shankar (2007).

# **Parity**

The least squares analysis of variance (Table-20) revealed highly significant (P<0.01) effect of lactation order on MPEKD and its contribution to the total variation for this trait was 34.88%. As evident from table-18, the average estimate of MPEKD was found to be the lowest (7.01±0.28 gm) in first parity which then gradually increased with the increase in sequence of lactation. The least squares mean of MPEKD was found to be the highest (9.13±0.25 gm) in 4<sup>th</sup> lactation which was found to

be significantly (P<0.05) higher by 2.12, 1.95 and 0.72 gm than those animals in 1st, 2nd and 3rd parity respectively. The average estimate of MPEKD in the animals of 3<sup>rd</sup> parity was also found to be significantly (P<0.05) higher by 1.40 and 1.23 gm than those animals in 1st and 2nd parity respectively. The animals in 2<sup>nd</sup> parity though had higher average estimate of MPEKD than those in 1st parity but did not differ significantly. The average estimate of MPEKD was started to be declined from 5th parity onwards, however, the differences between 4th and 5th parity as well as 4th and 6<sup>th</sup> parity were statistically non-significant. The trend observed in MPEKD was similar to the trend observed in lactation milk yield (LMY) in the present investigation (Table-9) and was logical as the lactation milk yield was one of the components in deriving this milk production efficiency trait. Significant effect of parity on MPEKD was also reported by Kumar (2004) for milch animals consisting of cows & buffaloes in and around Darbhanga and by Shankar (2007) for buffaloes in and around Patna which are in confirmation to the findings of the present study.

# MEASURES OF REPRODUCTION DRY PERIOD

Dry period is the period during which milch animals do not produce milk. It is an important economic indicator of dairy animals. Longer dry period is one of the major factors resulting in uneconomical milk production. There is inverse relation between length of dry period and reproduction efficiency of milch animals. The ideal dry period both in cows and buffaloes has been suggested as 60 to 70 days. The over all least squares mean for dry period in buffaloes consisting of three genetic groups viz. Graded Murrah, Diara and Non-descript in and around Danapur was observed to be 146.82±5.86 days (Table-21). The dry period observed in buffaloes of the present study was higher than the optimum range desirable for profitable milk production. The probable reason for longer dry

Table 21: Least squares mean±S.E. and Cv% of Dry Period (DP) and Calving Interval (CI) of buffaloes in and around Danapur (Patna).

De all a l	Mean ± SE (CV%)			
Particulars	DP (days)	CI (days)		
Population mean	146.82 <u>+</u> 5.86 (9.41)	462.81 <u>+</u> 5.18 (5.96)		
Factors				
Genetic group				
Graded Murrah	135.84 <sup>a</sup> ±6.02 (11.11)	436.34 <sup>a</sup> ±5.32 (5.59)		
Diara buffalo	155.26 <sup>b</sup> ±6.39 (8.85)	474.88 <sup>b</sup> ±5.66 (5.65)		
Non-descript type	159.37 <sup>b</sup> ±6.14 (8.76)	477.21 <sup>b</sup> ±5.43 (5.43)		
Location of herd				
East	148.08 <u>+</u> 6.25 (9.12)	464.66 <u>+</u> 5.52 (5.75)		
West	144.25±6.24 (9.02)	459.82 <u>+</u> 5.52 (5.62)		
Central	148.15 <u>+</u> 6.05 (8.14)	463.93 <u>+</u> 5.36 (5.61)		
Herd size				
3-4	142.48 <u>+</u> 7.81 (9.11)	459.18 <u>+</u> 6.91 (5.84)		
5-6	146.96 <u>+</u> 5.59 (9.04)	462.75 <u>+</u> 4.95 (5.61)		
7 & above	151.03 <u>+</u> 5.88 (8.77)	466.49 <u>+</u> 5.21 (5.44)		
Farming system				
Dairying alone	150.53 <u>+</u> 2.01 (8.30)	466.18 <u>+</u> 9.95 (5.12)		
Mixed farming	143.12 <u>+</u> 11.25 (9.12)	459.43 <u>+</u> 1.78 (5.02)		
Lactation order				
1 <sup>st</sup>	161.04 <sup>a</sup> ±7.35 (9.64)	476.05°±6.51 (5.53)		
2 <sup>nd</sup>	149.60 <sup>b</sup> ±6.25 (10.11)	475.16 <sup>a</sup> ±5.53 (5.63)		
3 <sup>rd</sup>	142.96 <sup>bc</sup> ±6.25 (10.41)	458.29 <sup>b</sup> ±5.62 (5.78)		
4 <sup>th</sup>	150.02 <sup>b</sup> ±6.56 (9.78)	455.75 <sup>b</sup> ±5.86 (5.65)		
5 <sup>th</sup>	139.38°±6.49 (12.11)	448.77 <sup>bc</sup> ±5.74 (5.62)		
6 <sup>th</sup>	137.94°±6.49 (12.43)	444.82°±5.75 (6.01)		

- Means with similar superscripts (column wise) did not differ significantly.
- Values in parentheses indicating CV%.

period could be the letting down of the milk by the private khatal owners from the animals in late gestation. The other probable cause might be the indiscriminant use of oxytocin for letting down of milk which may interfere with the subsequent pregnancy of the animals, as the khatal owners force the male calf to die. Longer dry periods of buffaloes reported by Rao *et al.* (1995), Sethi (1996-97) in Surti, by Paliwal (1994) in Mehsana and Chawla (1996-97) in Nili-Ravi buffaloes were in contrary to the finding of the present study in which comparatively shorter dry periods have been recorded. Contrary to the findings of the present study shorter dry periods have been reported by Devraj and Gupta (1994) in local buffaloes of Rajasthan. Dry periods in buffaloes consisting of three genetic groups Viz. Graded Murrah, Diara and Non-descript types reported by Sinha (2006) in and around Barh and Shankar (2007) in and around Patna were similar to the findings of the present study.

# Factors affecting dry period

Least squares analysis of variance (Table-22) revealed that genetic constitution of the animals and lactation order had significant (P<0.01) influence on dry period. The effects of location of herd, herd size and farming system were statistically non-significant. Least squares mean for different levels of factors affecting dry period have been presented in table-21.

# Genetic group

The analysis of variance revealed highly significant (P<0.01) effect of genetic group on dry period and its contribution to the total variation for this trait was 60.64% (Table-22). As evident from table-21, the least squares mean for dry period was found to be the lowest (135.84±6.02 days) in Graded Murrah which was significantly (P<0.05) shorter by 19.42 and 23.53 days than Diara and Non-descript buffaloes respectively. The Dry period in Diara buffalo was found to be shorter by 4.11 days than the Non-



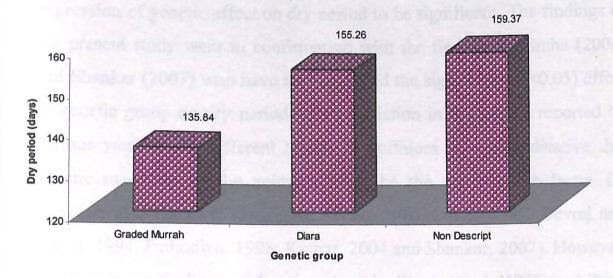


Fig. 13: Graph showing the average Dry period (days) of buffaloes in and around Danapur.

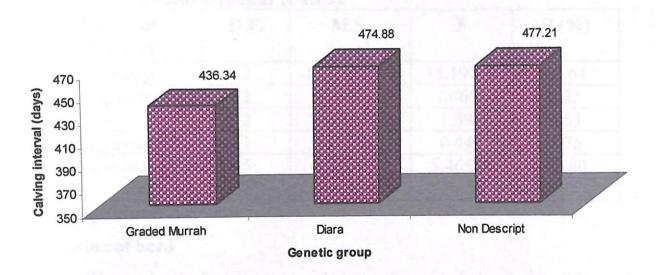


Fig. 14: Graph showing the average Calving interval (days) of buffaloes in and around Danapur.

descript but did not differ significantly. The dry period is supposed to be influenced by non-genetic factors but the genetic divergence between Graded Murrah, Diara and Non-descript buffaloes might have resulted into expression of genetic effect on dry period to be significant. The findings of the present study were in confirmation with the findings of Sinha (2006) and Shankar (2007) who have also observed the significant (P<0.05) effect of genetic group on dry period. Much variation in dry period reported by various workers for different breeds of buffaloes may be indicative that genetic make up of the animals might be the considerable factor for variation in dry period (Siddiquee *et. al.*, 1984, Singh, 1992, Devraj and Gupta, 1994, Pathodiya, 1998; Kumar, 2004 and Shankar, 2007). However, contrary to the findings of the present study, Singh *et. al.* (1983) and Priya Raj (2002) did not record the significant effect of genetic group on dry period.

Table 22: Least squares analysis of variance for the effect of genetic and non-genetic factors on Dry period of buffaloes in and

around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	12432.5700	15.197**	60.64
Location/zone	2	871.3724	1.0651	4.25
Herd size	2	1547.5190	1.891	7.55
Farming system	1	361.8036	0.442	1.76
Lactation order	5	4470.8430	5.465**	21.80
Error	527	818.1120		

<sup>\*\* =</sup> Significant at P<0.01

# Location of herd

The analysis of variance revealed that the animals located in different zones did not differ significantly among themselves with respect to their dry periods and contribution of location of herd to the total variation for this trait was only 4.25% (Table-22). The animals located in the West had the shorter dry period (144.25±6.24 days) than those located in the East and Central Danapur but did not differ significantly (Table-21). Non-significant

effect of location of herd on dry period of buffaloes in and around Patna reported by Shankar (2007) was similar to the finding of the present study. Srivastava et al. (1998), Rao et al. (2000), Priya Raj (2002) and Kumar (2004) have also reported this effect to be non-significant in cows and buffaloes under private sector.

# Herd size

The analysis of variance revealed non-significant influence of herd size on dry period and its contribution to the total variation for this trait was 7.55% (Table-22). As evident from table-21, the average dry period was found to be the shortest of the animals maintained in the herd size of 3-4 which is gradually increased with the increase in herd size, however, the variation in dry period between different herd size was found to be statistically non-significant. The non-significant effect of herd size on dry period has also been reported by Priya Raj (2002), Kumar (2004) and Kumar (2005), all under farmers management conditions of cows, which are in conformity with the findings of the present study.

# Farming system

The analysis of variance (Table-22) revealed that farming system had no significant influence on dry period and its contribution to the total variation for this trait was only 1.76%. The least squares mean for dry period of the animals managed in the units integrated with agriculture was 143.12±11.25 days which was shorter by 7.41 days than those animals maintained in the units involved dairying alone but did not differ significantly (Table-21). Non-significant effect of farming system on dry period in buffaloes consisting of three genetic groups viz. Graded Murrah, Diara and Non-descript in and around Patna has also been reported by Shankar (2007) which is in confirmation with the findings of the present study.

# **Parity**

The analysis of variance (Table-22) revealed highly significant (P<0.01) effect of lactation order on dry period and its contribution to the total variation was 21.80%. As evident from table-21, the average dry period was found to be the longest (161.04±7.35 days) in 1st lactation which then, in general, gradually decreased with the increase in sequence of lactation. The animals in 6th lactation had the shortest dry period (137.94±6.49 days) which was significantly (P<0.05) shorter by 23.10, 11.68 and 12.08 days than those animals in 1st, 2nd and 4th parity respectively. The animals in 5<sup>th</sup> lactation also had significantly (P<0.05) shorter dry period than those in 1st, 2nd and 4th lactations by 21.68, 10.22 and 10.64 days respectively but did not differ significantly from those in 3<sup>rd</sup> and 6<sup>th</sup> parity. The animals in 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> parity had significantly (P<0.05) shorter dry period than those in 1<sup>st</sup> parity but did not differ significantly among themselves. The similar trend of decreasing dry period gradually from 1st parity onwards as observed in the findings of present study was also reported by Singh (1992) and Shankar (2007). However, Singh (1992) reported the effect of parity on dry period to be nonsignificant. Significant effect of parity on dry period as observed in the present study was also reported by Kumar (2004) in cows and buffaloes and Shankar (2007) in buffaloes maintained under farmers management system in and around Darbhanga and Patna respectively.

# **CALVING INTERVAL**

Sound reproductive system of milch animal can be judged by calving interval. The inter calving period of 12-13 months has been recommended as an ideal calving interval in cows and buffaloes. The over all least squares mean for calving interval of buffaloes consisting of three genetic groups namely Graded Murrah, Diara and Non-descript in and around Danapur was found to be 462.81±5.18 days (Table-21). The period of calving

interval observed in the present study was longer than the optimum range desirable for profitable milk production but the estimate was closer to the findings reported by Dev Raj and Gupta (1994), Kumar (2004), Sinha (2006) and Shankar (2007). In comparison to the findings of the present study, the higher estimates of calving interval have been reported by Johari and Bhatt (1979), Rao et al. (1995) and Yadav et al. (2003<sup>b</sup>) in Murrah buffaloes and by Siddiquee et al. (1984) and Singh (1992) in Mehsana buffaloes.

# Factors affecting calving interval

Least squares analysis of variance revealed significant (P<0.01) effect of genetic group and lactation order on calving interval (Table-23). Location of herd, herd size and farming system had no significant influence on calving interval. Least squares mean for different levels of the factors affecting calving interval have been presented in table-21.

# Genetic group

Least squares analysis of variance (Table-23) revealed highly significant (P<0.01) effect of genetic group on calving interval and its contribution to the total variation for calving interval was very high which is reckoned to be 81.30%. As evident from table-21, the shortest calving interval (436.34±5.32 days) was shown by Graded Murrah, which was significantly (P<0.05) shorter by 38.54 and 40.87 days than the Diara and Non-descript buffaloes respectively. Diara buffalo had the shorter calving interval (474.88±5.66 days) than the Non-descript by 2.33 days but did not differ significantly. Calving interval is supposed to be influenced by non-genetic factors but in the present study the genetic divergence among Graded Murrah, Diara and Non-descript buffaloes might have resulted into expression of genetic effect to be significant. Singh *et al.* (2000) and Kumar (2004) reported the effect of genetic group on calving interval to be significant in case of crossbred cows and buffaloes maintained in private

dairy units. Significant effect of genetic group on calving interval in buffaloes maintained in private dairy units in and around Barh and Patna (Bihar) was also reported respectively by Sinha (2006) and Shankar (2007). The longest and shortest calving intervals of Non-descript buffaloes and Graded Murrah respectively as observed in the present study were similar to the findings of Sinha (2006).

Table 23: Least squares analysis of variance for the effect of genetic and non-genetic factors on calving Interval (C.I.) of buffaloes in and around Danapur (Patna).

Source of variation	D.F.	M.S.	F	R (%)
Genetic group	2	73402.6500	114.548**	81.30
Location/zone	2	1216.0370	1.898	1.35
Herd size	2	122.9430	1.9084	1.35
Farming system	1	301.0582	0.4698	0.33
Lactation order	5	13496.8300	21.0623**	14.95
Error	527	640.8046		

<sup>\*\* =</sup> Significant at P<0.01

# Location of herd

Least squares analysis of variance (Table-23) revealed that location of herd had no significant influence on calving interval and its contribution to the total variation for this trait was only 1.35%. As evident from table-21, the animals located in the West of Danapur had the shortest calving interval (459.82±5.52 days) which was shorter by 4.84 and 4.11 days than those animals located in the East and Central Danapur respectively but the differences were statistically non-significant. Shankar (2007) also reported the non-significant effect of location of herd on calving interval in buffaloes maintained in the private dairy units in and around Patna which is in confirmation to the findings of present study. The non-significant effect of location of herd on calving interval in milch animals have also been reported by Shrivastava *et al.* (1988), Rao *et al.* (2000), Priya Raj (2002) and Kumar (2004). Non-significant effect of location of herd on calving interval might to be attributed to the fact that the total area under study was

within the radius of 15 km which was divided into three zones and as such the variation in agro-climatic condition between the zones was non-significant.

# Herd size

Least squares analysis of variance (Table-23) revealed nonsignificant effect of herd size on calving interval and its contribution to the total variation for calving interval was only 1.35%. As evident from table-21, the animals maintained in the herd size of 3-4 had the shortest calving interval (459.18±6.91 days) which was observed to be gradually increased with the increase in herd size. The animals maintained in the herd size of 7 & above group had 7.31 and 3.74 days longer calving interval than those animals maintained in the herd size of 3-4 and 5-6 respectively but did not differ significantly. Non-significant effect of herd size on calving interval observed in the present study has also been reported by Priya Raj (2002) in crossbred cows, Kumar (2004) and Kumar (2005) in Desi and crossbred cows maintained in private dairy units under farmers management conditions. The trend observed in the present study was similar to the findings of Kumar (2005) who observed that the cows maintained in the herd size of 3-6 had shorter calving interval than those animals maintained in larger groups.

# Farming system

Least squares analysis of variance (Table-23) revealed that farming system had no significant influence on calving interval and its contribution to the total variation was only 0.33%. As evident from table-21, the animals maintained in the units integrated with the agriculture had the shorter calving interval (459.43±1.78 days) which was shorter by 6.75 days than those animals managed in the units involved dairying alone but the difference was found to be statistically non-significant. The non-significant influence of farming system on calving interval observed in the present study was similar to the findings of Shankar (2007). The non-significant effect of farming system on calving interval might be attributed to the fact that the level of management and feeds & fodder resources given to the

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animals under two farming systems might be similar in and around Danapur. However, Johar & Bhat (1979) reported highly significant (P<0.01) effect of farms and period on calving interval in buffaloes.

# **Parity**

The analysis of variance (Table-23) revealed highly significant (P<0.01) effect of lactation order on calving interval and its contribution to the total variation for calving interval was 14.95%. As evident from table-21, the estimate of calving interval was found to be the longest (476.05±6.51 days) in first parity which was found to be decreased gradually with the increase in sequence of lactation. The average estimate of calving interval in first parity was significantly (P<0.05) longer than those animals in 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> parity by 17.76, 20.30, 27.28 and 31.23 days respectively, however, did not differ significantly from those in 2<sup>nd</sup> parity. The animals in 2<sup>nd</sup> parity also had longer calving interval (475.16±5.53 days) than those in 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> parity by 16.87, 19.41, 26.39 and 30.34 days respectively. The animals in 3<sup>rd</sup> parity also had significantly (P<0.05) longer calving interval (458.29±5.62 days) than those in 6th parity by 13.47 days but did not differ significantly from those in 4<sup>th</sup> and 5<sup>th</sup> parity. The animals in 4<sup>th</sup> parity had significantly (P<0.05) longer calving interval than those in 6th parity by 10.93 days but did not differ significantly from those in 5<sup>th</sup> parity. The animals in 6<sup>th</sup> parity though had shorter calving interval than those in 5<sup>th</sup> parity but the difference was statistically non-significant. The significant effect of parity on calving interval observed in the present investigation was also reported by Singh (1992) and Kumar (2004) in cows and buffloes as well as Shankar (2007) in buffaloes maintained in private dairy units. The trend of decreasing calving interval from 2<sup>nd</sup> parity onwards observed in the present study was also reported by Singh (1992) in cows and Shankar (2007) in buffaloes. However, Siddiquee et al. (1984), Tailor et al. (1998) and Raheja (1992) reported non-significant effect of parity on calving interval.

# CONSTRAINTS PERCEIVED BY THE OWNERS OF PRIVATE DAIRY UNITS

The owners of private airy units (khatal) in and around Danapur were interviewed to enumerate the constraints pertaining to breeding, feeding management and disease control of their buffaloes in order of priority. The type of constraints were found to be varied from one dairy unit to another depending upon the location of the units and farming system. As perceived and reported by the owners of different dairy units, the common constraints were identified and ranked on the basis of frequency of the dairy units owners expressing the same constraints and that have been depicted in table-24.

Table-24 Constraints perceived by the owners of dairy units in and around Danapur, Patna.

Sl. No.	Constraints	Rank
1.	High cost of buffaloes	I
2.	Lack of proper housing due to costly land	II
3.	Non-availability of high yielding buffaloes in the locality	III
4.	High incidences of repeat breeding	IV
5.	Non-availability of green fodder throughout the year	V
6.	High cost of feeds, fodder and feed supplement	VI
7.	High cost of Veterinary medicines	VII
8.	Poor results of A.I.	VIII
9.	Lack of finance / credit facility	IX
10.	Non-remunerative price of milk	X
11.	Uneconomical male calves	XI

High cost of high yielding buffaloes ranked 1<sup>st</sup> in the list of constraints as perceived by the owners of the dairy unit. The non-availability of large number of good dairy buffaloes in the locality, which have been ranked 3<sup>rd</sup> constraints in the list is the main reason for high cost of high yielding buffaloes. Indeed, as compared to the other leading milk producing states of the country, the number of high yielding buffaloes are lesser in Bihar. Resultantly, the khatal owners had to procure high yielding buffaloes from out side the state, mostly from Hariana and Punjab, making the animals costly.

Since Danapur is a subdivisional town of Patna district and situated adjustment to Patna, the capital of Bihar, hence, the cost of land had gone very high. Therefore it was not within the approach of khatal owners to have sufficient land for building the houses for animal. The khatal owners are resource poor and find difficulties in construction of proper housing for the animal. Thus lack of proper housing due to costly land was the 2<sup>nd</sup> major constraints perceived by the dairy owners. Besides, the khatal owners were utilizing the small piece of land on rent basis for construction of byres for maintaining of the buffaloes. All these led to improper and unhygienic housing for the animals.

"High incidence of repeat breeding" ranked as 4<sup>th</sup> constraint. The reason might be attributed mainly to the deficiency of greens in their feed. The other reasons might include the lack of optimum quantity of essential minerals and trace elements required necessarily to maintain the breeding efficiency of buffaloes.

Non-availability of green fooder through out the year ranked as 5<sup>th</sup> constraint in this study which is directly correlated with high incidence of repeat breeding. High cost of feeds & fodders ranked as 6<sup>th</sup> constraint due to non-availability of sufficient quantity of green fodders and poor production of cereals necessary for preparation of feed. High cost of veterinary medicines which ranked as 7<sup>th</sup> constraint that might be possibly, one of the important reasons for not to provide proper treatment to the animals, in general and repeat breeding cases in particular. The owners of different dairy units also reported the poor results of A.I. which ranked as 8<sup>th</sup> constraint. This might be possibly due to lapses in detection of heat at the right time and timely insemination with quality semen by trained personnels which need to be improved with better management practice.

Lack of financial credit felicities ranked as 9<sup>th</sup> constraint. It could plausibly be explained as there were several financial agencies but there

were certain terms and conditions of financing and enterprise including mortgage of assets of value more than the amount to be credited. Most of the khatal owners did not have such assets, except their animals which are also not in sure.

Non remunerative price of milk in and around Danapur was one of the constraints reported by the dairy farmers. Dairy farmers also perceived that the male calves are uneconomical as they did not fetch lucrative amount of money. Hence uneconomical male calves ranked as the last constraint of this study. Due to spacio-temporal entity of the constraints varying from place to place, time to time and farmer to farmer, the findings of this investigation were not quite comparable with the similar studies conducted elsewhere. However, Shankar (2007) made similar studies in buffaloes in and around Patna (Bihar) and his findings were similar to the results obtained in the present study. Singh and Thomas (1992), Raju et al. (1993), Velmurugor (1998), Yedukondalu et al. (2000), Sawarkar et al. (2001) and Mishra and Pal (2003) have also made similar studies in different agro-climatic and socio-economic systems of the country. The different constraints were also perceived by the farmers in their study areas, however, the priority order (ranks) of the different constraints varied in different studies made in different parts of the country.

# SUMMARY AND CONCLUSION

# SUMMARY AND CONCLUSION

The present study was conducted on 90 randomly selected dairy units consisting of 198 Graded Murrah, 126 Diara and 216 Non-descript buffalo cows utilizing the procedures of "Stratified random sampling with proportionate allocation" (Snedecor & Cochran, 1967) in and around Danapur with the following objectives:

- To estimate the phenotypic parameters of some of the milk production efficiency measures of buffaloes managed in unorganized farms in and around Danapur.
- To estimate the nature and magnitude of variation in various measures of milk production efficiency traits under consideration due to genetic and non-genetic factors in buffaloes in and around Danapur.
- To study the variation in morphometic traits due to genetic and nongenetic factors of buffaloes in unorganized farms in and around Danapur.
- To study the different constraints perceived by the dairy farmers in rearing buffaloes in and around Danapur.

The aim of this investigation was to study the effect of genetic and non-genetic factors on various morphometrics as well as production and reproduction efficiency traits in buffaloes under farmer's management system. Besides, the various constraints perceived by the dairy farmers were also taken into account and ranked them on priority basis to suggest a suitable package of dairy practices for profitable milk production in that locality. The morphometric traits included in the study were Height at Wither (HAW, cm), Body Length (BL, cm) and Heart Girth (HG, cm) as

well as Body weight (BW, kg) of the adult buffalo cows. The milk production efficiency traits included in the study were Lactation Milk Yield (LMY, kg), Lactation Length (LL, days), Peak Yield (PY, kg), Days to attain Peak yield (DAPY, days) Milk Yield per day of Lactation Length (MY/LL, kg), Milk Yield per day of Calving Interval (MY/CI, kg), Milk production efficiency per kg body weight within first month of calving (MPEK, kg) and Milk production efficiency per kg body weight per day of lactation length (MPEKD, gm). The traits for reproduction efficiency under study were Dry period (DP, days) and Calving Interval (CI, days).

The genetic factors were the three different genetic groups of buffaloes viz. Graded Murrah, Diara and Non-descript prevalent in Bihar. The non-genetic factors included in the study were location of herd, herd size, farming system and lactation order.

The data were subjected to statistical analysis through computer in ARIS (Agricultural Research Information System) Cell in the Department of Animal Breeding & Genetics, Bihar Veterinary College, Patna. Least squares analysis of variance (Harvey, 1966) was utilized to study the effect of genetic and various non-genetic factors on morphometric traits, Body weight, milk production efficiency traits and reproduction efficiency traits, whereas Duncan's Multiple Range Test (DMRT) as modified by Kramer (1957) was utilized for pair-wise comparison of least squares means at 0.05 level of probability.

The genetic group and lactation order were found to have significant (P<0.01) influence on all the morphometric traits, milk production efficiency and reproduction efficiency traits.

Graded Murrah had significantly (P<0.05) higher estimates of all the morphometric traits (HAW, BL and HG) than Diara and Non-descript.

Diara buffaloes though had superiority over Non-descript for body length and height at wither but did not differ significantly. The average estimates of body length, heart girth and height at wither of Graded Murrah were 139.16±0.63, 199.62±1.34 and 132.77±0.62 cm respectively. Therefore, the size of Diara buffalo was in between Graded Murrah and Non-descript types. The lactation order had significant (P<0.01) influence on BL, HG, HAW whereas location of herd, herd size and farming system had no significant influence on these traits. However, the animals managed under mixed farming system had higher estimates of morphometric traits, than those maintained in the units involved dairying alone. The animals in first parity had the lowest magnitudes of all the morphometric traits and significantly (P<0.05) increased upto 4<sup>th</sup> parity indicating that the skeletal maturity of the buffaloes might be attained at the age of 4<sup>th</sup> parity.

The average estimates of body weight (BW) of Graded Murrah, Diara and Non-descript buffaloes were observed to be 514.48±7.59, 464.65±8.06 and 470.12±7.74 kg respectively. The Graded Murrah were significantly (P<0.05) heavier than those of Diara and Non-descript, however, the difference was statistically non-significant. The lactation order had significant (P<0.05) influence on body weight and the trend was similar to that of morphometirc traits. The animal attained highest body weight at 4<sup>th</sup> parity indicating that skeletal maturity of the animals attained at this age when they are in 4<sup>th</sup> parity. The animals maintained under mixed farming system were heavier than those animals maintained in the units involved dairying alone but did not differ significantly.

The average lactation milk yield (LMY) of Graded Murrah, Diara and Non-descript buffaloes were found to be 1431.02±35.22, 1385.08±37.42 and 1115. 58±35.94 kg respectively. The genetic group,

herd size and lactation order had significant (P<0.05) influence on LMY. The average estimates of LMY was significantly (P<0.05) more in Graded Murrah than the Diara and Non-descript buffalo. Diara buffalo also had significantly (P<0.05) higher estimate of LMY than the Non-descript. The animals maintained in the herd size of 5 to 6 and 7 & above had significantly (P<0.05) higher estimates of LMY than those animals maintained in the herd size of 3 to 4. The average estimates of LMY were observed to be increased significantly (P<0.05) with the increase in sequence of lactation and LMY was recorded to be the highest in 4<sup>th</sup> lactation.

The least squares means of lactation length (LL) of Graded Murrah, Diara and Non-descript buffaloes in and around Danapur were reckoned to be 297.84±4.76, 316.59±5.60 and 313.83±4.86 days respectively. The effect of genetic constitution of the animals and lactation order had significant (P<0.05) influence on lactation length. Diara buffalo had the longest lactation length which was significantly (P<0.05) longer than that of Graded Murrah but did not differ significantly from Non-descript type. The animals in 2<sup>nd</sup> lactation had the longest lactation length which was observed to be decreased significantly (P<0.05) with the increase in sequence of lactation.

The least squares means of peak yield (PY) in Graded Murrah, Diara and Non-descript buffaloes were estimated to be 7.87±0.26, 7.28±0.28 and 5.74±0.27 kg respectively. The genetic make up of the animals, location of herd and lactation order had significant (P<0.01) influence on peak yield. Graded Murrah had the highest peak yield which was significantly (P<0.05) higher than the peak yield of Non-descript but it was not significantly different from Diara buffalo. Animals located in central Danapur had

significantly (P<0.05) higher peak yield than those located in the East but did not differ significantly from those located in the West. The animals in the 1<sup>st</sup> and 2<sup>nd</sup> lactation had the lowest peak yield which then increased gradually and significantly (P<0.05) with the increase in sequence of lactation. The highest peak yield was recorded in 4<sup>th</sup> lactation.

Least squares means for Days to attain Peak Yield (DAPY) of Graded Murrah, Diara and Non-descript buffaloes were reckoned to be  $37.67\pm0.74$ ,  $41.10\pm0.78$  and  $41.91\pm0.75$  days respectively. The animals in  $1^{st}$  lactation had the shortest DAPY which then increased gradually over the sequence of lactation but did not differ significantly upto  $4^{th}$  lactation. The animals in  $5^{th}$  lactation had the longest DAPY which was significantly (P<0.05) longer than those animals in  $1^{st}$  and  $2^{nd}$  lactation.

The least squares means for Milk Yield per Day of Lactation Length (MY/LL) of Graded Murrah, Diara and Non-descript buffaloes in and around Danapur were calculated to be 4.83±0.14, 4.37±0.15 and 3.60±0.15 kg respectively. The genetic group and lactation order had significant (P<0.01) influence on MY/LL. The average estimate of MY/LL was highest in graded Murrah which was significantly (P<0.05) more than the Non-descript but did not differ significantly from Diara buffalo. The animals in 1<sup>st</sup> lactation had the lowest average estimate of MY/LL which was found to be increased gradually and significantly (P<0.05) over the sequence of lactation, the highest average estimate was observed in 4<sup>th</sup> lactation. The trend was similar to that of LMY as observed in the present study.

The least squares means for Milk Yield per Day of Calving Interval (MY/CI) of Graded Murrah, Diara, and Non-descript buffaloes were estimated to be 3.31±0.08, 2.91±0.09 and 2.33±0.09 kg respectively. The

genetic constitution of animals, herd size and lactation order had significant (P<0.01) effect on MY/CI. Graded Murrah had the highest average estimate of MY/CI which was significantly (P<0.05) higher than the average estimates of Diara and Non-descript buffaloes. Diara buffalo also had significantly (P<0.05) higher estimate of MY/CI than the Non-descript buffaloes. The animals maintained in the herd size of 7 & above had the highest average estimates of MY/CI which was significantly (P<0.05) higher than those animals maintained in the herd size of 3-4, but did not differ significantly from those managed in the herd size of 5-6. The animals in 1<sup>st</sup> lactation had the lowest average estimate of MY/CI which was found to be increased significantly (P<0.05) from 3<sup>rd</sup> parity onward and the highest average estimate of MY/CI was observed in 4<sup>th</sup> lactation. The trend was similar to that of LMY observed in the present study.

The least squares means for Milk Production efficiency per kg of Body weight within 1<sup>st</sup> month of calving (MPEK) of Graded Murrah, Diara and Non-descript buffaloes were estimated to be 2.66±0.15, 2.87±0.17 and 2.28±0.16 kg respectively. Diara buffalo had the highest average estimate of MPEK which was significantly (P<0.05) higher than the Non-descript buffaloes but did not differ significantly from Graded Murrah. The animals in 1<sup>st</sup> lactation had the lowest average estimate of MPEK which was found to be increased significantly (P<0.05) from 3<sup>rd</sup> Parity onwards. The animals in 5<sup>th</sup> lactation had the higher average estimate of MPEK. The trend was similar to that of LMY as observed in the present study as it was one of the components required for estimation of MPEK.

The least squares means for Milk Production efficiency per kg of Body Weight per day of Lactation Length (MPEKD) of Graded Murrah, Diara and Non-descript buffaloes were 9.24±0.23, 8.98±0.25 and 7.12±0.24

gm respectively. The genetic group and lactation order had significant (P<0.01) influence on MPEKD. Graded Murrah had the highest average estimate of MPEKD which was significantly (P<0.05) higher than the average estimate of Non-descript buffaloes but did not differ significantly from Diara. The animals in 1<sup>st</sup> lactation had the lowest average estimate of MPEKD which was found to be increased gradually and significantly (P<0.05) from 3<sup>rd</sup> lactation onwards and the highest average estimate of MPEKD was obtained in the animals of 4<sup>th</sup> parity. The trend was similar to that of LMY observed in the present study as it was one of the components for estimation of MPEKD.

The least squares means for Dry Period (DP) of Graded Murrah, Diara and Non-descript buffaloes were observed to be 135.84±6.02, 155.26±6.39 and 159.37±6.14 days respectively. The genetic group of the animals and lactation order had significant (P<0.01) effect on dry period. The average estimate of dry period was found to be the lowest in Graded Murrah which was significantly (P<0.05) lower than the Diara and Non-descript buffaloes. Diara buffalo though had lower average estimate of dry period than the Non-descript but did not differ significantly. The animals in 1<sup>st</sup> lactation had the longest dry period which was found to be decreased gradually and significantly (P<0.05) with the increase in sequence of lactation. The average estimate of dry period was significantly (P<0.05) shorter in the animals of 6<sup>th</sup> lactation than those in 1<sup>st</sup>, 2<sup>nd</sup> and 4<sup>th</sup> parity but did not differ significantly from those in 3<sup>rd</sup> & 5<sup>th</sup> parity.

The least squares means for Calving Interval (CI) of Graded Murrah, Diara and Non-descript buffaloes were obtained as 436.34±5.32, 747.88±5.66 and 477.21±5.43 days respectively. The genetic group of the animals and lactation order had significant (P<0.01) effect on calving

interval. Graded Murrah had the shortest calving interval which was significantly (P<0.05) shorter than the average estimates of calving interval in Diara and Non-descript buffaloes. Diara buffalo though had shorter calving interval than the Non-descript but the difference was not statistically significant. The animals in 1<sup>st</sup> lactation had the longest calving interval which was found to be decreased gradually and significantly (P<0.05) from 3<sup>rd</sup> parity onwards and the animals in 6<sup>th</sup> lactation had the shortest calving interval, but did not differ significantly from those in 5<sup>th</sup> lactation.

The farming System though had no significant influence of any of the traits considered in the present study, however, the animals managed under mixed farming system in the field condition in and around Danapur performed better than those animals maintained in the units involved dairying alone.

The farmers of the dairy units located in and around Patna recorded 11 constraints perceived by them of which high cost of buffaloes ranked first followed by lack of proper housing due to high cost of land, non-availability of high yielding buffaloes, high incidences of repeat breeding, non-availability of green fodders and feed supplement, high cost of veterinary medicines, poor results of A.I., lack of finance / credit facility, uneconomical male calves and Non-remunerative price of milk which require proper attention on priority basis.

# **CONCLUSION:**

On the basis of findings of the present study it was concluded that the Diara buffaloes were significantly different from Graded Murrah in respect to morphometrics, body weight, milk production and milk production efficiency traits. Diara buffaloes though had significantly (P<0.05) lower

lactation milk yield and milk yield per day of calving interval in comparison to Graded Murrah but they were efficient milk producer in respect to MPEK due to their lower body weight and size. Diara buffalo had superiority over Graded Murrah in respect to lactation length. Diara buffalo though had lower average estimates of peak yield, milk yield, milk yield per day of lactation length (MY/LL) and milk production efficiency per kg of body weight per day of lactation length (MPEKD) than the Graded Murrah but did not differ significantly. Diara buffaloes were found to be significantly (P<0.05) superior over the Non-descript buffaloes in respect to lactation milk yield, peak yield, MY/LL, MY/CI and milk production efficiency traits. Diara buffaloes had significantly longer dry period and calving interval than the Graded Murrah but did not differ significantly from the Non-descript. The genetic group of the animals and lactation order had significant (P<0.01) influence on all the morphometric traits, body weight, as well as milk production and milk production efficiency traits. Body weight, lactation milk yield, peak yield, MY/LL, MY/CI and milk production efficiency traits were in general found to be increased significantly upto 4<sup>th</sup> lactation.

The similar type of work may be repeated in the entire Tal and Diara areas of the river Ganges, Gandak and Sone flowing through Bihar to identify and enumerate the number of Diara buffaloes so that a suitable breeding plan can be chalked out for improvement of buffaloes in general and Diara buffaloes in particular and to improve the livelihood of the dairy farmers in the state.

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