

**'GENETIC ANALYSIS OF MILK
PRODUCTION EFFICIENCY &
MORPHOMETRICS OF BUFFALO IN
& AROUND PATNA (BIHAR)'**

THESIS

Submitted to the
Rajendra Agricultural University
(Faculty of Veterinary & Animal Sciences)
Pusa (Samastipur) Bihar

By
Dr. Shashi Shankar
Reg. No-M/ABG/80/2004-05

In partial fulfillment of the requirement
For the Degree of

Master of Veterinary Science

(Animal Breeding & Genetics)

Department of Animal Breeding & Genetics
Bihar Veterinary College
Patna (Bihar)

2007

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

2007



***Dedicated
To
My Respected
Parents***

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


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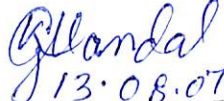
CERTIFICATE – I

This is to certify that the thesis entitled “*Genetic analysis of milk production efficiency and morphometrics of Buffalo in and around Patna (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. Shashi Shankar, Registration No. M/ABG/80/2004-05**, under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Endorsed



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CERTIFICATE – II

We, the undersigned members of the Advisory Committee of **Dr. Shashi Shankar**, Registration No. **M/ABG/80/2004-2005**, a candidate for the Degree of Master of Veterinary Science with major in **Animal Breeding & Genetics** have gone through the manuscript of the thesis and agree that the thesis entitled “*Genetic analysis of milk production efficiency and morphometrics of Buffalo in and around Patna (Bihar)*” may be submitted by **Dr. Shashi Shankar** in partial fulfilment of the requirements for the degree.


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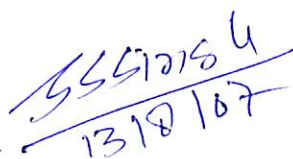
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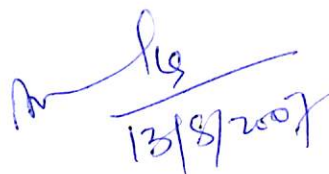
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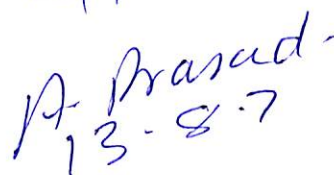
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CERTIFICATE – III

This is to certify that the thesis entitled “*Genetic analysis of milk production efficiency and morphometrics of Buffalo in and around Patna (Bihar)*” submitted by **Dr. Shashi Shankar**, Registration No. **M/ABG/80/2004-05** in partial fulfillment of the requirements for the Degree of Master of Veterinary Science (**Animal Breeding & Genetics**) of the Faculty of Post-Graduate Studies, Rajendra Agricultural University, Pusa, Samastipur, Bihar was examined and approved on 05 / 01 / 08 .



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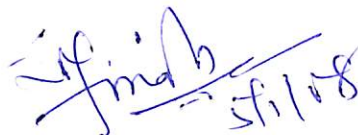
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Date : 13.08.07

Place : B.V.C., Patna

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INTRODUCTION

INTRODUCTION

With 2.5% of the total land area of the world, India is bestowed with 7-8% of the total livestock species of the World and recognised as 7th largest mega biodiversity. There are 30 breeds of cattle, 10 breeds of buffalo, 42 sheep, 20 goats, 8 camel, 6 horse and 18 breeds of poultry in our country in addition to other species like Pig, Dunkey, Mithun, Yak, Turkey, Ducks, Quail, etc. A large range of agro-ecological zones in India has helped to develop this large number of breeds of various species. Livestock plays an important role in poverty alleviation for all sectors of the society through year round employment and income generation. 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.

India has now emerged as the largest milk producer in the world producing about 91 million tonnes of milk per annum (India, 2007). Although the per capita availability of milk is estimated to be increased to 230 g per day, yet there is a big gap between availability and requirement of milk mainly because of steep rise in the human population of the country which has already crossed the mark of 100 crores in 2001 itself. Thus, intensive efforts are being made to increase milk production through scientific breeding, feeding, health care and better management of milch animals.

Cattle and buffaloes are the main milk producing animals in our country. Buffalo forms the backbone 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, 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 buffaloes or river buffaloes as they derived their name from their usual habitat, the river valley, and majority of them are non-descript types. Out of the ten descript breeds majority of them are confined to the North and Central Western parts of the country.

India has not only the best breed of buffalo (Murrah) in the World, but also the prized genetic diversity in the form of non-accredited population groups spread out in different parts of the country. Some of these populations have sufficient numbers with different traits to be conserved as distinct population. These populations are well adapted to the local agro-climatic conditions, can thrive and efficiently produce on prevalent feeds and fodders without any external support, have strong disease resistance powers, less health and reproduction problems and can survive in adverse conditions, besides optimum / profitable production of milk and generation of draught power.

Buffaloes are important milk producing animals in Bihar. According to 17th Livestock Census, Govt. of India, 2003, Bihar has 5.75 million buffaloes which comes to about 34.86% of the total bovine population of the state. 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 buffaloes. 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 buffaloes are almost true to the breed and have acquired full adoption to the

socio-agro-climatic and ecological conditions of gangetic plains, particularly in the “Tal and Diara” area of the rivers Ganga, 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 buffaloes 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 west to Raj Mahal in east.

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

Patna, the capital city of Bihar situated in the South Gangetic plain of Bihar. It has clusters of buffaloes including so called ‘Diara buffaloes’ are being maintained by the farmers of this area. To meet the demands of ever growing population for milk and milk products in the city, a large number of private dairy units popularly known as khatahs are being maintained by the farmers. Buffaloes are preferred by the farmers of this area probably due to high fat and SNF content in their milk, the most desirable character

for khoa production. Farmers of this area are getting remunerative price through selling buffalo khoa as well as raw milk. It is, therefore, essential to evaluate the milk production efficiency of these three groups of buffaloes viz. Graded Murrah, Diara and Non-descript types under farmers' management system so that a suitable breeding program and package of practices may be evolved for their development in general and Diara buffaloes in particular.

The milk production efficiency of buffaloes is dependent upon various genetic and non-genetic factors. Besides, the dairy farmers perceive many constraints in maintaining the dairy units in different agro-climatic and socio-economic zones. Although there are some information available on milk production efficiency of buffaloes in organized farms, yet the information on buffaloes maintained under unorganised farms is very scanty (Kumar, 2004). Therefore, keeping in view the above facts the present study 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 Patna.
2. To estimate the nature and magnitude of variation in various measures of milk production efficiency under consideration due to genetic and non-genetic factors in buffaloes in and around Patna.
3. To study the variation in morphometric traits due to genetic and non-genetic factors in buffaloes of unorganized farms in and around Patna.
4. To study the different constraints perceived by the dairy farmers in rearing buffaloes in and around Patna.

REVIEW OF LITERATURE

Buffaloes, a potent milk producing species in India, had been an important subject of investigation for animal scientists since long. A large number of publications pertaining to different physical and physiological parameters of different morphometrics as well as production and reproduction traits estimated for the animals in organized farms may not be quite comparable with the findings based on the data on buffaloes maintained at farmer's door and collected by field survey methods. Studies on buffaloes maintained in their native tracts under farmers' management system have been initiated 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 organised as well as in unorganised sectors of Bihar, however, some of the relevant research findings of the studies conducted on buffaloes managed in different argo-eco-socio-economic conditions of the country as well as in Bihar, particularly managed under farmers' management system have been reviewed here.

MORPHOMETRIC TRAITS

Morphometric traits are associated with the productivity of the animals and have an important role in input and output relationship.

Randhawa (1958) estimated 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) measured the 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 ± 0.7 cm 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 ± 0.8 , 146.5 ± 0.4 and 203.3 ± 0.6 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 , 118.8 ± 1.1 and 184.1 ± 2.0 cm respectively.

Singh *et al.* (1995) 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 ± 0.20 cm, 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 sub division of Patna district in Bihar and reported the population mean for height at wither, body length and heart girth of buffaloes to be 129.36 ± 0.29 , 135.64 ± 0.31 and 193.68 ± 0.65 cm respectively. The corresponding values for Diara buffaloes 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 buffaloes 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, 124.96 ± 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 withers, body length, and heart girth of the adult buffaloes were reported to be 123.90 ± 0.65 cm, 134.38 ± 0.92 cm and 184.21 ± 1.28 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 (1991) estimated the body weight of adult Murrah buffalo cows to be 509.0 ± 6.8 kg.

Singh *et al.* (1995) 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 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

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 (1986) 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 significantly lower at the first parity and continued to increase upto 3rd parity.

Singh *et al.* (1995) 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.

Body weight

Johari and Bhat (1979) analysed the data of four genetic groups of buffaloes viz. Murrah, Murrah grades, Nili 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 and Nili grades had 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 significantly lower 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.

PRODUCTION AND REPRODUCTION TRAITS

Lactation Milk Yield (LMY)

Lactation milk yield is the most important economic character of dairy animal 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 lactation milk yield pooled over first four parities in UNION and LRS herds as 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 *et al.* (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.

Factors affecting lactation milk yield

Johari and Bhat (1979^b) 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.

Lactation Length (LL)

Tajane and Sidiquee (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 the Churu district of Rajasthan to be 310 days.

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

Shah and Sharma (1994) 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 not covered under milk producer cooperative society. 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.

Shashidhar *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 Maharashtra 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 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.

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 lactatin 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 longest in first and 4th parities of buffaloes in LRS and UNION herd respectively. 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.

Peak Yield

The peak yield is an important production trait which expresses the 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.* (1994) 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.

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^a) 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.

Days to attain Peak yield

A milch animal is supposed to be economical if she attains peak yield shortly after calving and has higher persistency of peak 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 ± 0.52 and 44.00 ± 0.47 days respectively and the overall estimate of days to attain peak yield to be 41.83 ± 0.28 days.

Factors affecting days to attain peak yield

Choudhary and Choudhary (1981) reported significant effect of breeds on average number of 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 buffaloes (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 non-significant.

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.

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) recorded 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 square mean for MY/LL of Surti buffaloes to be 3.68 ± 0.05 kg which was lower than the estimates reported by Vij and Tiwaha (1988) in Murrah and Singh *et al.* (1989) in Nili-Ravi Buffaloes, indicating breed differences. Tailor *et al.* (1990) 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 Maharashtra 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.

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 (1986) and Kandasam *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 interval is reported to be increased gradually from first to third parity and then declined from fourth parity onwards.

Milk production efficiency with respect to body weight

Barhat and Choudhary (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) as suggested by Gaines *et al.* (1940). 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 lighter ones were more efficient than the heavier.

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.

Dry Period

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 UNION 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 a sub-divisional town of Patna district 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.

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.

Calving Interval

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 *et al.* (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^a) reported the average calving interval in Murrah buffalo to be 477.08 ± 13.73 days.

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.

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, Nili 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 and Jain (1986) 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 in private Khatahs of Dharbhanga (Bihar). The longest and the shortest calving intervals were reported to be in second and first parity respectively.

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 of animal breeding was non-availability of crossbred cattle in local market following the high breeding charges, inadequate knowledge of A.I., costly treatment of repeat breeders and unavailability of timely A.I. facilities. The main constraints in feeding of animals were the high cost of feed and fodders. Inadequate 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 of 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 the 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%), non-availability 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%).

MATERIALS AND METHODS

Source of Data

Buffaloes consisting of three genetic groups namely Graded Murrah, Diara and Non-descript types maintained in private dairy units at farmer's door located in a radius of 15 km in and around Patna were the experimental animals for the present study.

Study area

The whole area under study was divided into three distinct zones, which are as follows :

- Zone - I North West Patna** : Raja Bazar, Kautilya Nagar, Asiana, Jaiprakash Nagar, Digha, Dujara, Mainpura, Seikhpura etc.
- Zone - II South West Patna** : Rupaspur, Dhanaut, Mahuabagh, Ufarpura, Rukunpura, Khajpura, Muralichak, Phulwarisharif, Bhikachak, Shaichak, Beur, Makdumpur, Makdumpur Harnichak, Anisabad etc.
- Zone - III East Patna** : Parsa Bazar, Karmalichak, Agamkuan, Sandalpur, Bhadurpur, Jaganpur, Khemnichak, Hanuman Nagar, Daud Bigha Kumhrar etc.

Geography

Patna, the capital of Bihar is famous for its historical importance. It is located 25° 36' N latitude and 85° 06' E longitude at an altitude of 60 m from mean sea level. On the basis of records for the last 30 years, the average climatological details of Patna obtained from meterological centre Patna is 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 private diary units popularly known as "khatal" located in a radius of 15 km in and around Patna. Those khatal which consisted of atleast 2 or more buffaloes consisting of Graded Murrah, Diara or Non-descript buffaloes either alone or in combination were enumerated utilizing a "door-to-door survey" method. A 'khatal' may be described as small diary units managed in private sector with cows and / or buffaloes as the milk producing animals and having prime objective of profitable production. Altogether 920 buffaloes consisting of 331 Graded

Murrah, 221 Diara and 368 Non-descript buffaloes were enumerated from 145 dairy units located in and around Patna. The details of zone-wise distribution of buffaloes are tabulated below :

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

| Zones | Dairy units enumerated | Genetic groups | | | Total |
|--------------|------------------------|----------------|-------------|--------------------|------------|
| | | Graded Murrah | Diara types | Non-descript types | |
| I | 52 | 119 | 79 | 132 | 330 |
| II | 48 | 111 | 74 | 123 | 308 |
| III | 45 | 101 | 68 | 113 | 282 |
| Total | 145 | 331 | 221 | 368 | 920 |

General Managerial Practices in Dairy units

The managerial practices in all the khatala were not uniform and approved scientific practices, particularly feeding and physical as well as sexual disease control measures, were not adopted by khatal owners. The animals were generally managed in sub-optimal condition of housing and sanitation, but in order to fulfill the sole objective of profitable milk production, buffaloes were supplied with high quality concentrate mixture to challenge the animals to produce milk to their maximum.

In general, the buffaloes were stall fed with individual feeding. Concentrates were fed to the animals on the basis of different physical and physiological status such as body size, milk production, stage of lactation, dry period etc. In general, home made concentrate mixtures were fed to the animals. However, wheat bhusa and chaffed paddy straw consisted of most common items of dry fodder, whereas seasonal cultivated and uncultivated

grasses were the source of green fodders. Mineral mixture, vitamins and common salt were also added to balance the ration as general practice. Although strict complete scientific schedules regarding vaccination are not followed by majority of the units, yet prophylactic and curative measures against various diseases were usually taken up in majority of the units.

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

Buffaloes were maintained either in $\frac{1}{2}$ Kutcha, $\frac{3}{4}$ th Pucca or even complete pucca houses (Picture-1&2). 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 areas in different units which are as follows :

Type A - Full Kutcha house

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

Type C - $\frac{3}{4}$ th Pucca house (wall, floors and feeding through pucca)

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

Genetic groups of the animals

In the study area maintenance of history-pedigree records of buffaloes was not in practice. However, on the basis of physical attributes, the farmers were classifying buffaloes in following three distinct groups (i) Punjabiya (Graded Murrah) (ii) Deshila (Diara) and (iii) Non-descript (other than above two types). In fact, the Punjabiya type of buffaloes were those having of Murrah germ plasma in their ancestry. Buffaloes of this type were possessing some of the phenotypic characters of Murrah buffalo

Picture-2 : Housing System (Makeshift type)



Picture-1 : Housing System (Puca)



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 were positive in providing relevant information were called respondent units. Out of 145 enumerated units, only 120 units were the respondent units which provided relevant information. These respondent units consisted of buffaloes which included 275 Graded Murrah, 185 Diara and 308 Non-descript buffaloes. The zone-wise distribution of the respondent units along with buffaloes of different genetic groups are presented in the following table.

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

| Zones | Respondent Dairy Units | Genetic groups | | | Total |
|-------|------------------------|----------------|-------------|--------------------|-------|
| | | Graded Murrah | Diara types | Non-descript types | |
| I | 43 | 100 | 68 | 112 | 280 |
| II | 40 | 89 | 59 | 98 | 246 |
| III | 37 | 86 | 58 | 98 | 242 |
| Total | 120 | 275 | 185 | 308 | 768 |

Such units were shorted out for further approaches to collect information in the light of objectives of this investigation. Altogether 60 such units consisting of 307 buffaloes of different age and genetic groups were sorted out.

Sampling of respondent units

Out of the total 120 units, 50% i.e. 60 dairy units consisting of 430 buffaloes of different genetic groups were randomly selected utilizing the procedures of "stratified random sampling with proportional allocation" (Snedecor and Chochran, 1967). The zone-wise distribution of selected respondent units along with the number of buffaloes in three genetic groups i.e. Graded Murrah, Diara and Non-descript types and the number of discarded buffaloes have been presented in the following table.

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

| Particulars / Genetic group | Zones | | | Total |
|-----------------------------|-------|-----|-----|-------|
| | I | II | III | |
| No. of units selected | | | | |
| No. of buffaloes studied | | | | |
| Graded Murrah | 41 | 39 | 36 | 116 |
| Diara | 25 | 23 | 22 | 70 |
| Non-descript types | 43 | 41 | 37 | 121 |
| Sub-total (A) | 109 | 103 | 95 | 307 |
| Discarded buffalo | | | | |
| Graded Murrah | 21 | 23 | 22 | 66 |
| Diara | 7 | 6 | 10 | 24 |
| Non-descript | 13 | 9 | 11 | 33 |
| Sub-Total (B) | 42 | 38 | 43 | 123 |
| Total (A+B) | | | | |
| Graded Murrah | 62 | 62 | 58 | 182 |
| Diara | 33 | 29 | 32 | 94 |
| Non-descript | 56 | 50 | 48 | 154 |
| Graded Total | 151 | 141 | 138 | 430 |

A total of 123 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 type
 - (iii) Non-descript type
- (b) 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)
- (f) Milk yield per day of calving interval kg (MY/CI)
- (g) MPEK
- (h) MPEKD

(C) Measures of Reproduction efficiency :

- (a) Dry Period (days)
- (b) Calving interval (days)

(D) Morphometric traits :

- (a) Height at withers (cm)
- (b) Body length (cm)
- (c) Chest 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), 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 under three genetic groups such as :

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

(2) Location of herd :

- (i) South West Patna
- (ii) North West Patna
- (iii) East Patna

(3) Lactation order :

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

- (i) 1st parity
- (ii) 2nd parity
- (iii) 3rd parity
- (iv) 4th parity

(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) Only Animal husbandry

Statistical Method

Stratified random sampling with proportional allocation :

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

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

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

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

$$\text{Let } n_i \propto N_i$$

$$\text{or, } n_i = C N_i \dots\dots\dots (1)$$

Where,

C is the constant of proportionality

After taking summation on both the sides, we get

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

$$\text{Or, } n = CN$$

$$\text{Hence, } n/N = C \text{ (constant)}$$

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

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

Let Y_{ij} be the value of j^{th} unit in the i^{th} strata of population ($i = 1, 2, 3, \dots, K$ and $j = 1, 2, 3, \dots, N_i$ and y_{ij} be the corresponding sample observation ($i = 1, 2, 3, \dots, K$ and $j = 1, 2, 3, \dots, n_i$), then population mean \bar{Y} is given by :

$$\begin{aligned} \bar{Y} &= \frac{1}{N} \sum_{i=1}^K \sum_{j=1}^{N_i} Y_{ij} \\ &= \frac{1}{N} \sum_{i=1}^K N_i \bar{y}_i \end{aligned}$$

Where,

$$\bar{y}_i = \frac{1}{N_i} \sum_{j=1}^{N_i} Y_{ij}, \text{ which is the mean of the } i^{th} \text{ strata of the population.}$$

The population variance

$$\begin{aligned} V(\bar{y}) &= \sum_{i=1}^K \frac{N_i(N_i-1)}{N} \left(\frac{1}{N_i} - \frac{1}{N} \right) s_i^2 \\ &= \sum_{i=1}^K w_i^2 \left(\frac{1}{n_i} - \frac{1}{N} \right) s_i^2 \end{aligned}$$

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

Similarly, the sample mean can be defined as :

$$\bar{y} = \frac{1}{n} \sum_{i=1}^K n_i \bar{y}_i$$

Where, $y_1 = 1/K \sum_{i=1}^K y_{ij}$ i.e. the sample mean of the i^{th} strata and

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

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

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

Least squares analysis

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

$$Y_{ijklm} = \mu + G_i + Z_j + F_k + P_l + e_{ijklm}$$

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

μ = The overall population mean

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

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

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

P_l = The effect of l^{th} parity ($l = 1, 2, 3, 4$)

e_{ijklm} = The random error associated with individual which is randomly and independently distributed with mean zero and variance σ_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

$$\text{Weight of buffalo (in pond)} = (L \times G^2) / 300$$

L = Length of animal in inch

G = Heart girth of animal in inch

$$1 \text{ Kg} = 2.2046 \text{ lbs}$$

Constraints in dairy farming

The respondents were requested to provide the important technological and managerial problems, perceived by them, in maintaining the dairy units in and around Patna. Garrett'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 (Garrett & Woodworth, 1969).

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

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

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

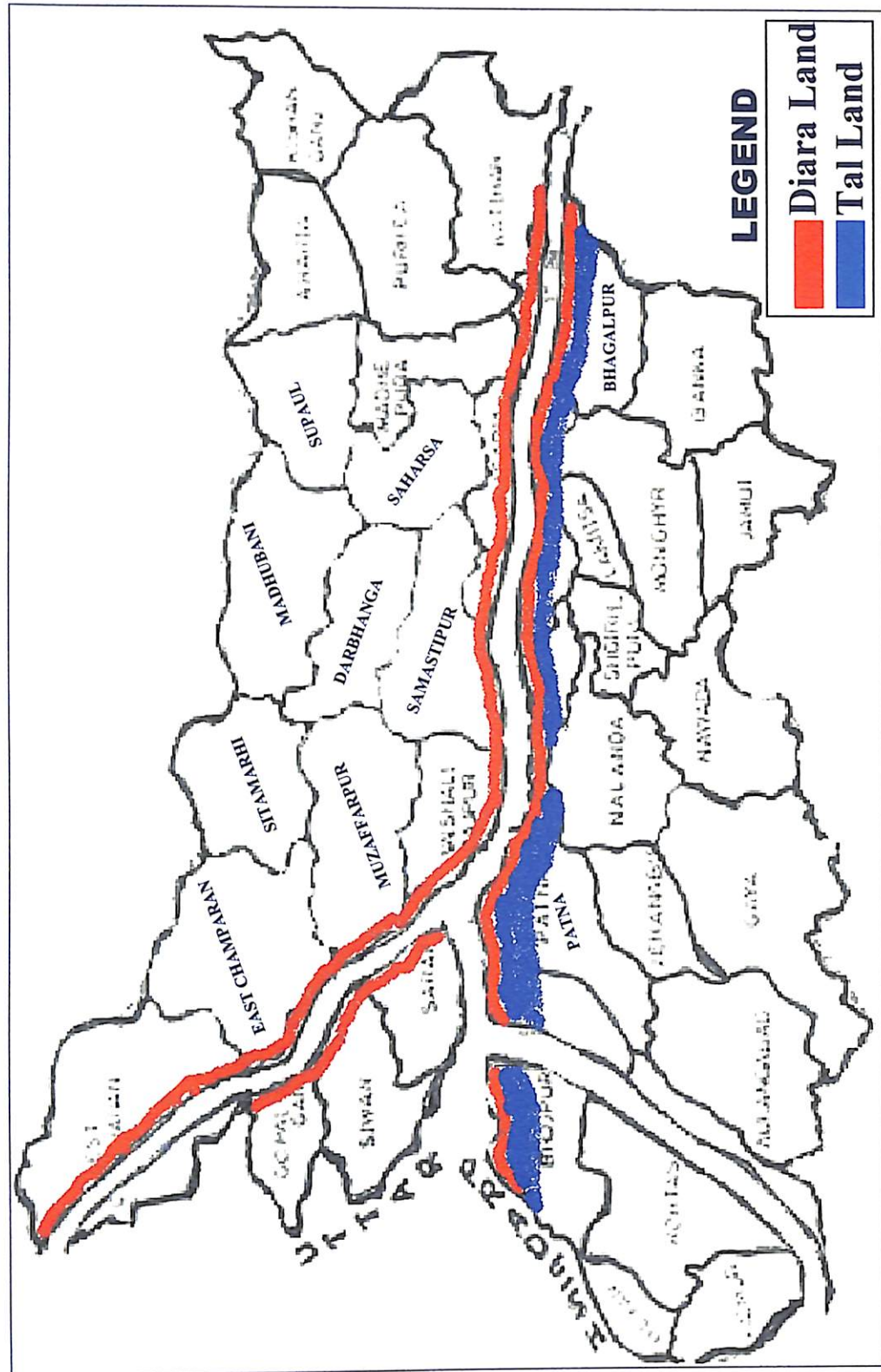
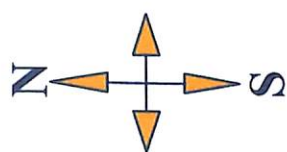
The percent position of each rank was converted into scores by referring Garrett's ranking table. Then for each factor the scores of individual respondents were added. The mean scores for all the factors were arranged in descending order and ranked.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

Small buffalo herds are distributed throughout the length and breadth of the state but the area under South and North Gangetic planes 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 "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 type of buffaloes. The breeding tract of Diara type buffaloes has been extended from Buxar to Rajmahal in the North and South Gangetic planes of Bihar (Picture-3).

From the study it could be revealed that phenotypically Diara buffaloes are light black to brown or silver gray (Bhuria) in colour (Picture-4a & 4b) whereas Graded Murrah (Picture-5) and Non-descript (Picture-6) types are jet black in colour. Switch of the tail is either black or brown in Diara buffaloes whereas black or white in Graded Murrah and Non-descript types. Sometimes there is white marking on the forehead and feet below the hock joint in Non-descript types. Muzzle, hoofs and horn are usually black in colour all the genetic groups. In Diara buffaloes, horns are dorso-ventrally flat, loosely coiled and emerging from side of the head extended backward and inward. 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 morphometric traits of these three genetic groups have been presented in the following sections.



Picture-3 : Breeding tract of Diara buffalo



Picture-4(a) : Adult female of Diara buffalo (Silver gray/ Bhuria)



Picture-4(b) : Diara Buffalo (Left) in Group



Picture-5 : Graded Murrah



Picture-6 : Non-Descript Buffalo

MORPHOLOGICAL TRAIT

Body size and body measurement traits of an animal are associated with the productivity and have an important role in input and output relationship. This function gains more significance under stringent condition of feed and fodder scarcity. In the present investigation three body measurement traits viz. height at wither, body length and chest girth were taken as morphometric traits. Body size of an animal was measured in terms of body weight. It is very difficult to record the body weight of large animal under field condition. Hence, the live body weights of animals 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 the results are presented in tables from 1 to 22 accordingly.

HEIGHT AT WITHER

The overall least squares mean for height at wither (HAW) of buffaloes consisting of three different genetic groups viz. Diara, Graded Murrah and Non-descript types was estimated to be 130.248 ± 0.110 cm (Table-1)

Factors affecting height at wither

Least squares analysis of variance (Table-2) revealed that genetic group, farming system and order of lactation had highly significant ($P < 0.01$) effect on height at wither, while the location did not influence this trait.

Genetic group

The genetic group had highly significant ($P < 0.01$) influence on height at wither and its contribution to the total variation in height at wither

Table 1 : Least squares means±SE and CV% of morphometric traits of buffaloes in and around Patna.

| Particulars | Morphometric traits (cm) | | |
|---------------------------|---------------------------------------|---------------------------------------|---------------------------------------|
| | HAW (Mean±S.E.) | B.L. (Mean±S.E.) | C.G. (Mean±S.E.) |
| Overall Mean(μ) | 130.248±0.110 (1.47) | 136.478±0.138 (1.77) | 195.692±0.384 (3.43) |
| Factors | | | |
| Genetic group | | | |
| Graded Murrah | 132.113 ^a ±0.187 (1.41) | 138.598 ^a ±0.235 (1.69) | 199.153 ^a ±0.653 (3.27) |
| Diara | 129.818 ^b ±0.185 (1.42) | 135.507 ^b ±0.232 (1.71) | 191.282 ^b ±0.646 (3.41) |
| Non Descript | 128.814 ^c ±0.184 (1.42) | 135.328 ^b ±0.231 (1.70) | 196.640 ^c ±0.642 (3.34) |
| Location | | | |
| 1. North West Patna | 130.180±0.177 (1.44) | 136.384±0.222 (1.72) | 195.257±0.619 (3.35) |
| 2. South West Patna | 130.456±0.183 (1.44) | 136.796±0.230 (1.73) | 196.953±0.641 (3.35) |
| 3. East Patna | 130.109±0.198 (1.44) | 136.253±0.249 (1.72) | 194.866±0.693 (3.35) |
| Farming System | | | |
| 1. Animal Husbandry alone | 129.983 ^a ±0.149 (1.45) | 135.952 ^b ±0.187 (1.73) | 193.800 ^a ±0.520 |
| 2. Mixed Farming | 130.513 ^b ±0.157 (1.46) | 137.003 ^a ±0.197 (1.74) | 197.584 ^b ±0.549 |
| Lactation order | | | |
| 1 st | 124.391 ^a ±0.197 (1.49) | 130.947 ^a ±0.247 (1.77) | 186.467 ^a ±0.688 (3.48) |
| 2 nd | 128.907 ^b ±0.188 (1.42) | 135.226 ^b ±0.236 (1.70) | 194.317 ^b ±0.657 (3.31) |
| 3 rd | 133.952 ^c ±0.213 (1.38) | 140.007 ^c ±0.268 (1.66) | 201.829 ^c ±0.745 (3.31) |
| 4 th | 133.743 ^c ±0.273 (1.38) | 139.731 ^c ±0.343 (1.66) | 200.154 ^c ±0.955 (3.23) |

- Means with different superscripts (column-wise) differed significantly (P<0.05)
- Values in parentheses are CV%

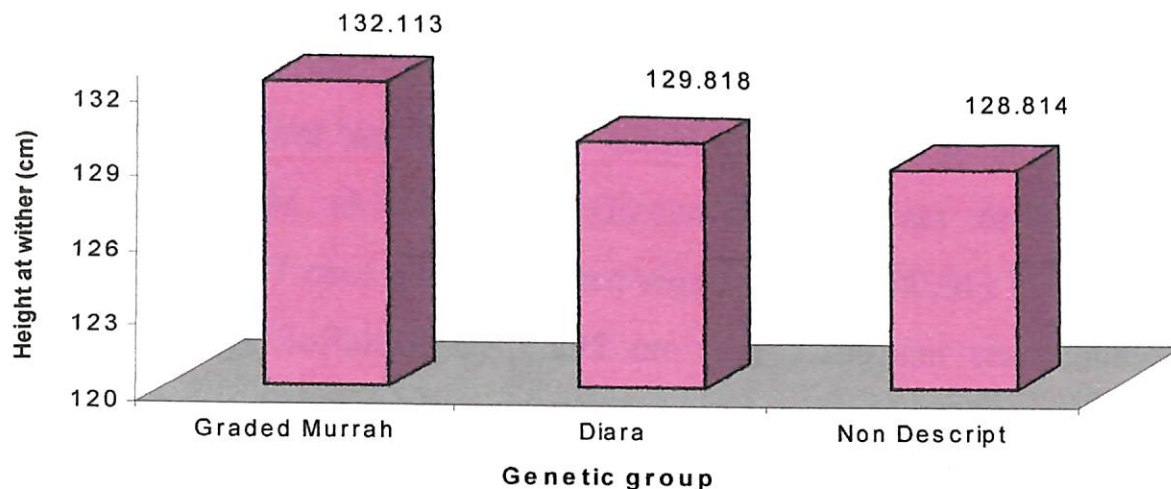


Fig. 1 : Graph showing the average height at wither (cm) of buffaloes in and around Patna.

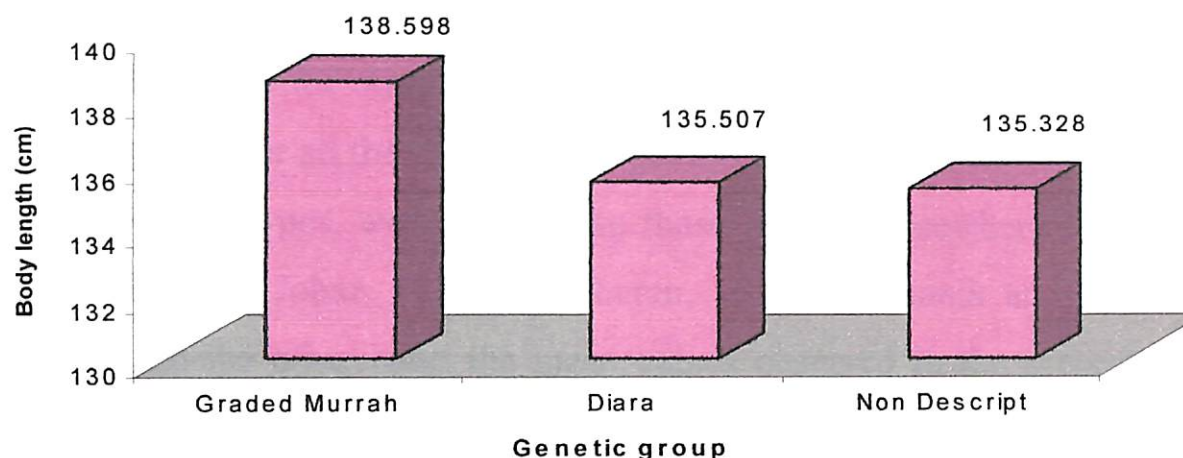


Fig. 2 : Graph showing the average body length (cm) of buffaloes in and around Patna.

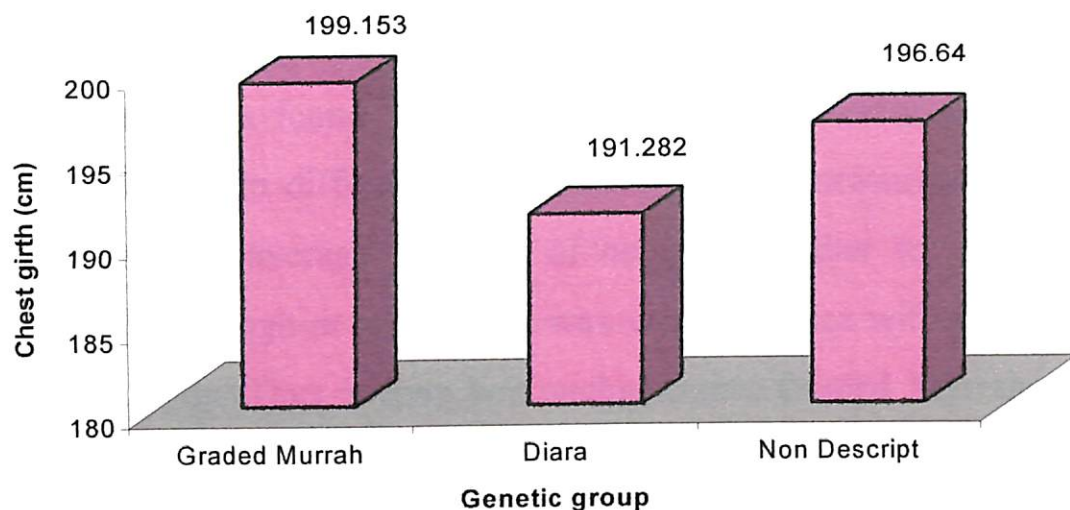


Fig 3 : Graph showing the average chest girth (cm) of buffaloes in and around Patna.

was 15.58% (Table-2). As evident from table-1 and fig.-1, the Graded Murrah buffaloes had the greatest height among all the genetic groups. The average height at wither of Graded Murrah was estimated to be 132.113 ± 0.187 cm., which differed significantly ($P < 0.01$) from Diara and Non-descript buffaloes by 2.295 cm and 3.299 cm respectively. The average height at wither of Diara buffaloes (129.881 ± 0.185 cm,) was significantly ($P < 0.01$) higher than the height at wither of Non-descript types by 1.004 cm. Conversely Non-descript buffaloes were the shortest in height. The overall average height at wither as well as the mean values for this trait obtained in the present study for Diara and Non-descript buffaloes native to Patna (Bihar) are very much comparable to the findings available in the literature for other breeds. The mean values obtained in the present investigation for all the three genetic groups viz. Graded Murrah, Diara and Non-descript types, were lower than those reported elsewhere for Murrah (Jawarkar and Johar, 1975; Sreedharan, 1976 and Manik and Iqbalnath, 1981). On the other hand the mean values observed in the present study were higher than the values reported by Prajapati (1988) and Singh *et al.* (1995) in Nagpuri, by Jogi and Patel (1990) in Surti, by Singh and Singh (1998) and Kushwaha *et al.* (2006) in Bhadawari buffaloes.

The mean values reported by Sinha (2006) for Graded Murrah, Diara and Non-descript buffaloes in and around Barh (Bihar) were quite higher than the values found in the study area of the present experiment. This might be due to difference in methodology for measurement of the trait. However, the average estimate of height of wither for Diara buffaloes reported by Singh *et al.* (2006) was in consonance with the result of the present study. Thus it may be concluded that Graded Murrah, Diara and Non-descript buffaloes in and around Patna (Bihar) were observed to be smaller and lighter than Murrah but heavier than Mehsana, Surti, Bhadawari and Nagpuri buffaloes.

Location

As evident from table-1, the average height at wither was highest (130.456 ± 0.183 cm) in the animals located in South West Patna of the study area followed by North West (130.180 ± 0.177 cm.) and East Patna (130.109 ± 0.198 cm.). The contribution of location effect to the total variation for HAW was only 0.18% and the animals of different locations were not significantly different among themselves with respect to their height at wither (Table-2).

Singh *et al.* (1995) also reported the non-significant difference for HAW in Mehsana buffaloes located at different herds which supports the findings of the present study.

This may be attributed to the fact that the experimental area was limited in a radius of 15 km only which was divided into three zones in and around Patna and as such there was not much variation in agro-climatic condition of the different zones.

Table 2 : Least squares analysis of variance showing effects of genetic and non-genetic factors on height at wither of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|---------|---------------------|--------------------|
| Genetic group | 2 | 577.99 | 288.99** | 15.58 |
| Location | 2 | 6.656 | 3.328 ^{NS} | 0.18 |
| Farming system | 1 | 20.9704 | 20.97** | 1.13 |
| Lactation order | 3 | 4616.21 | 1538.73** | 82.93 |
| Error | 298 | 1010.00 | 3.389 | 0.18 |

NS = Non-significant, ** = Significant at $P < 0.01$

Farming system

The farming system had significant ($P < 0.01$) influence on height at wither although its contribution to the total variation was only 1.13% (Table-2). The animals reared under mixed farming system integrated with

agriculture had the higher estimate (130.513 ± 0.157 cm) for HAW than those managed in the units exclusively involved in dairying by 0.53 cm (Table-1). The difference was statistically significant ($P < 0.05$). Significantly higher estimates of HAW in all the age groups for animals maintained in Livestock Research Station than those maintained under farmer's management system as observed by Singh (1995^a) were in consonance with the findings of the present study. Significant ($P < 0.05$) difference for HAW between animals managed under different farming system might be attributed to the fact that animals managed under better management system may have better growth.

Parity

Results (Table-2) revealed that order of lactation had significant ($P < 0.01$) influence on height at wither, its contribution to the total variation on HAW was 82.93%. The average HAW was found to be increased significantly ($P < 0.05$) and steadily from first (124.391 ± 0.197 cm) to third lactation (133.952 ± 0.213 cm) by 9.561 cm followed by slight decrease in fourth lactation. However, the difference in HAW between third and fourth parity was not statistically significant. The average estimates for height at wither in third and fourth parities were also significantly ($P < 0.05$) higher than the second parity by 5.045 and 4.836 cm respectively. Significant ($P < 0.01$) influence of parity on height at wither observed in the present investigation was in accordance with the findings of many workers (Jawarkar and Johar, 1975; Saini and Gill, 1986; Jogi and Patel, 1990; Singh *et al.* 1995. Significant ($P < 0.05$) increase in height at wither upto third parity as observed in the present study was also reported by Jawarkar and Johar (1975) and Jogi and Patel (1990) in Murrah and by Singh *et al.* (1995c) and Singh *et al.* (2000) in Mehsana buffaloes. Significant increase in HAW upto third parity indicated the fact that growth of buffaloes was

taken place upto third parity, which might be due to the influence of growth stimulating hormones upto this age.

BODY LENGTH

The overall least squares mean for body length pooled over three different genetic groups of buffaloes viz. Diara, Graded Murrah and Non-descript types included in this study, was reckoned to be 136.478±0.138 cm (Table-1).

Factors affecting body length

Least squares analysis of variance (Table-3) revealed that genetic group, farming system and order of location had significant (P<0.01) influence on body length. The effect of lactation or zone was statistically non-significant. Least squares means for different levels of the factors affecting body length are presented in table-1.

Table 3 : Least squares analysis of variance showing effects of genetic and non-genetic factors on body length of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|---------|-----------------------|--------------------|
| Genetic group | 2 | 678.89 | 339.44 ^{**} | 18.78 |
| Location | 2 | 15.85 | 7.929 ^{NS} | 0.44 |
| Farming system | 1 | 82.46 | 82.46 ^{**} | 4.56 |
| Lactation order | 3 | 4116.61 | 1372.20 ^{**} | 75.92 |
| Error | 298 | 1591.50 | 5.340 | 0.30 |

NS = Non-significant, ** = Significant at P<0.01

Genetic group

Genetic group had highly significant (P<0.01) effect on body length and its contribution to the total variation in body length was 18.78% (Table-3). As revealed from Table-1 and Fig.-2, the Graded Murrah had longest body length (138.598±0.235 cm) followed by Diara (135.507±0.232 cm), and Non-descript had the shortest body length

(135.328±0.231 cm). The average body length of Graded Murrah differed significantly ($P<0.05$) from Diara and Non-descript types. The average body length of Graded Murrah was significantly ($P<0.05$) longer than the Diara and Non-descript buffaloes in and around Patna by 3.091 and 3.270 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 different 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 present study were lower than the body length of Murrah buffaloes as reported else where by Jawarkar and Johar (1975), Sreedharan (1976) and Manik and Iqbalnath (1981). Mehsana buffaloes had also longer body length as reported by many workers (Randhawa, 1958; Prajapati, 1988 and Singh *et al.*, 1995). However, comparatively shorter body length is reported by Nandedkar *et al.* (2006) in Nagpuri buffaloes; by Singh and Singh (1998) and Kushwaha *et al.* (2006) in Bahdawari and by Jogi and Patel (1990) in Surti buffaloes. Significant ($P<0.05$) effect of genetic group on body length reported by Sinha (2006) and Singh *et al.* (2006) was in agreement with the findings of the present study. Thus it can be stated that the buffaloes in and around Patna (Bihar) namely Graded Murrah, Diara and Non-descript types were shorter in length than Murrah and Mehsana buffaloes but longer than Surti, Bhadawari and Nagpuri.

Location

As evident from table-1, the average body length found to be was the highest (136.796±0.230 cm) in the animals located in South West Patna of the study area followed by North West (136.384±0.22 cm) and lowest in East Patna (136.253±0.249 cm). The least squares analysis of variance (Table-3) revealed non-significant effect of zone on body length and

contribution of zone effect to the total variation for body length was only 0.44%. Non-significant effect of location on body length as observed in the findings of the present study is in agreement with the results reported by Singh *et al.* (1995) in Mehsana buffaloes. Non-significant effect of location on body length observed in the present study 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.

Farming System

The farming system was found to have significant ($P<0.01$) influence on body length and its contribution to the total variation for this trait was 4.56% (Table-3). The animals managed in the units integrated with agriculture farming had significantly ($P<0.05$) higher mean body length (137.003 ± 0.197 cm) in comparison to those involved in the dairying alone by 1.151 cm (Table-1). Differences in body length were also observed by Singh *et al.* (1995^a) in all the age groups of Mehsana buffaloes managed in LRS herd from those managed in milk union sheds under farmers management system which supports the finding of the present study. Differences in body length between the animals under different farming system might be attributed to the variation in the level of nutrition and availability of feeds and fodder given to the animals.

Parity

As evident from table-3, that the lactation order had highly significant ($P<0.01$) effect on body length and its contribution to the total variation was 75.92%. The lowest average body length pooled over all the three genetic groups viz. Graded Murrah, Diara and Non-descript types was estimated to be 130.947 ± 0.247 cm in the first parity and then increased significantly ($P<0.05$) over the lactations. The highest average body length (140.007 ± 0.268 cm) was observed in third parity which was significantly

($P<0.05$) longer than the average body length observed during first and second parity by 4.279 and 9.06 cm respectively. The average body lengths during third and fourth order of lactations were also significantly ($P<0.05$) longer than in second parity by 4.781 and 4.505 cm respectively. However, though the body length in fourth parity was little bit shorter than in third parity but did not differ significantly.

Significant influence of parity on body length as observed in the present study has also been reported by Jawarkar and Johar (1975), Saini and Gill (1986), Jogi and Patel (1990) in Murrah buffaloes and by Singh *et al.* (1995) and Singh *et al.* (2000) in Mehsana buffaloes who stated that body length in buffaloes increased significantly upto third parity. Significant increase in body length up to third parity revealed that the skeletal maturity in buffaloes may be taken place up to the age at third parity. Slight reduction in body length during fourth parity over the first parity might be attributed to wearing and tearing of tissues and muscles but not due to reduction of skeleton.

CHEST GIRTH

The overall least squares mean for chest girth pooled over three different genetic groups of buffaloes, viz. Diara, Graded Murrah and Non-descript, included in this study was estimated to be 195.692 ± 0.384 cm (Table-1).

Table 4 : Least squares analysis of variance showing effects of genetic and non-genetic factors on chest girth of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|----------|----------------------|--------------------|
| Genetic group | 2 | 3247.79 | 1623.89** | 24.82 |
| Location | 2 | 244.91 | 122.45 ^{NS} | 1.87 |
| Farming system | 1 | 1068.69 | 1068.69** | 16.33 |
| Lactation order | 3 | 11060.23 | 3686.74** | 56.35 |
| Error | 298 | 12312.00 | 41.31 | 0.63 |

NS = Non-significant, ** = Significant at $P<0.01$

Factors affecting chest girth

Least squares analysis of variance (Table-4) revealed significant ($P<0.01$) influence of genetic group, farming system and order of lactation on chest girth while the influence of zone on this trait was not statistically significant. Least squares means for chest girth of buffaloes under the influence of various factors have been presented in table-1.

Genetic group

Genetic group had highly significant ($P<0.01$) influence on chest girth and its contribution to the total variation was reckoned to be 24.82% (Table-4). As evident from table-1 and fig.-3, the Graded Murrah had the largest chest girth (199.153 ± 0.653 cm) followed by Non-descript (196.640 ± 0.6421 cm) and Diara buffaloes (191.282 ± 0.646 cm). The chest girth in Diara buffaloes was found to be significantly ($P<0.05$) lowered than the Graded Murrah and Non-descript buffaloes by 7.871 and 5.358 cm respectively.

Graded Murrah had significantly ($P<0.05$) larger chest girth than the Non-descript by 2.513 cm. The overall population mean and the mean values for chest girth in three different genetic groups viz. Graded Murrah, Diara and Non-descript buffaloes as 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 the findings of Jawarkar and Johar (1975), Sreedharan (1976) and Manik and Iqbalnath (1981) who reported higher estimates of chest girth in Murrah buffaloes. Higher estimates for chest girth were also reported by Randhawa (1958), Prajapati (1988) and Singh *et al.* (1995) in Mehsana buffaloes, whereas comparatively shorter chest girth is reported by Nandedkar *et al.* (2006) in Nagpuri buffaloes, by Singh and Singh (1998) and Kushwaha *et al.* (2006) in Bhadawari and by Jogi and Patel (1990) in Surti. However, the results obtained in the present investigation are in agreement with the findings of

Sinha (2006) who reported the average chest girth for Diara, Graded Murrah and Non-descript buffaloes in and around Barh a subdivision of Patna district to be 188.95 ± 1.08 , 196.75 ± 1.19 and 195.34 ± 1.09 cm respectively. Thus it can be concluded that the three genetic groups of buffaloes namely Graded Murrah, Diara and Non-descript types in and around Patna (Bihar) were shorter in chest girth than the Murrah and Mehsana buffaloes but larger than the Surti, Bhadawari and Nagpuri buffaloes.

Location

As evident from table-1, the highest average chest girth was found to be 196.953 ± 0.641 cm in the animals located in South West Patna of the Study area followed by North West Patna (195.257 ± 0.619 cm) and lowest in East Patna (194.866 ± 0.693 cm). The least squares analysis of variance (Table-4) revealed non-significant effect of zone on chest girth and contribution of zone effect to the total variation for this trait was only 1.87%. Non-significant effect of location on chest girth reported by Singh *et al.* (1995^a) in Mehsana buffaloes is in confirmation with the results of the present study. Non-significant effect of location on chest 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 in and around Patna, and as such there was not much variation in agro-climatic condition in different zones.

Farming system

The farming system was found to have highly significant ($P < 0.01$) influence on chest girth and its contribution to the total variation for chest girth was 16.33% (Table-4). The animals managed in the units integrated with agriculture farming had significantly ($P < 0.05$) higher average chest girth (197.584 ± 0.549 cm) in comparison to those involved in dairying alone by 3.785 cm (Table-1). Similar findings have also been reported by Singh

et al. (1995) who observed significant difference in heart girth among all the age groups of Mehsana buffaloes between LRS herd and milk union sheds where animals were under farmers management system. Difference in chest girth between animals managed under different farming system may be attributed to the availability of feeds and fodder and their level of nutrition and of course health status of animals.

Parity

As evident from table-4, that the order of lactation had highly significant ($P<0.01$) influence on chest girth in buffaloes in and around Patna and its contribution to the total variation for this trait was 56.35%. The average chest girth pooled over all the three genetic groups viz. Graded Murrah, Diara and Non-descript buffaloes was found to be the lowest (186.467 ± 0.688 cm) at first parity. The average estimates of chest girth in second, third and fourth parities were observed to be increased significantly ($P<0.05$) than the average chest girth at first parity by 7.85, 15.362 and 13.687 cm respectively. The highest average chest girth was reckoned to be 201.829 ± 0.745 cm during the age at third parity. The average estimates of chest girth during third and fourth parities were significantly ($P<0.05$) higher than the estimate of second parity by 7.512 and 5.837 cm respectively. However, the average estimates of chest girth between third and fourth parities did not differ significantly. The trend of variation in chest girth was similar to the trend of variation in HAW and body length in this study. Significant effect of parity on chest girth is also reported by Jawarkar and Johar (1975), Saini and Gill (1986), Jogi and Patel (1990) in Murrah and Singh *et al.* (1995) and Singh *et al.* (2000) in Mehsana buffaloes. Significant ($P<0.05$) increase in chest girth upto third parity as observed in the present investigation was also reported in Murrah and Mehsana buffaloes by those workers as mentioned above. The explanation

for significant ($P<0.05$) increase in chest girth upto third parity also stands valid like previous character i.e. body length.

BODY WEIGHT

The overall least squares mean for body weight in buffaloes consisting of three different genetic groups namely Diara, Graded Murrah and Non-descript types in and around Patna was estimated to be 484.875 ± 1.98 kg (Table-5). The average estimates of body weight at maturity in Murrah buffaloes were reported to be 513.4 ± 1.7 kg by Jawarkar and Johar (1975), 561.8 ± 7.6 kg by Sreedharan (1976) and 509.0 ± 6.8 kg by Saini and Gill (1991). The average estimates of body weight at maturity in Murrah and Mehsana buffaloes were reported to be 461 and 533 kg respectively (Taneja, 1999). The average body weight at maturity in Surti, Bhadawari and Mehsana buffaloes were reported to be ranged from 319-413 kg, 346-467 kg and 335-567 kg respectively (Taneja, 1999).

Factors affecting body weight

Least squares analysis of variance (Table-6) revealed that genetic group, farming system and order of lactation had significant ($P<0.01$) influence on body weight. The effect of location on body weight was found to be non-significant. Least squares means for different levels of factors influencing body weight of buffaloes are presented in table-5.

Genetic group

Genetic group had highly significant ($P<0.01$) effect on body weight and its contribution to the total variation in body weight was reckoned to be 19.95% (Table-6). As evident from table-5 and fig.-4, the Graded Murrah was the heaviest (508.972 ± 3.36 kg) followed by Non-descript (483.857 ± 3.30 kg) and the lowest body weight (461.798 ± 3.32 kg) was recorded in Diara buffaloes. The Diara buffalo had significantly ($P<0.05$) lesser body weight than the Graded Murrah and Non-descript types in and

around Patna by 47.174 and 22.059 kg respectively, and Graded Murrah was significantly ($P<0.05$) heavier than the Non-descript types by 25.115 kg. The results obtained in the present

Table 5 : Least squares means \pm SE and CV% of body weight (kg) of buffaloes in and around Patna.

| Particulars | Body weight (Kg) |
|---------------------------|---|
| Overall Mean(μ) | 484.875 \pm 1.98 (7.15) |
| Factors | |
| Genetic group | |
| Graded Murrah | 508.972 ^a \pm 3.36 (6.60) |
| Diara | 461.798 ^b \pm 3.32 (7.26) |
| Non Descript | 483.857 ^c \pm 3.30 (6.98) |
| Location | |
| 1. North East Patna | 484.493 \pm 3.18 (6.94) |
| 2. South West Patna | 488.708 \pm 3.30 (6.95) |
| 3. East Patna | 481.426 \pm 3.57 (6.99) |
| Farming System | |
| 1. Animal Husbandry alone | 473.399 ^a \pm 2.68 (7.16) |
| 2. Mixed Farming | 496.352 ^b \pm 2.82 (6.88) |
| Lactation order | |
| 1 st | 420.847 ^a \pm 3.54 (7.93) |
| 2 nd | 472.259 ^b \pm 3.38 (7.01) |
| 3 rd | 527.217 ^c \pm 3.83 (6.33) |
| 4 th | 519.179 ^c \pm 4.92 (6.42) |

- Means with different superscripts (column-wise) differed significantly ($P<0.05$)
- Values in parentheses are CV%

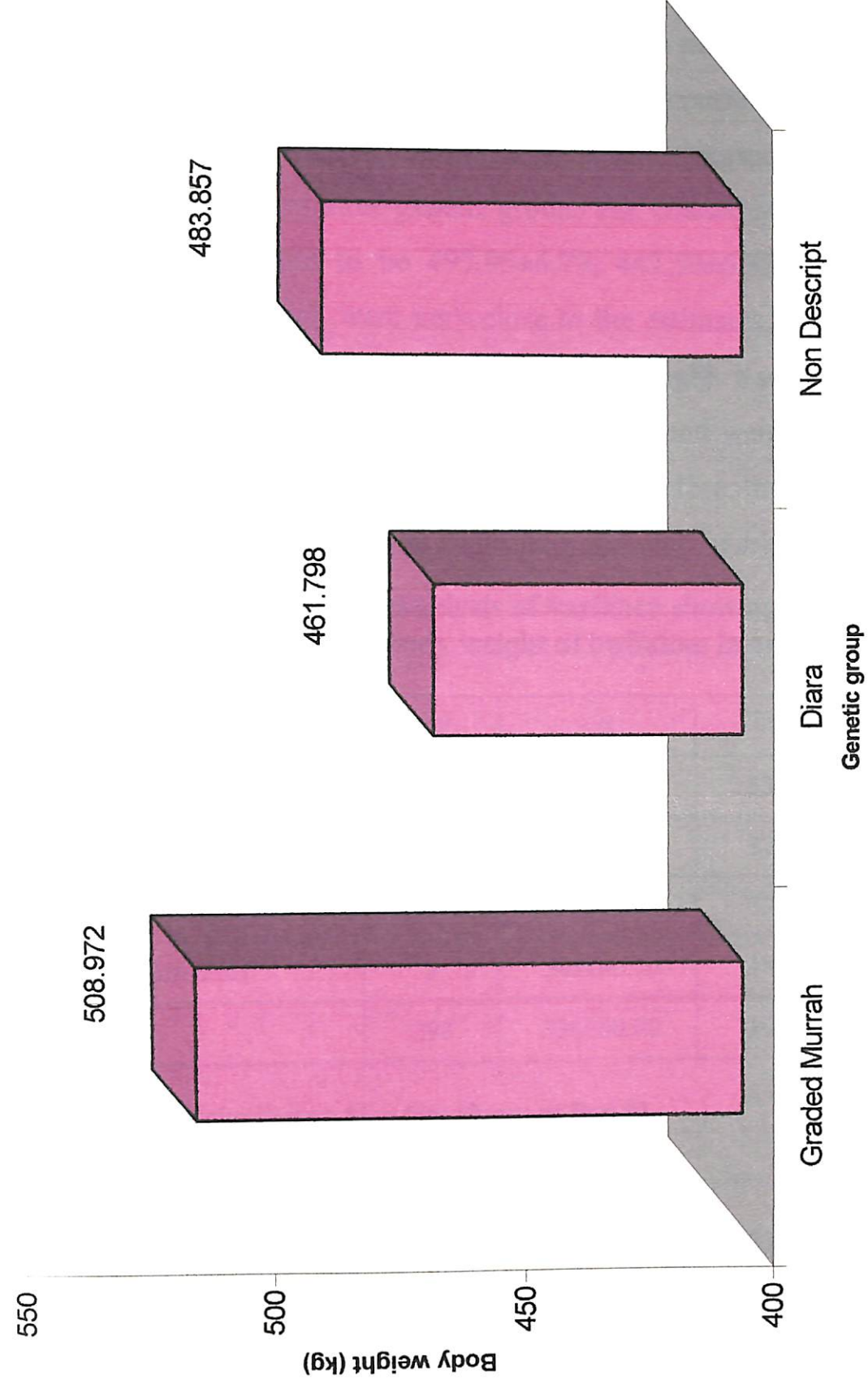


Fig. 4 : Graph showing the average body weight (kg) of buffaloes in and around Patna.

study were in agreement with the findings of Johari and Bhat (1979) who also reported significant effect of genetic group on body weight at various ages. They reported that Nili and Nili grades were significantly heavier than the Murrah and Murrah grades at two years of age and at the age of first calving. Sinha (2006) conducted the study on buffaloes in and around Barh, a sub-division of Patna district in Bihar and reported the average estimates of body weight in three genetic groups viz. Graded Murrah, Diara and Non-descript buffaloes to be 497.95 ± 6.79 , 447.50 ± 6.35 and 473.23 ± 6.12 kg respectively which were very close to the estimates recorded in this study. The effect of genetic group on body weight was also reported to be significant (Sinha, 2006). As the body size and weight vary from breed to breed and environment to environment, therefore, the estimates obtained in this study substantiates the findings of the other workers.

Table 6 : Least square analysis of variance showing effects of genetic and non-genetic factors on body weight of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|-----------|-----------------------|--------------------|
| Genetic group | 2 | 111530.80 | 55765.41** | 19.95 |
| Location | 2 | 2590.08 | 1295.04 ^{NS} | 0.46 |
| Farming system | 1 | 39306.80 | 39306.80** | 14.06 |
| Lactation order | 3 | 546190.70 | 182063.60** | 65.13 |
| Error | 298 | 326560.00 | 1095.83 | 0.39 |

NS = Non-significant, ** = Significant at P<0.01

Location

As evident from table-5, the average body weight was highest (488.708 ± 3.30 kg) in the animals located in South West Patna of the study area followed by the animals in North East Patna (484.493 ± 3.18 kg) and lowest in East Patna (481.426 ± 3.57 kg). The least squares analysis of variance (Table-6) revealed non-significant effect of location on body

weight and contribution of location effect to the total variation for this trait was only 0.46%. Reports were not available in the literature to substantiate the findings of the present study. However, non-significant effect of location on body weight as observed in the present study might be attributed to the fact that the experimental area was limited in a radius of 15 km only, which was divided in three different zones as such there was not much variation in agro-climatic condition at different locations.

Farming system

The farming system had significant ($P<0.01$) influence on body weight and its contribution to the total variation for this trait was 14.06% (Table-6). The animals managed in the units integrated with agriculture framing were significantly ($P<0.05$) heavier (496.352 ± 2.82 kg) in comparison to those maintained in the units dairying alone (473.399 ± 2.68 kg). The results obtained in the findings of this study are in agreement with the findings of Johari and Bhat (1979) and Nautiyal and Bhat (1979) who also observed significant effect of farm on body weight in buffaloes. Difference in body weight under different farming system might be attributed to the difference in the availability of feeds and fodder resources and management practice adopted in different framing systems.

Parity

As evident from table-6, that the lactation order had highly significant ($P<0.01$) effect on body weight and its contribution to the total variation for this trait was 65.13%. The lowest average body weight pooled over three genetic groups viz. Graded Murrah, Diara and Non-descript type buffaloes was estimated to be 420.847 ± 3.54 kg at the first parity. The growth and body weight of buffaloes was found to be increased linearly and significantly ($P<0.05$) upto third parity and then started declining at fourth parity. The animals at second, third and fourth parity were significantly ($P<0.05$) heavier than those at second parity by 54.958 and 46.92 kg

respectively. Though the animals at third parity were heavier than those at fourth parity but did not differ significantly. Significant increase in body weight as observed in the present study was also reported by Singh et al. (1995^o) in Mehsana buffaloes. The average estimates of body weight at first, second and third parities were reported to be 442.5 ± 10.0 kg, 464.5 ± 12.6 kg and 542.2 ± 11.7 kg respectively. Significant increase in body weight upto third parity as observed in the present investigation revealed that skeletal maturity in buffaloes pertaining to this study is achieved at third parity when the animals are nearly 6-7 years of age.

MEASURES OF PRODUCTION

In the present study altogether eight economic traits i.e. Lactation milk yield, Lactation length, Peak yield Days to attain peak yield milk, production efficiency in terms of Milk yield per day of lactation length, Milk yield per day of calving interval, milk yield per kg of body weight (MPEK) at calving and milk production efficiency per kg body weight per day of lactation (MPEKD) were taken as the measures of production. Out of these eight traits, the first four traits i.e. 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 have been presented in tables 7-21 accordingly.

LACTATION MILK YIELD (LMY)

Lactation milk yield is the most important economic trait of a dairy animal as it is the major source of income to the dairy framers. Milk yielded by a milch animal during normal lactation period was taken as Lactation Milk Yield (LMY). The over all least squares mean for lactation milk yield of buffaloes consisting of three different genetic groups namely

Graded Murrah, Diara and Non-descript types, included in the study, in and around Patna was estimated to be 1283.37 ± 5.37 kg (Table-7).

Table 7 : Least squares means \pm SE and CV% of lactation milk yield (kg) and lactation length (days) of buffaloes in and around Patna.

| Particulars | Lactation Milk Yield (Kg) Mean \pm S.E. | Lactation Length (days) Mean \pm S.E. |
|---------------------------|--|--|
| Overall Mean(μ) | 1283.37 ± 5.37 (7.33) | 306.21 ± 1.29 (7.38) |
| Factors | | |
| Genetic group | | |
| Graded Murrah | $1395.82^a \pm 9.13$ (6.54) | $293.92^a \pm 2.19$ (7.45) |
| Diara | $1347.44^b \pm 9.02$ (6.76) | $312.59^b \pm 2.16$ (6.97) |
| Non Descript | $1106.85^c \pm 8.97$ (8.30) | $312.11^b \pm 2.15$ (7.05) |
| Location | | |
| 1. North West Patna | $1260.90^a \pm 8.64$ (7.25) | 307.11 ± 2.07 (7.13) |
| 2. South West Patna | $1315.17^b \pm 8.96$ (7.01) | 305.32 ± 2.15 (7.24) |
| 3. East Patna | $1274.04^a \pm 9.68$ (7.16) | 306.19 ± 2.32 (7.14) |
| Farming System | | |
| 1. Animal husbandry alone | $1256.92^a \pm 7.27$ (7.31) | 304.69 ± 1.74 (7.22) |
| 2. Mixed farming | $1309.82^b \pm 7.67$ (7.09) | 307.72 ± 1.84 (7.24) |
| Lactation order | | |
| 1 st | $912.68^a \pm 9.61$ (9.93) | $310.02^a \pm 2.31$ (7.02) |
| 2 nd | $1197.17^b \pm 9.18$ (7.51) | $310.00^a \pm 2.20$ (6.95) |
| 3 rd | $1528.91^c \pm 10.41$ (5.93) | $302.74^b \pm 2.50$ (7.19) |
| 4 th | $1494.72^c \pm 13.35$ (6.05) | $302.06^b \pm 3.20$ (7.18) |

➤ Means with different superscripts (column-wise) differed significantly ($P < 0.05$)

➤ Values in parentheses are CV%

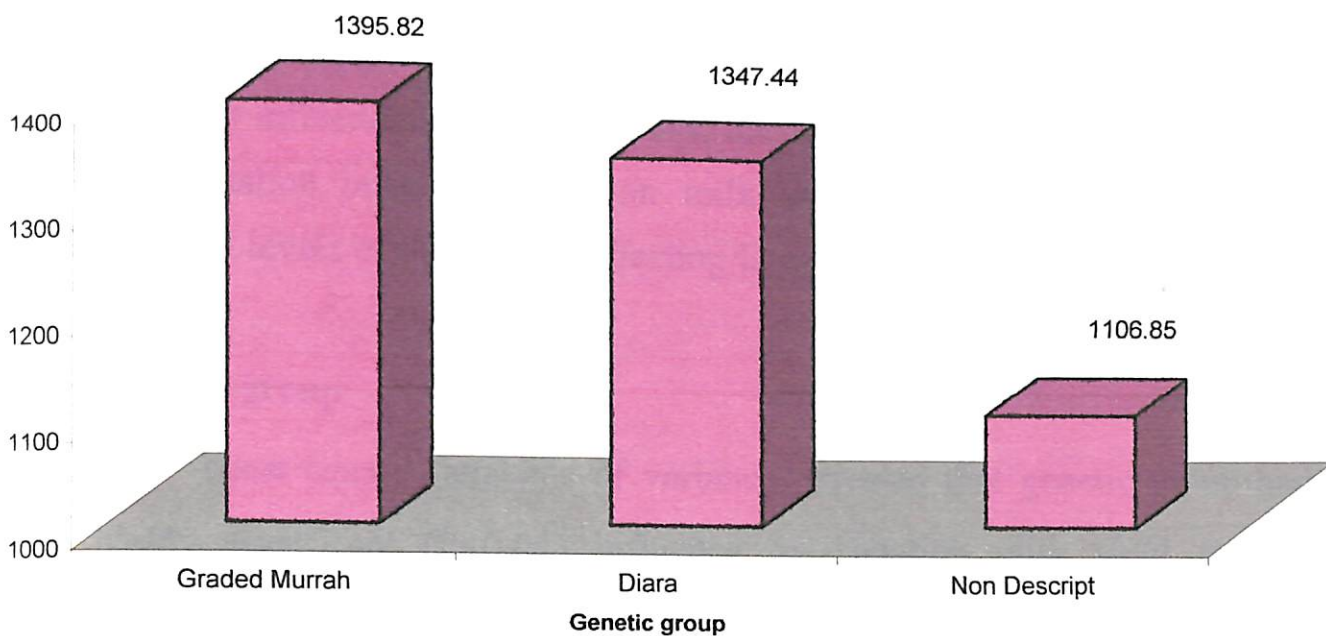


Fig. 5 : Graph showing the average lactation milk yield (kg) of buffaloes in and around Patna.

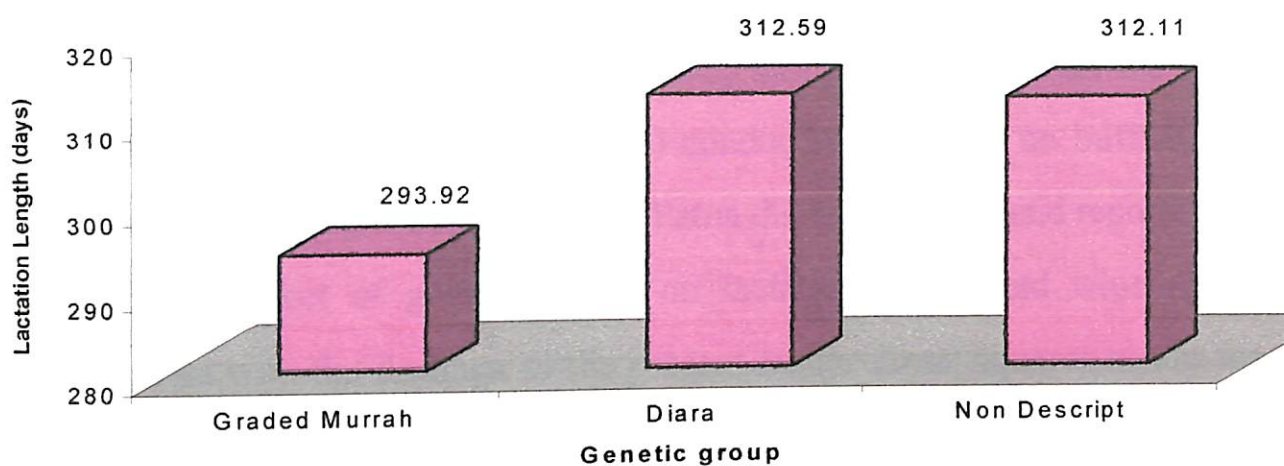


Fig. 6 : Graph showing the average lactation length (days) of buffaloes in and around Patna.

Factor affecting lactation milk yield

Least squares analysis of variance (Table-8) revealed significant ($P<0.01$) influence of genetic group, location of animals, farming system and lactation order on lactation milk yield. Least squares means for different levels of the factors affecting lactation milk yield are presented in table-7.

Genetic group

Least squares analysis of variance revealed that genetic group had highly significant ($P<0.01$) influence on lactation milk yield and its contribution to the total variation on LMY was 27.33% (Table-8).

As evident from table-7 and fig.-5 that Graded Murrah had the highest average lactation milk yield (1395.82 ± 9.13 kg) followed by Diara buffaloes (1347.44 ± 9.02 kg) and Non-descript types (1106.85 ± 8.97 kg). The animals of three different genetic groups differed significantly ($P<0.05$) among themselves with respect to their lactation milk yield. Graded Murrah had significantly ($P<0.05$) more milk yield than Diara and Non-descript buffaloes by 48.38 and 288.97 kg respectively. Diara buffaloes also had significantly ($P<0.05$) more milk yield than the Non-descripts by 240.59 kg. Sinha (2006) conducted the study on buffaloes in Diara areas of Barh, a subdivision of Patna district in Bihar and reported the significant effect of genetic group on lactation milk yield which is in agreement with the findings of the present study. Least squares means for lactation milk yield of three different genetic groups obtained in this study were in accordance with the findings of Sinha (2006) except that Diara buffaloes though had lower lactation yield than the Murrah but did not differ significantly. 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 types with respect to lactation milk yield.

Table 8 : Least squares analysis of variance showing effect of genetic and non-genetic factors on lactation milk yield (LMY) of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|-------------|--------------|--------------------|
| Genetic group | 2 | 4920443 | 2460222.00** | 27.33 |
| Location | 2 | 165958.50 | 82979.24** | 0.92 |
| Farming system | 1 | 208740.50 | 208740.80** | 2.32 |
| Lactation order | 3 | 18720920.00 | 6240306.00** | 69.33 |
| Error | 298 | 2401920.00 | 8060.135 | 0.09 |

**** = Significant at P<0.01**

Location

As evident from (table-8), the location of animals or zone had highly significant ($P<0.01$) effect on lactation milk yield, and its contribution to the total variation on lactation milk yield was 0.92%. The highest average lactation milk yield (1315.17 ± 8.96 kg) was found to be produced by the animals located at South-west Patna (Table-7). The average lactation milk yield of the animals located at South-west Patna was significantly ($P<0.05$) higher than the milk yielded by the animals located in North-west and Eastern zones of Patna by 54.27 and 41.13 kg respectively. Though the animals located in East Patna yielded more milk than the animals located in North-West Patna but did not differ significantly.

The effect of location on LMY could not be made available in the literature to substantiate the findings of the present study, however, many workers (Patro and Bhat, 1979 and Singh, 1992) have reported significant effect of farms on lactation milk yield Murrah buffaloes. Significant ($P<0.05$) effect of location on LMY observed in the present investigation might be attributed to the variation in management practices adopted by the framers at different locations.

Farming systems

The least squares analysis of variance (Table-8) revealed highly significant ($P<0.01$) effect of farming system on lactation milk yield and its contribution to the total variation on lactation milk yield was 2.32%. As evident from least squares means (table-7), the animals maintained in the units integrated with agriculture farming had significantly ($P<0.05$) more milk yield (1309.82 ± 7.67 kg) than the animals managed in the units involved in the dairying alone by 52.9 kg. Kumar (2004) did not record the significant influence of farming system on lactation milk yield in the dairy animals in and around Darbhanga of Bihar. However, the significant influence of farming system on LMY observed in the present study might be attributed to the better management practices along with the availability of good quality feeds and fodder resources to the animals managed under mixed farming system.

Parity

Analysis of variance revealed that the order of lactation had significant ($P<0.01$) influence on lactation milk yield and its contribution to the total variation for lactation milk yield was 69.33% (Table-8). Least squares means (Table-7) revealed that the average lactation milk yield increased linearly from 1st to 3rd parity and thereafter decreased gradually from 4th parity. The lowest average LMY was found to be 912.68 ± 9.61 kg in first lactation which increased significantly ($P<0.05$) in second, third and fourth parity. The animals in third lactation had significantly ($P<0.05$) higher average lactation milk yield (1528.91 ± 10.41 kg) followed by those in fourth (1494.72 ± 13.35 kg) and second (1197.17 ± 9.18) lactation. Though the third and fourth parity had significantly ($P<0.05$) more milk yield than the first and second parity but did not differ significantly among themselves Patro and Bhat (1979), Jain and Kothari (1983), Gajbhaiye (1987) and Biradar (1991) also found significant influence of parity on lactation milk

yield in Mehsana, Murrah and Surti buffaloes respectively. It was indicative of the fact that the lactation maturity in buffaloes attained in third lactation. It could be explained as there would have been increased number of functional genes responsive for milk yield with the advancement in lactation sequence and their expression could reach maximum around 3rd lactation. The another probable reason for increase in milk yield with lactation sequence could be ascribed to the increased functional activities of the secretary tissues of mammary gland during latter lactations, being maximum at the age conceding with the third parity. Probably due to this reason, the lactation milk yield gradually reduces from subsequent lactations. The reports available in the literature for average lactation milk yield in Murrah, Nili Ravi, Surti and Mehsana buffaloes were higher than the estimates obtained in this study for this trait (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 was higher than the LMY of Bhadawari buffaloes as reported by Taneja (1999).

LACTATION LENGTH (LL)

Lactation period is one of the important factors affecting economics of dairy enterprises. Either too long or too short lactation length is not desirable. For buffaloes the ideal lactation length is regarded to be 305 days. The overall least squares mean for lactation length in buffaloes of three genetic groups viz. Graded Murrah, Diara and Non-descript types included in this study, in and around Patna was estimated to be 306.21 ± 1.29 days (Table-7). The overall average lactation length of buffaloes consisting of aforesaid three genetic groups in Barh, a subdivisional town of Patna district, has been reported to be 306.36 ± 3.05 days (Sinha, 2006) which corroborates the finding of the present study. Similar finding has also been reported by DevRaj and Gupta (1994) in buffaloes native to Churu district of Rajasthan under farmer's management system.

Table 9 : Least squares analysis of variance showing effects of genetic and non-genetic factors on lactation length (LL) of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|----------|------------------------|--------------------|
| Genetic group | 2 | 22707.35 | 11353.68 ^{**} | 81.27 |
| Location | 2 | 168.58 | 84.29 ^{NS} | 0.60 |
| Farming system | 1 | 686.43 | 686.43 ^{NS} | 4.91 |
| Lactation order | 3 | 4140.01 | 1380.00 [*] | 9.88 |
| Error | 298 | 138620 | 465.16 | 3.34 |

NS = Non-significant, ** = Significant at $P < 0.01$, * = Significant at $P < 0.05$

Factors affecting lactation length

Least squares analysis of variance (Table-9) revealed that genetic group and order of lactation had significant influence on lactation length, while the effects of location and farming system were not statistically significant.

Genetic group

The genetic group had highly significant ($P < 0.01$) influence on lactation length and its contribution to the total variation in lactation length was 81.27% (table-9). As evident from table-7 and fig.-6, the Diara buffaloes had the longest average lactation length (312.59 ± 2.16 days) which differed significantly ($P < 0.05$) from the average lactation length of Graded Murrah (239.92 ± 2.19 days) by 18.67 days but did not differ significantly from Non-descript types (312.11 ± 2.15 days). Sinha (2006) reported the effect of genetic group on lactation length to be statistically non-significant and Non-descript buffaloes had the longest lactation length followed by Diara and Graded Murrah.

Reports on the effect of genetic group on lactation length in buffaloes were very scanty in the literature, however, the average lactation length for

different breeds of buffaloes reported by different workers may be cited here for valid comparison. The average estimate of lactation length of buffaloes as obtained in this investigation was close to the findings of Yadav (1995-96) and Dev Raj and Gupta (1994). However, in Surti buffaloes contrary to the findings of the present study, the higher estimates have been reported by Singh^{*} (1992) in Mehsana by Kumar and Gupta (1992) in local buffaloes managed at farmers door in U.P., by Shah and Sharma (1994), Rao *et al.* (1995) and Singh (2002) in Murrah buffaloes and Rao *et al.* (2000) in Graded buffaloes both under co-operative and non-cooperative societies in Vishakhapathanam district of Andhra Pradesh. 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 higher than the average estimates obtained in this study. Whereas, the findings of Tajane and Siddiquee (1985) and Singh *et al.* (1986) in Mehsana buffaloes were lower than the average estimates of lactation length for all the three genetic groups included in this study.

Location

As evident from table-7, the average lactation length was the longest (307.11 ± 2.07 days) in the animals maintained in North West zone of the study area followed by those located in East (306.19 ± 2.32 days) and South West (305.32 ± 2.15 days) zones. However, the contribution of the effect of location to the total variation in lactation length was only 0.60% and the animals in different zones were not significantly different among themselves with respect to their lactation length (Table-9). This may be attributed to the fact that the study 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 of the different zones.

Farming system

The farming system did not have significant influence on lactation length in buffaloes maintained in the Khatala in and around Patna. The contribution of farming system to the total variation was 4.91% (Table-9). There was not much difference for the average lactation length between the animals managed in the units exclusively involved in dairying (321.08 ± 1.43 days) and the animals managed in the units integrated with agriculture farming (320.17 ± 1.79 days). Kumar (2004) also observed the effect of farming system on lactation length in dairy animals, including both cattle and buffaloes, in and around Dharbhanga district town, to be non-significant.

Parity

As evident from least squares analysis of variance (table-9) that the order lactation had significant ($P < 0.05$) effect on lactation length and its contribution to the total variation was 9.88%. The average lactation length, pooled over all the three different genetic groups viz. Graded Murrah, Diara and Non-descript buffaloes was found to be longest (310.69 ± 1.74 days) in first lactation followed by second (310.00 ± 2.20 days), third (302.74 ± 2.50 days) and fourth (302.06 ± 3.20 days) lactations (table-7). The least squares means (Table-7) revealed that average lactation lengths in first and second parities were significantly ($P < 0.05$) longer than the average lactation lengths in third and fourth parities, however, the differences in mean lactation length between first and second parity were not statistically significant. Significant effect of parity on lactation length as observed in the present investigation is also reported by Patro and Bhat (1979), Jain and Kothari (1983), Singh (1992) and Kumar (2004), however, the trend was not the same. Patro and Bhat (1979) reported longest lactation length in second parity while Singh (1992) observed the longest and the shortest

lactation length in first and fourth parity respectively. The optimal reproductive function in buffaloes may be attained at second order of lactation and as such, the lactation length might not vary much between first and second lactations, as recorded in this study.

PEAK YIELD

Peak milk yield is a directly observed economic trait of very high practical significance in dairy farming and it is one of the important economic indicators in determining worth of milch animals. The overall least squares mean for peak yield in buffaloes of three genetic groups viz. Graded Murrah, Diara and Non-descript types, included in this study in and around Patna, was estimated to be 7.59 ± 0.07 kg (Table-10).

Factors affecting peak yield

Least squares analysis of variance (Table-11) revealed that genetic constitution of the animals, farming system and order of lactation had significant influence on peak milk yield, while the effect of location was statistically non-significant. Least squares means for different levels of the factors affecting peak milk yield are depicted in table-10.

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 23.98% (Table-11). As evident from table-10 and fig.-7, the highest average (8.45 ± 0.11 kg) peak milk yield was observed in Graded Murrah followed by Diara (7.51 ± 0.11 kg) and Non-descript (6.80 ± 0.11 kg) buffaloes. The animals of different genetic constitution differed significantly ($P < 0.05$) among themselves with respect to peak yield. The trend recorded in this study was in accordance with the expectation because graded buffaloes in

Table 10 : Least squares means \pm SE and CV% of peak yield (kg) and days to attain peak yield of buffaloes in and around Patna.

| Particulars | Peak Yield (Kg) Mean \pm S.E. | Days to attain peak yield Mean \pm S.E. |
|---------------------------|---|---|
| Overall Mean(μ) | 7.59 \pm 0.07 (16.15) | 42.02 \pm 0.21 (8.75) |
| Factors | | |
| Genetic group | | |
| Graded Murrah | 8.45 ^a \pm 0.11 (13.01) | 37.81 ^a \pm 0.36 (9.52) |
| Diara | 7.51 ^b \pm 0.11 (14.79) | 42.73 ^b \pm 0.36 (8.50) |
| Non Descript | 6.80 ^c \pm 0.11 (16.75) | 45.53 ^c \pm 0.36 (8.10) |
| Location | | |
| 1. North West Patna | 7.56 \pm 0.11 (15.39) | 42.31 \pm 0.34 (8.50) |
| 2. South West Patna | 7.75 \pm 0.11 (14.61) | 41.88 \pm 0.36 (8.85) |
| 3. East Patna | 7.46 \pm 0.12 (15.17) | 41.88 \pm 0.38 (8.55) |
| Farming System | | |
| 1. Animal husbandry alone | 7.44 ^a \pm 0.09 (15.30) | 42.05 \pm 0.29 (8.72) |
| 2. Mixed farming | 7.74 ^b \pm 0.10 (15.66) | 42.00 \pm 0.30 (8.66) |
| Lactation order | | |
| 1 st | 5.60 ^a \pm 0.12 (20.21) | 41.74 \pm 0.38 (8.58) |
| 2 nd | 6.77 ^b \pm 0.12 (17.36) | 41.63 \pm 0.36 (8.47) |
| 3 rd | 9.04 ^c \pm 0.13 (12.53) | 42.11 \pm 0.41 (8.48) |
| 4 th | 8.95 ^c \pm 0.17 (12.88) | 42.62 \pm 0.53 (8.43) |

- Means with different superscripts (column-wise) differed significantly (P<0.05)
- Values in parentheses are CV%

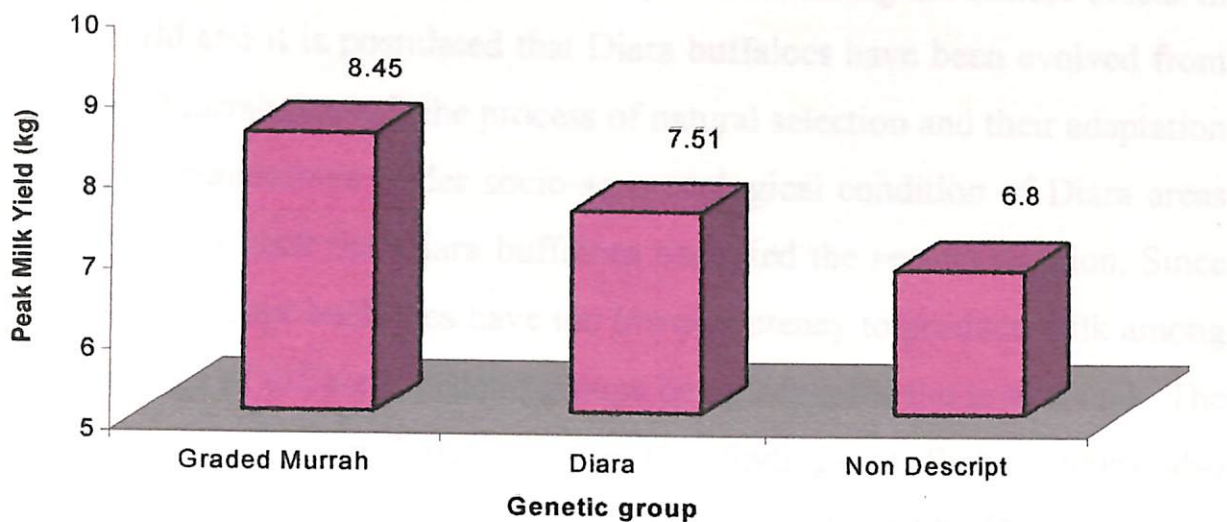


Fig. 7 : Graph showing the average peak milk yield (kg) of buffaloes in and around Patna.

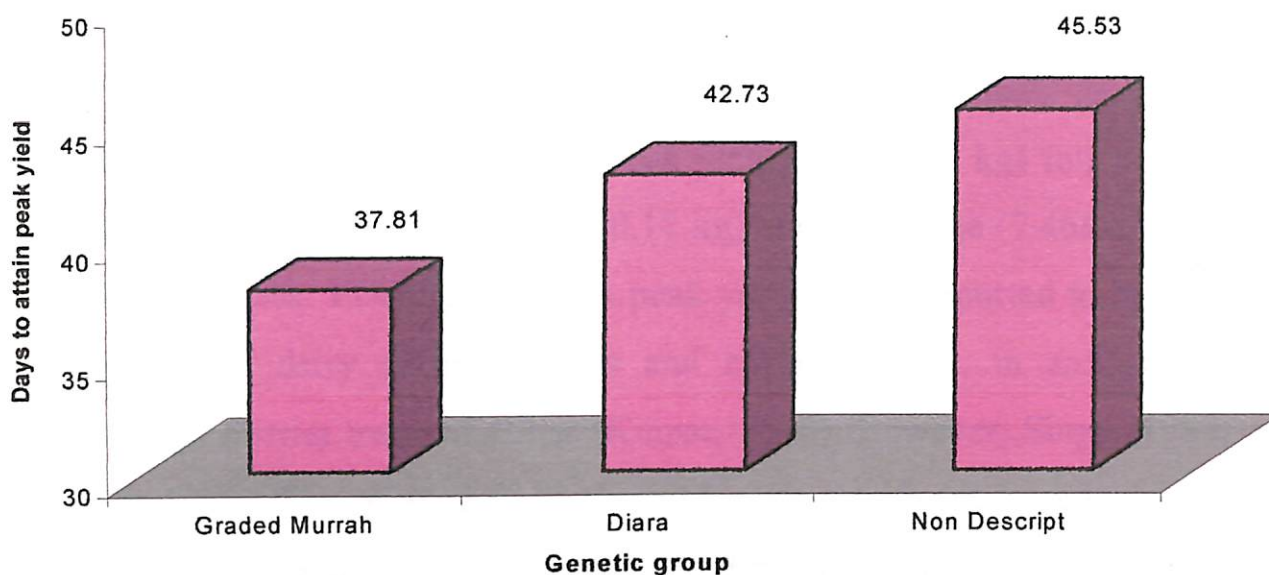


Fig. 8 : Graph showing the average days to attain peak yield of buffaloes in and around Patna.

Bihar have been developed through up gradation of non-descript types 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 adaptation over the generations under socio-agro-ecological condition of Diara areas in Bihar. As such the Diara buffaloes occupied the second position. Since the Non-descript buffaloes have the lowest potency to produce milk among the animals of different genetic groups being occupied the lowest rank. The results were in corroboration with the findings of Sinha (2006) also observed highest peak yield in Graded Murrah followed by Diara and Non-Descript buffaloes. The results of this study re-substantiated the dogma that peak milk yield was an indicator of lactation milk yield because the average lactation milk yield of these three genetic groups observed in the same order (Table-7).

Location

The analysis of variance revealed non-significant effect of location on peak milk yield and its contribution to the total variation was only 0.72% (Table-11). As evident from the table-10, the animals located in South-West Patna had the highest peak yield (7.75 ± 0.11 kg) followed by those located in North-West (7.56 ± 0.11 kg) and East zone (7.46 ± 0.12 kg) of the study area. Effect of zone on peak yield is also reported to be non-significant in dairy animals, cows and buffaloes both, in and around Darbhanga district town of Bihar (Kumar, 2004). However, Singh (1984) observed the effect of zone on peak yield to be significant in cows in and around Ranchi, which was contrary to the findings of this study. The non-significant effect of location on peak yield observed in the study might be attributed to the fact that the present experiment was carried out in the area of 15 km radius, which was divided into three zones and as such there was not much variation in the agro-climatic condition between the zones.

Table 11 : Least squares analysis of variance showing effect of genetic and non-genetic factors on peak yield (PY) of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|--------|---------------------|--------------------|
| Genetic group | 2 | 138.78 | 69.39** | 23.98 |
| Location | 2 | 4.177 | 2.088 ^{NS} | 0.72 |
| Farming system | 1 | 6.959 | 6.959** | 2.40 |
| Lactation order | 3 | 628.72 | 209.57** | 72.42 |
| Error | 298 | 411.52 | 1.38 | 0.48 |

**** Significant at $P < 0.01$, NS = Non-significant**

Farming system

As evident from table-11, the least squares analysis of variance revealed significant ($P < 0.01$) effect of farming system on peak yield and its contribution to the total variation was 2.40%. The animals managed in the units integrated with agriculture farming had significantly ($P < 0.05$) higher peak yield than those units which involved in dairying alone. However, Kumar (2004) did not observe the significant effect of farming system on peak yield in dairy animals. The significant difference in peak yield due to different farming system might be ascribed to the differences in management practices including availability of feeds and fodders in two faming systems.

Parity

The least squares analysis of variance (Table-11) revealed highly significant ($P < 0.01$) influence of the order of lactation on peak milk yield and contribution of the parity to the total variation was 72.42%. As evident from table-10, the average peak yield was found to be increased gradually from first to third parity and then started declining slightly from fourth parity. The animals in third parity had significantly ($P < 0.05$) higher peak yield (9.04 ± 0.13 kg) than those in first and second parities by 3.44 and 2.27

kg respectively. However, third parity did not differ significantly from fourth parity in respect to peak yield. The lowest peak yield (5.60 ± 0.12 kg) was recorded in the first lactation which differed significantly ($P < 0.05$) from the average peak yield of second parity. Fourth parity had significantly ($P < 0.05$) higher peak yield than the first and second parity. The trend of variation in peak yield was similar to the trend of variation in lactation milk yield of this study and the explanation for lactation milk yield would also stand valid for this trait too. Singh (1992^a), Singh and Singh (1998) and Kumar (2004) reported significant effects of parity on peak yield, however, Choudhary and Choudhary (1981) did not record the significant influence of parity on peak milk yield.

Table 12 : Least squares analysis of variance showing effect of genetic and non-genetic factors on days to attain peak yield (DAPY) of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|---------|-----------------------|--------------------|
| Genetic group | 2 | 3092.24 | 1546.12 ^{**} | 98.02 |
| Location | 2 | 12.27 | 6.139 ^{NS} | 0.39 |
| Farming system | 1 | 0.126 | 0.126 ^{NS} | 0.008 |
| Lactation order | 3 | 35.780 | 11.926 ^{NS} | 0.76 |
| Error | 298 | 3894.50 | 13.068 | 0.83 |

**** Significant at $P < 0.01$, NS = Non-significant**

DAYS TO ATTAIN PEAK YIELD (DAPY)

A milch animal is supposed to be economical, if she attains peak yield shortly after calving and she has higher persistency of peak milk yield. The overall least squares mean for days to attain peak milk yield in buffaloes consisting of three genetic groups namely Graded Murarh, Diara and Non-descript types, included in the study, was estimated to be

42.02±0.21 days (Table-10). Sinha (2006) observed the overall least squares mean for days to attain peak yield in buffaloes consisting of these three genetic groups to be 41.83±0.28 days.

Factors affecting Days to attain peak yield

Least squares analysis of variance (Table-12) revealed significant ($P<0.01$) influence of genetic constitution of the animals on days to attain peak yield. The effect of location, farming system and lactation order were statistically non-significant. Least squares means for different levels of the factors affecting Days to attain peak yield are presented in table-10.

Genetic group

Genetic group had highly significant ($P<0.01$) influence on days to attain peak yield and its contribution to the total variation was 98.02% (Table-12). As evident from table-10 and fig.-8, the Graded Murrah attained peak milk yield at the shortest period (39.81±0.36 days) followed by Diara buffaloes (42.73±0.36 days). Non-descript buffaloes took longest period (45.73±0.36 days) to attain peak milk yield. The trend for days to attain peak milk yield by the animals of different genetic groups, included in the study, also followed the similar trend as observed in their lactation length i.e. the animals attaining peak yield earlier had shorter lactation length. The Graded Murrah had significantly ($P<0.05$) shorter days to attain peak yield than Diara and Non-descript buffaloes by 4.92 and 7.71 days respectively. Diara buffaloes also had significantly ($P<0.05$) shorter days to attain peak yield by 2.8 days than the Non-descript types. Similar trend for days to attain peak milk yield as shown by these three genetic groups viz. Graded Murrah, Diara and Non-descript buffaloes has also been reported

by Sinha (2006) in and around Barh, a subdivisional town of Patna district in Bihar.

Location

The analysis of variance revealed non-significant influence of location on days to attain peak yield and its contribution to the total variation in days to attain peak yield was only 0.39% (Table-12). The animals located in South-West and East zones of Patna attained peak yield earlier than those located in North-East zone. However, the difference was not statistically significant. Non-significant effect of zone on days to attain peak yield has also been reported by Kumar (2004) in dairy animals i.e. both cows and buffaloes. The non-significant effect of zone on days to attain peak yield might be attributed to the fact that the present experiment was conducted in a small area within the 15 km radius which was divided into three zones and as such there was no variation in agro-ecological condition in different zones.

Framing system

As evident from table-10, the animals managed in the units involving dairying alone as well as those maintained in the units integrated with agriculture farming have attained the peak yield almost in the same period i.e. 42 days. As such, the least squares analysis of variance also revealed non-significant influence of farming system on days to attain peak milk yield and contribution of farming system to the total variation was 0.008%(Table-12). Non significant effect of farming system on days to attain peak yield reported by Kumar (2004) re-substantiates the findings of the present study.

Parity

The analysis of variance revealed that the effect of lactation order on days to attain peak yield to be non significant and its contribution to the

variation on days to attain peak yield was only 0.76% (Table-12). As evident from table-10, the animals in first and second parity had the shorter days to attain peak yield than those in third and fourth parity, but the differences were statistically non-significant. The shortest (41.63 ± 0.36 days) and the longest (42.62 ± 0.53 days) days to attain peak milk yield were shown by the animals in second and fourth parity respectively. However, the difference was non-significant. Contrary to the findings of the present study, Singh (1992) reported significant effect of parity on days to attain peak yield in Mehsana buffaloes, and Kumar (2004) reported significant effect of parity on days to attain peak yield in dairy animals i.e. cows and buffaloes both. However, Choudhary and Choudhary (1981) reported non-significant effect of parity on this trait which supports the findings of the present study.

MEASURES OF MILK PRODUCTION EFFICIENCY

In order to evolve highly productive, input responsive and efficient milk producing stock, selection on the basis of their relative efficiency of milk production seems to be much more advantageous as it includes selection for general adaptability, inherent capacity to produce and resource utilization efficiency. Out of several derived measures of milk producing efficiency, only four efficiency traits viz. 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 at calving (MPEK) 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 during a lactation (MY/LL)”. Abnormal lactation length i.e. less than 200 days and more than

350 days were ignored. The overall least squares mean for milk yield per day of lactation length (MY/LL) in buffaloes comprising of three different genetic groups viz. Graded Murrah, Diara and Non-descript types was estimated to be 4.22 ± 0.02 kg (Table-13).

Table 13 : Least squares means±SE 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 Patna.

| Particulars | MY/LL (Kg) Mean ± S.E. | MY/CI (kg) Mean ± S.E. |
|----------------------------|------------------------------------|-------------------------------------|
| Overall Mean(μ) | 4.22±0.02 (8.30) | 2.84±0.01 (6.16) |
| Factors | | |
| Genetic group | | |
| Graded Murrah | 4.76 ^a ±0.04 (8.40) | 3.28 ^a ±0.02 (6.09) |
| Diara | 4.31 ^b ±0.04 (9.37) | 2.86 ^b ±0.02 (7.06) |
| Non Descript | 3.60 ^c ±0.04 (11.3) | 2.39 ^c ±0.02 (8.57) |
| Location | | |
| 1. North West Patna | 4.15 ^a ±0.04 (10.20) | 2.79 ^a ±0.02 (7.58) |
| 2. South West Patna | 4.31 ^b ±0.04 (9.55) | 2.91 ^b ±0.02 (7.07) |
| 3. East Patna | 4.21 ^{ab} ±0.04 (8.96) | 2.83 ^{ab} ±0.03 (10.00) |
| Farming System | | |
| 1. Animal husbandry alone. | 4.15 ^a ±0.03 (9.14) | 2.80 ^a ±0.02 (9.03) |
| 2. Mixed farming | 4.30 ^b ±0.03 (8.45) | 2.89 ^b ±0.02 (8.39) |
| Lactation order | | |
| 1 st | 2.98 ^a ±0.04 (12.66) | 1.92 ^a ±0.03 (14.74) |
| 2 nd | 3.89 ^b ±0.04 (10.07) | 2.62 ^b ±0.02 (7.47) |
| 3 rd | 5.06 ^c ±0.05 (8.61) | 3.46 ^c ±0.03 (7.55) |
| 4 th | 4.97 ^c ±0.06 (8.18) | 3.38 ^c ±0.04 (8.02) |

- Means with different superscripts (column-wise) differed significantly (P<0.05)
- Values in parentheses are CV%

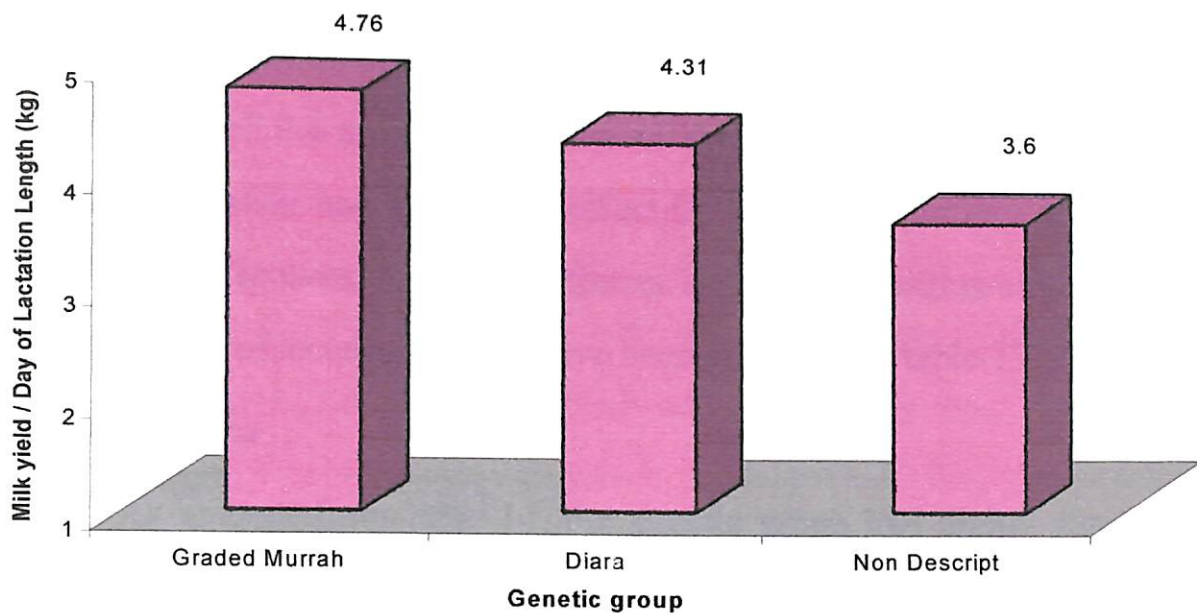


Fig. 9 : Graph showing the average milk yield / day lactation length (kg) of buffaloes in and around Patna.

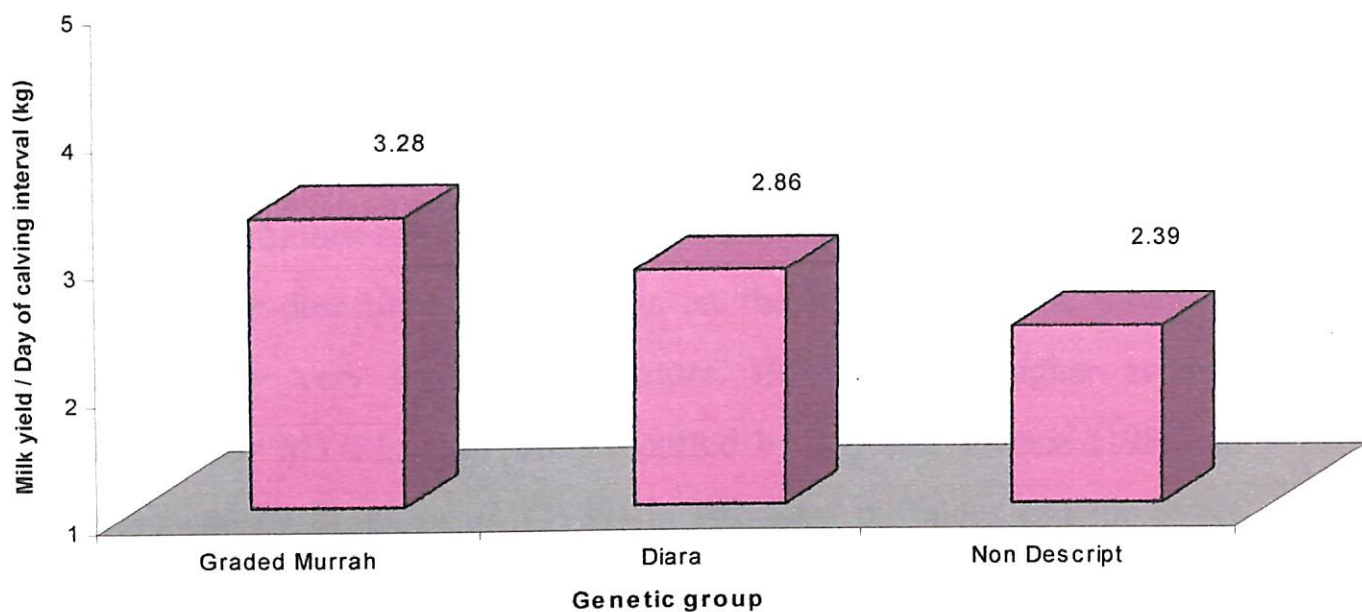


Fig. 10 : Graph showing the average milk yield / day of calving interval (kg) of buffaloes in and around Patna.

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

Least squares analysis of variance (Table-14) revealed that genetic constitution of the animals, location of the animals, farming system and order of lactation had significant effect on milk yield per day of lactation length. Least squares means for different levels of the factors affecting milk yield per day of lactation length have been presented in table-13.

Genetic group

As evident from table-14, the genetic group had highly significant ($P < 0.01$) influence on milk yield per day of lactation length (MY/LL) and its contribution to the total variation for MY/LL was 30.64%. The least squares mean (Table-13) revealed that the Graded Murrah had the highest average MY/LL (4.76 ± 0.04 kg) followed by Diara (4.31 ± 0.04 kg) and Non-descript type (3.60 ± 0.04 kg) (Fig.-9). The three genetic groups differed significantly ($P < 0.05$) among themselves with respect to this trait. Sinha (2006) reported significant influence of genetic groups on MY/LL in buffaloes at Barh, a subdivisional town of Patna district in Bihar, which corroborates the findings of the present study. Graded Murrah though reported to have higher estimate for MY/LL than the Diara buffaloes but the difference was not statistically significant. However, Graded Murrah and Diara buffaloes had significantly ($P < 0.05$) higher estimates of MY/LL than the Non-descript types. Reports on the effect of genetic group on MY/LL were very scanty in 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 the lower estimate (2.88 ± 0.29 kg) reported by Singh and Singh (1998) in Bhadawari buffaloes indicate 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, which was one of the components in its derivation.

Location

The least squares analysis of variance (Table-14) revealed that the location of animals had significant ($P<0.05$) influence on MY/LL and its contribution to the variation for MY/LL was 0.62%. As evident from table-13, the animals located in the South West zone of Patna had the highest average MY/LL (4.31 ± 0.04 kg) which was significantly ($P<0.05$) higher than the animals located in North-West zone but did not differ significantly from the animals located in East Patna. The effect of location on MY/LL could not be made available in the literature to substantiate the findings of the present study. However, Kumar (2004) reported the effect of zone on MY/LL in dairy animals to be non-significant. Significant effect of location on MY/LL observed in this study might be attributed to the variances in management and feeding practices adopted by the framers at different locations.

Table 14 : Least squares analysis of variance showing effects of genetic and non-genetic factors on MY/LL of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|--------|---------|--------------------|
| Genetic group | 2 | 70.13 | 35.06** | 30.64 |
| Location | 2 | 1.409 | 0.704* | 0.62 |
| Farming system | 1 | 1.829 | 1.829** | 1.60 |
| Lactation order | 3 | 217.88 | 76.62** | 66.97 |
| Error | 298 | 57.96 | 0.194 | 0.17 |

* = Significant at $P<0.05$, ** Significant at $P<0.01$, NS = Non-significant

Farming system

Least squares analysis of variance (table-14) revealed highly significant ($P<0.01$) effect of farming system on MY/LL and its contribution to the total variation for MY/LL was 1.60%. As evident from table-13, the animals managed in the units involved dairying alone had

significantly ($P<0.05$) lower average estimate (4.15 ± 0.03) for MY/LL than the animals managed in the units integrated with agriculture farming (4.30 ± 0.03). However, Kumar (2004) reported the effect of farming system on MY/LL in dairy animals to be non-significant. The significant effect of farming system on MY/LL observed in the present investigation might be attributed to better management and feeding practices available to the animals managed in mixed farming system.

Parity

Least squares analysis of variance (Table-14) revealed that order of lactation had highly significant ($P<0.01$) influence on MY/LL and its contribution to the total variation for MY/LL was reckoned to be 66.97%. As evident from table-13, that there was gradual increase in the average estimate of MY/LL from 1st to 3rd order of lactation and it decreased at 4th parity. The animals in third lactation had significantly ($p<0.05$) higher average estimate (5.06 ± 0.05 kg) of MY/LL followed by those in fourth parity (4.97 ± 0.06 kg). The lowest average estimate for MY/LL was recorded in first parity (2.98 ± 0.04 kg) which was significantly ($P<0.05$) lower than the second, third and fourth parities by 0.91, 2.08 and 1.99 kg respectively. The average MY/LL in second parity was also significantly ($P<0.05$) lower than in third and fourth parities by 1.17 and 1.08 kg respectively. The trend of variation in MY/LL was the same as recorded for lactation milk yield in different parities and the reasons could be explained in the similar way as explained for lactation milk yield i.e. the lactation maturity in buffaloes of the study area was attained in third lactation. Though the reports on the effect of parity on MY/LL could not be made available in literature with respect to buffaloes, however, the significant effect of parity on MY/LL is reported by many workers in cattle (Srivastava and Singh, 2000; Priya Raj, 2002 and Kumar, 2004).

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

Average daily milk yielded by a cow during its one calving interval was taken as 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 intercalving period. The overall least squares mean for MY/CI in buffaloes pooled over three genetic groups viz. Graded Murrah, Diara and Non-descript types was estimated to be 2.84 ± 0.01 kg (Table-13). Tailor *et al.* (1998) reported the overall least squares mean for MY/CI in Surti buffaloes to be 2.04 ± 0.05 kg and Kumar (2004) reported the average MY/CI in buffaloes in and around Dharbhanga, a district town to be 3.10 ± 0.05 kg.

Table 15 : Least squares analysis of variance showing effects of genetic and non-genetic factors on MY/CI of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|----------|-----------|--------------------|
| Genetic group | 2 | 3964.15 | 1982.07** | 33.09 |
| Location | 2 | 71.73 | 35.86* | 0.60 |
| Farming system | 1 | 71.84 | 71.84** | 1.20 |
| Lactation order | 3 | 11699.57 | 3899.85** | 65.11 |
| Error | 298 | 2462 | 8.26 | 0.14 |

* = Significant at P<0.05, ** Significant at P<0.01, NS = Non-significant

Factors affecting milk yield per day of calving interval

Least squares analysis of variance (Table-15) revealed that all the genetic and non-genetic factors included in this study had significant influence on MY/CI. Least squares means for different levels of the factors affecting MY/CI are presented in table-13.

Genetic group

Least squares analysis of variance (tabel-15) revealed that genetic group had highly significant (P<0.01) influence on MY/CI and its contribution to the total variation was calculated to be 33.09%. As depicted

in table-13 and fig.-10, the Graded Murrah had the highest MY/CI (3.28 ± 0.02 kg) which was significantly ($P < 0.05$) higher than the Diara and Non-descript buffaloes by 0.42 and 0.89 kg respectively. Diara buffaloes also had significantly ($P < 0.05$) higher average estimate of MY/CI than the Non-descript buffaloes by 0.47 kg. The trend of variation in MY/CI among three genetic groups was similar to that in their lactation milk yield (Table-7) 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. Kumar (2004) reported significant effect of genetic group on MY/CI in milch animals in and around Darbhanga district town (Bihar).

Location

Least squares analysis of variance (Table-15) revealed significant ($P < 0.05$) influence of zone on MY/CI and its contribution to the total variation for MY/CI was estimated to be 0.60%. As evident from table-13, the animals located in South West Patna had the highest average MY/CI followed by those located in East and North-West zones. The animals located in South West zone had significantly ($P < 0.05$) higher average estimate of MY/CI than the animals located in North-West by 0.12 gm but did not differ significantly from the animals located in Eastern zone. Reports about the effect of location on MY/CI in buffaloes could not be made available in the literature to substantiate the findings of the present study. However, Kumar (2004) reported the effect of zone on MY/CI in milch animals (cow and buffalo) to be non-significant. Significant effect of location on MY/CI observed in the present study might be attributed to the

variances in management and feeding practices adopted by the farmers at different locations.

Farming system

Least squares analysis of variance (Table-15) revealed that farming system had highly significant ($P<0.01$) influence on MY/CI and its contribution to the total variation was 1.20%. As evident from table-13, the animals maintained in the units integrated with agriculture farming had significantly ($P<0.05$) higher MY/CI than those managed in the units exclusively for dairying. The trend of variation in MY/CI was similar to that of lactation milk yield (Table-7) since lactation milk yield is one of the components for its derivation. However, Kumar (2004) reported the effect of farming system on MY/CI in milch animals, in and around Dharbhangha, to be non-significant. The significant effect of farming system on MY/CI observed in the present study might be attributed to the differences in management and feeding practices in two different kinds of farming systems.

Parity

Least squares analysis of variance (table-15) revealed that order of lactation had highly significant ($P<0.10$) influence on MY/CI and its contribution to the total variation for MY/CI was estimated to be 65.11%. As evident from Table-13, there was gradual increase in the average estimate of MY/CI from 1st to 3rd order of lactation and then started declining from fourth parity. The animals in third lactation had significantly ($P<0.05$) higher average estimate (3.46 ± 0.03 kg) of MY/CI followed by those in fourth parity (3.38 ± 0.04 kg). The average estimate of MY/CI in first parity (1.92 ± 0.03 kg) was significantly ($P<0.05$) lower than the estimates obtained in second, third and fourth parities by 0.7, 1.54 and 1.46 kg respectively. The average estimate of MY/CI in second parity was also significantly ($P<0.05$) lower than the third and fourth parities by 0.84 and

0.76 kg respectively. The trend of variation in MY/CI was similar to the trend recorded for lactation milk yield in different parities (Table-7). The reports on the effect of MY/CI could not be made available in the literature with respect to buffaloes, however, Kumar (2004) reported significant effect of parity on MY/CI in milch animals consisting of both cows and buffaloes.

MILK PRODUCTION EFFICIENCY PER KG BODY WEIGHT AT CALVING (MPEK)

In this study the average amount of milk yielded by an animal with respect to its per kg metabolic body weight at calving was taken as one of the measures of production efficiency. It was derived as 'the ratio of total milk yield (kg) during a lactation to the total body weight (kg) of the animals at the time of calving (MPEK)'. The overall least squares mean for milk production efficiency per kg body weight (MPEK) in buffaloes consisting of three different genetic groups viz. Graded Murrah, Diara and Non-descript types was estimated to be 2.62 ± 0.01 kg (Table-16).

Factors affecting MPEK

Least squares analysis of variance (Table-17) revealed that variation in genetic constitution of the animals, location of the animals and the order of lactation had significant ($P < 0.01$) influence on MPEK. The effect of farming systems was not statistically significant. Least squares means for different levels of the factors affecting MPEK have been presented in table-16.

Genetic group

The least squares analysis of variance (Table-17) revealed that genetic group had highly significant ($P < 0.01$) effect on MPEK and its contribution to the total variation for MPEK was 54.39%. The contribution of genetic make up of the animals to the total variation in MPEK was highest among all the factors included in the study. As evident from table-16 and fig.-11, the Diara buffaloes had the highest MPEK (2.90 ± 0.02 kg)

followed by Graded Murrah and Non-descript buffaloes. The average estimate of MPEK in Diara buffaloes was significantly ($P<0.05$) higher

Table 16 : Least squares means \pm SE and CV% of Milk production efficiency per kg body weight at calving (MPEK) and Milk production efficiency per kg body weight per day of lactation (MPEKD) of buffaloes in and around Patna.

| Particulars | MPEK (Kg) Mean \pm S.E. | MPEKD (g) Mean \pm S.E. |
|---------------------------|---|---|
| Overall Mean(μ) | 2.62 \pm 0.01 (6.68) | 8.60 \pm 0.055 (11.2) |
| Factors | | |
| Genetic group | | |
| Graded Murrah | 2.72 ^a \pm 0.02 (7.35) | 9.20 ^a \pm 0.093 (10.10) |
| Diara | 2.90 ^b \pm 0.02 (6.96) | 9.30 ^a \pm 0.092 (9.99) |
| Non Descript | 2.24 ^c \pm 0.02 (9.14) | 7.20 ^b \pm 0.092 (13.09) |
| Location | | |
| 1. North West Patna | 2.57 ^a \pm 0.02 (8.23) | 8.40 ^a \pm 0.088 (11.08) |
| 2. South West Patna | 2.67 ^b \pm 0.02 (7.71) | 8.70 ^b \pm 0.092 (10.88) |
| 3. East Patna | 2.62 ^{ab} \pm 0.02 (7.20) | 8.60 ^{ab} \pm 0.099 (10.86) |
| Farming System | | |
| 1. Animal husbandry alone | 2.63 \pm 0.01 (4.80) | 8.60 \pm 0.074 (10.88) |
| 2. Mixed farming | 2.61 \pm 0.02 (9.29) | 8.50 \pm 0.078 (11.12) |
| Lactation order | | |
| 1 st | 2.15 ^a \pm 0.02 (8.77) | 6.90 ^a \pm 0.098 (13.39) |
| 2 nd | 2.53 ^b \pm 0.02 (7.74) | 8.20 ^b \pm 0.094 (11.23) |
| 3 rd | 2.90 ^c \pm 0.02 (6.01) | 9.60 ^c \pm 0.10 (9.08) |
| 4 th | 2.89 ^c \pm 0.03 (7.04) | 9.50 ^c \pm 0.010 (7.13) |

➤ Means with different superscripts (column-wise) differed significantly ($P<0.05$)

➤ Values in parentheses are CV%

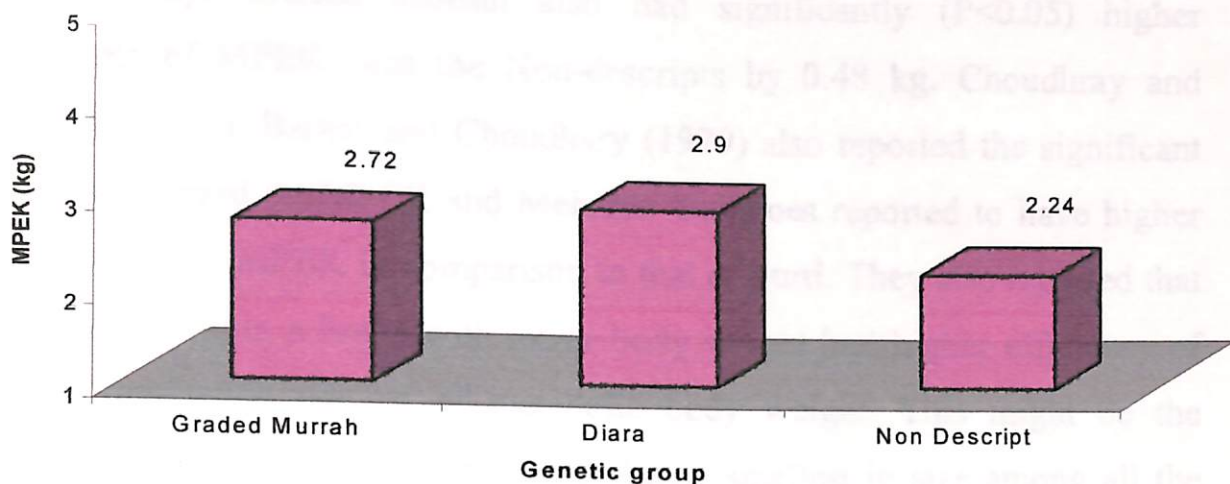


Fig. 11 : Graph showing the average MPEK (kg) of buffaloes in and around Patna.

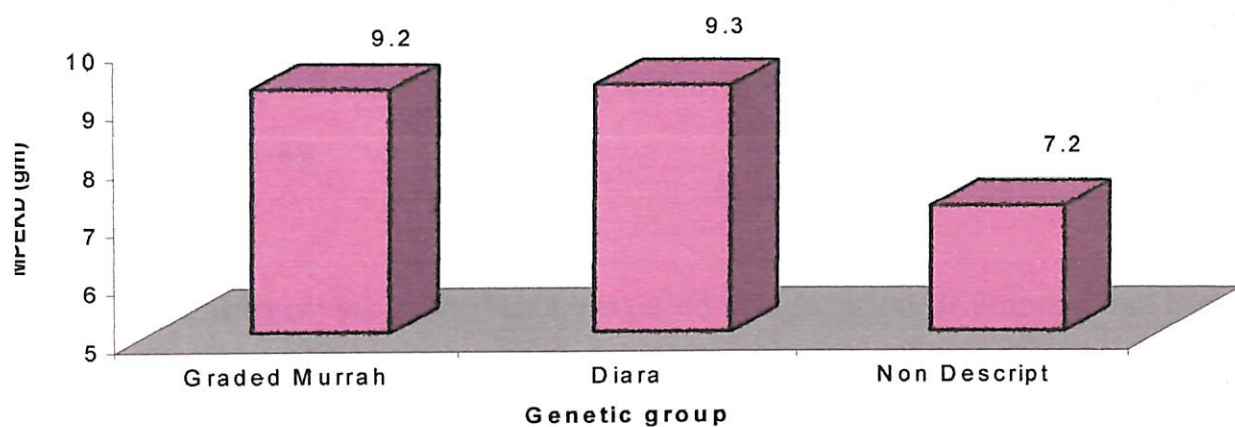


Fig. 12 : Graph showing the average MPEKD (gm) of buffaloes in and around Patna.

than the Graded Murrah and non-descript types by 0.22 and 0.66 kg respectively. Graded Murrah also had significantly ($P<0.05$) higher estimate of MPEK than the Non-descripts by 0.48 kg. Choudhary and Barhat (1979), Barhat and Choudhary (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 also reported that buffaloes within a breed with lower body weight had higher efficiency of milk production per kg of metabolic body weight. This might be the probable reason that Diara buffaloes being smallest in size among all the three genetic groups had higher milk production efficiency. The result of the study indicated that in and around Patna, the Diara buffaloes were the most efficient milk producer followed by Graded Murrah and Non-descript types. The results were in accordance with the expectation because MPEK was derived on the basis of lactation milk yield, body weight at calving and lactation length of the animal of different genetic groups. The reason for lower milk production efficiency of Non-descript buffaloes was due to relatively the lowest lactation milk yield in comparison to other genetic groups. Sharma (1978), Khanna *et al.* (1980) and Singh *et al.* (1987) also reported significant effect of genetic grades on MPEK, of course in crossbred cows.

Location

The analysis of variance revealed that location of animals had highly significant ($P<0.01$) influence on MPEK and its contribution to the total variation in MPEK was 1.13% (Table-17). As evident from table-16, the animals located in South West zone of Patna were the most efficient milk producer and differed significantly ($P<0.05$) from the animals located in North West zone but did not differ significantly from the animals located in East Patna. Superiority in milk production efficiency by the animals located in South West zone of Patna may be due to production of more amount of

milk by those animals as compared to the animals located in other zones. However, Kumar (2004) reported the effect of zone on MPEK in dairy animals consisting of cattle and buffaloes to be non- significant

Farming System

Least squares analysis of variance (Table-17) revealed that the effect of farming system on MPEK to be non-significant and its contribution to the total variation in MPEK was only 0.25%. As evident from table-16, the average estimates of MPEK for the animals under the two farming systems was almost same although the animals maintained under mixed farming system had significantly ($P<0.05$) higher milk production than those managed in the units involved dairying alone as evident for table-7. Significantly higher body weight and size of the animals under mixed farming system (Table-5) may be the probable reason for their low milk production efficiency which equates with the milk production efficiency as body weight is one of the components for derivation of MPEK.

Table 17 : Least squares analysis of variance showing effects of genetic and non-genetic factors on MPEK of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|-----------|-------------------------|--------------------|
| Genetic group | 2 | 235429.70 | 117714.90 ^{**} | 54.39 |
| Location | 2 | 4903.94 | 2451.97 ^{**} | 1.13 |
| Farming system | 1 | 545.20 | 545.20 ^{NS} | 0.25 |
| Lactation order | 3 | 285756 | 95252.01 ^{**} | 44.01 |
| Error | 298 | 136668 | 458.61 | 0.21 |

**** Significant at $P<0.01$, NS = Non-significant**

Parity

As evident from least squares analysis of variance (Table-17), the order of lactation had highly significant ($P<0.01$) effect on MPEK and its contribution to the total variation in MPEK was 44.01% which is next to the contribution of genetic groups. As evident from table-16, the least

squares mean for MPEK was the lowest (2.15 ± 0.02 kg) in first parity and then increased gradually with the increase in order of lactation up to third parity. The average estimates of MPEK in third and fourth parities were almost the same and did not differ significantly. The highest average MPEK was observed among the animals in third parity than the first and second parities by 0.75 and 0.37 kg respectively. The results followed the trend similar to the trends recorded for the lactation milk yield in the present study (Table-7) which was logical because the lactation milk yield was one of the components in deriving this efficiency trait. Kumar (2004) also reported the significant effect of parity on MPEK in cows and buffaloes in and around Dharbhanga (Bihar), however, Choudhary and Barhat (1979) did not report the significant effect of parity on MPEK in buffaloes.

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

The average amount of milk produced by an animal with respect to its per kg metabolic body weight at calving per day of lactation length was taken as another measure of its milk production efficiency. The milk production efficiency per kg body weight at calving 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 comprising of three different genetic groups viz. Graded Murrah, Diara and Non-descript types in and around Patna was estimated to be 8.60 ± 0.055 gm (Table-16). Barhat and Choudhary (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 in milch animals consisting of

cows and buffaloes in the district town of Dharbhanga (Bihar) to be 16.0 ± 0.20 gm, the higher estimate of MPEKD reported by him is very pertinent as the crossbred cows produced more amount of milk.

Table 18 : Least squares analysis of variance showing effects of genetic and non-genetic factors on MPEKD of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|----------|----------------------|--------------------|
| Genetic group | 2 | 28301.51 | 14150.75** | 52.98 |
| Location | 2 | 579.62 | 289.81* | 1.08 |
| Farming system | 1 | 110.70 | 110.76 ^{NS} | 0.41 |
| Lactation order | 3 | 36223.41 | 12074.47** | 45.20 |
| Error | 298 | 25425 | 85.31 | 0.32 |

* = Significant at $P < 0.05$, ** Significant at $P < 0.01$, NS = Non-significant

Factors affecting MPEKD

The least squares analysis of variance (Table-18) revealed that variation in genetic make up of the animals, location of the animals and the order of lactation had significant influence on MPEKD. The effect of farming system was found to be statistically non-significant. Least squares mean for different levels of the factors affecting MPEKD have been depicted in table-16.

Genetic group

The least squares analysis of variance (Table-18) revealed that the genetic group of the animals had highly significant ($P < 0.01$) effect on MPEKD and its contribution to the total variation for MPEKD was the highest among all the factors which accounted to be 52.98%. As evident from table-16 and fig.-12, the Diara buffaloes had the highest average

MPEKD (9.30 ± 0.092 g) followed by Graded Murrah (9.20 ± 0.093 g) and Non-descript types (7.20 ± 0.092 g). The average estimates of MPEKD in Diara buffaloes was significantly ($P < 0.05$) higher than the Non-descript animals by 0.21 g but did not differ significantly from Graded Murrah. Graded Murrah also had significantly ($P < 0.05$) higher estimate of MPEKD than the Non-descript buffaloes by 0.20 g. Barhat and Choudhary (1979) and Choudhary 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 that of Surti. They also reported that buffaloes within a breed with lower body weight had higher efficiency of milk production per kg of metabolic body weight. This might be the probable reason that Diara buffaloes being smaller in size among all the genetic groups included in the study had higher milk production efficiency. The results were in accordance with the expectations because MPEKD was derived on the basis of lactation milk yield, body weight at calving and corresponding lactation length of the animals of different genetic groups. The reason for lower milk production efficiency of Non-descript buffaloes was due to relatively lowest lactation milk yield in comparison to Graded Murrah and Diara buffaloes. Sharma (1978), Khanna *et. al.* (1980) and Singh *et. al.* (1987) also reported significant effect of genetic grades on MPEKD in crossbred cows.

Location

The analysis of variance (Table-18) revealed that location of animals had significant ($P < 0.05$) influence on MPEKD and its contribution to the total variation in MPEKD was 1.08%. As evident from table-16, the animals located in South West Zone of Patna were the most efficient milk

producer and had significantly ($P<0.05$) higher MPEKD than the animals located in North-West zone but did not differ significantly from the animals located in East Patna. The reports on the effect of location on MPEKD was very scanty in the literature, however, Kumar (2004) reported the effect of zone on this trait to be non-significant in dairy animals consisting of cattle and buffaloes.

Farming system

Least squares analysis of variance (Table-18) revealed that the effect of farming system on MPEKD to be non-significant and its contribution to the total variation in MPEKD was only 0.41%. As evident from table-16, the average estimates of MPEKD for the animals under the two farming systems were almost the same and the reasons behind it has already been explained under farming system for MPEK.

Lactation order

As evident from least squares analysis of variance (Table-18), the order of lactation had highly significant ($P<0.01$) effect on MPEKD and its contribution to the total variation in MPEKD was next to the contribution of genetic groups. The amount of variation for this factor was estimated to be 45.20%. As evident from table-16, the least squares means for MPEKD was the lowest (6.90 ± 0.098 g) in first parity followed by second (8.20 ± 0.094 g) and third (9.60 ± 0.01 g) parities. The average estimates of MPEKD in third and fourth order of lactations were almost the same and did not differ significantly. The highest average MPEKD was observed among the animals in third parity which was significantly ($P<0.05$) higher than estimates in first and second parities by 2.71 and 1.41 g respectively. The results followed the similar trend as recorded for the lactation milk

yield in the present investigation (Table-7) which was logical because the lactation yield was one of the components in deriving this milk production efficiency trait. Kumar (2004) also reported the significant effect of parity on MPEKD in cows and buffaloes in and around Dharbhanga. However, Choudhary and Barhat (1979) did not find significant effect of parity on MPEKD.

MEASURES OF REPRODUCTION

DRY PERIOD

Dry period is the period during which milch animals will not produce milk and thus it is an important economic indicator of dairy animals. Longer dry period in cows and buffaloes is one of the major factors resulting in uneconomical milk production in India. There is inverse relationship between length of dry period and reproduction efficiency of milch animals. Ideal dry period has been suggested as 60-70 days, both in cows and buffaloes. The overall least squares mean for dry period in buffaloes consisting of three genetic groups viz. Graded Murrah, Diara and Non-descript types, in and around Patna, was found to be 144.34 ± 0.77 days (Table-19) which was higher than the optimum range desirable for profitable milk production. The probable reason behind it could be the taking out of milk by the private khatal owners from the animals in late gestation. The other probable cause might be the indiscriminate 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 reported by Rao *et al.* (1995), Sethi (1996-97) and Yadav *et al.* (2003) in Murrah, by Pathodiya *et al.* (1998) and Yadav (1995-96) in Surti, by Paliwal (1994) in Mehsana and Chawla (1996-97) in Nili-Ravi buffaloes were in contrary to the findings of the present study in which

Table 19 : Least squares means \pm SE and CV% of Dry period (days) and Calving interval (days) of buffaloes in and around Patna.

| Particulars | Dry period (days) Mean \pm S.E. | Calving interval (days) Mean \pm S.E. |
|---------------------------|---|--|
| Overall Mean(μ) | 144.34 \pm 0.77 (9.34) | 450.24 \pm 1.53 (5.95) |
| Factors | | |
| Genetic group | | |
| Graded Murrah | 130.48 ^a \pm 1.32 (10.11) | 424.32 ^a \pm 2.60 (6.12) |
| Diara | 151.60 ^b \pm 1.30 (8.66) | 464.21 ^b \pm 2.57 (5.59) |
| Non Descript | 150.93 ^b \pm 1.30 (8.82) | 462.19 ^b \pm 2.55 (5.65) |
| Location | | |
| 1. North West Patna | 144.85 \pm 1.25 (9.13) | 452.17 \pm 2.46 (5.75) |
| 2. South West Patna | 143.07 \pm 1.29 (9.28) | 448.42 \pm 2.55 (5.85) |
| 3. East Patna | 145.09 \pm 1.40 (9.10) | 450.13 \pm 2.75 (5.76) |
| Farming System | | |
| 1. Animal husbandry alone | 144.10 \pm 1.05 (9.21) | 448.34 \pm 2.07 (5.84) |
| 2. Mixed farming | 144.58 \pm 1.11 (9.31) | 452.14 \pm 2.18 (5.84) |
| Lactation order | | |
| 1 st | 157.85 ^a \pm 1.39 (8.30) | 466.70 ^a \pm 2.74 (5.53) |
| 2 nd | 143.57 ^b \pm 1.33 (9.07) | 453.98 ^b \pm 2.61 (5.63) |
| 3 rd | 135.65 ^c \pm 1.50 (9.64) | 438.56 ^c \pm 2.96 (5.88) |
| 4 th | 140.27 ^{bc} \pm 1.93 (9.33) | 441.72 ^c \pm 3.80 (5.83) |

➤ Means with different superscripts (column-wise) differed significantly (P<0.05)

➤ Values in parentheses are CV%

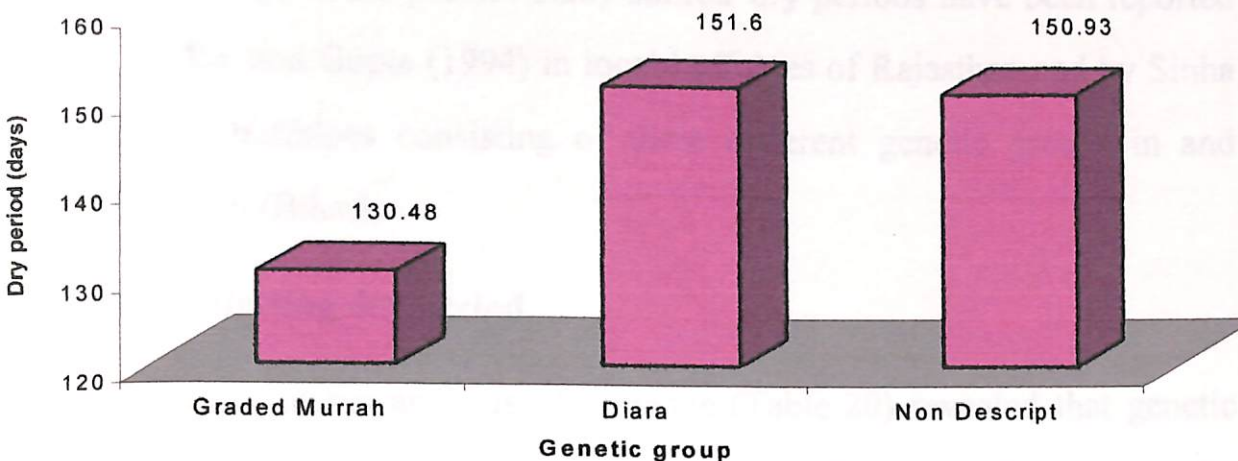


Fig. 13 : Graph showing the average dry period (days) of buffaloes in and around Patna.

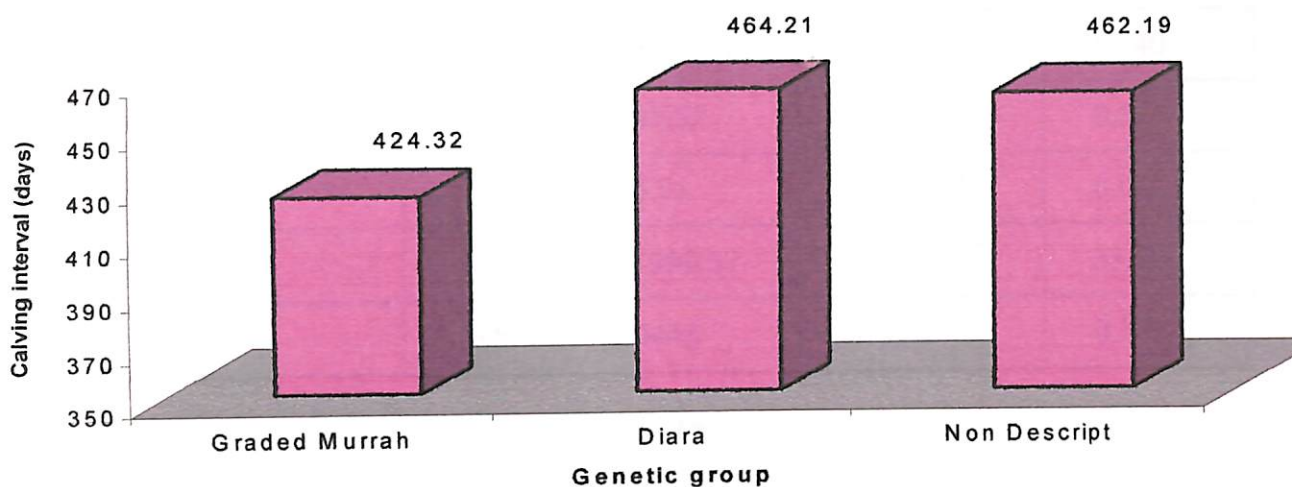


Fig. 14 : Graph showing the average calving interval (days) of buffaloes in and around Patna.

comparatively shorter dry periods have been recorded. However, contrary to the findings of the present study shorter dry periods have been reported by Dev Raj and Gupta (1994) in local buffaloes of Rajasthan and by Sinha (2006) in buffaloes consisting of three different genetic groups in and around Barh (Bihar).

Factors affecting dry period

Least squares analysis of variance (Table-20) revealed that genetic group and order of lactation had significant ($P \leq 0.01$) influence on dry period. The effects of location and farming system were statistically non-significant. Least squares means for different levels of the factors affecting dry period have been presented in table-19.

Table 20 : Least squares analysis of variance showing effects of genetic and non-genetic factors on dry period of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|----------|----------------------|--------------------|
| Genetic group | 2 | 28887.78 | 14443.89** | 65.40 |
| Location | 2 | 245.52 | 122.76 ^{NS} | 0.56 |
| Farming system | 1 | 16.95 | 16.95 ^{NS} | 0.08 |
| Lactation order | 3 | 21999.32 | 7333.10** | 33.20 |
| Error | 298 | 50448 | 169.28 | 0.76 |

**** Significant at $P < 0.01$, NS = Non-significant**

Genetic group

As evident from table-20, that genetic group had highly significant ($P < 0.01$) influence on dry period and its contribution to the total variation was the highest which is accounted to be 65.40%. The least squares means (Table-19, Fig.-13) revealed that Graded Murrah had the shortest dry period

(130.48±1.32 days) which was significantly ($P<0.05$) lower than the Diara and Non-Descript buffaloes by 21.12 and 20.45 days respectively. Diara buffaloes though had the longest dry period (151.60±1.30 days) but did not differ significantly from Non-descript type. Although dry period is supposed to be influenced by non-genetic causes but in the present study 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 finding of the present study was in accordance with the findings of Sinha (2006) who observed the effect of genetic constitution on dry period in buffaloes to be significant. However, the worker reported the longest dry period in Non-descript animals which was significantly longer than the Graded Murrah and Diara buffaloes. Much variation in dry period reported by various workers (Siddiquee *et al.* , 1984, Singh, 1992, Dev Raj and Gupta, 1994, Pathodiya *et al.* , 1998 and Kumar, 2004) for different breeds of buffaloes may be indicative that genetic constitution of the animals might be a considerable factor for variation in dry period. However, contrary to the findings of the present study, Singh *et al.* (1993) and Priya Raj (2002) did not record the significant effect of genetic group on dry period in cows.

Location

The animals located in different zones did not differ significantly among themselves with respect to their dry periods and the effect of location contributed only 0.56% to the total variation in this trait (Table-20). However, the least squares mean for average dry period was the longest (145.09±1.40 days) for the animals located in the khatala in East Patna followed by those located in North West (144.85±1.25 days) and

South West (143.07 ± 1.29 days) zones (Table-19). Srivastava *et al.* (1998), Rao *et al.* (2000), Priya Raj (2002) and Kumar (2004) also reported this effect to be non-significant in cows and buffaloes under private sector.

Farming System

The farming system did not have significant effect on dry period and its contribution to the total variation was only 0.08% (Table-20). As evident from table-19, the animals managed in both the units had almost the same duration of dry periods. The average estimates of dry period in the units involved dairy farming alone and those maintained in the units integrated with agriculture farming were 144.58 ± 1.11 and 144.10 ± 1.05 days respectively.

Parity

The effect of order of lactation on dry period was found to be highly significant ($P < 0.01$) and its contribution to the total variation for this trait was 33.20% (Table-20). A definite trend was observed in the variation of dry period. The average dry period was found to be the longest (157.85 ± 1.39 days) in first calvers followed by second (143.57 ± 1.33 days) and third (135.65 ± 1.50 days) calvers (Table-19). The average dry periods in second, third and fourth calvers were found to be decreased significantly ($P < 0.05$) by 14.28, 22.20 and 17.58 days respectively than the first calvers. The average dry period of fourth calvers was reckoned to be increased by 4.62 days than the third calvers but did not differ significantly. Singh (1992) also observed the similar trend of decreasing dry period gradually from first to third parity, as observed in the finding of the present study but reported the effect of parity to be non-significant. Contrary to the report of Singh (1992), significant effect of parity was reported by Kumar (2004) in

cows and buffaloes in private dairy units but he did not find a definite trend as observed in the present investigation.

CALVING INTERVAL

Calving interval is the indicator of sound reproductive status of milch animals. A period of 12-13 months has been recommended as an ideal calving interval in cows and buffaloes. The overall least squares mean for calving interval in buffaloes consisting of three genetic groups viz. Graded Murrah, Diara and Non-descript types, in and around Patna, was observed to be 450.24±1.53 days (Table-19) which was longer than the optimum range desirable for profitable milk production but close to the estimates reported by Dev Raj and Gupta (1994), Kumar (2004) and Sinha (2006). The higher estimates of calving interval in comparison to the findings of the present study has been reported by Johari and Bhat (1979), Rao *et al.* (1995) and Yadav *et al.* (2003) in Murrah buffaloes and Siddiquee *et al.* (1984) and Singh (1992) in Mehsana buffaloes.

Table 21 : Least squares analysis of variance showing effects of genetic and non-genetic factors on calving interval of buffaloes in and around Patna.

| Sources of variation | D.F. | S.S. | M.S. | R ² (%) |
|----------------------|------|-----------|-----------------------|--------------------|
| Genetic group | 2 | 101241.40 | 50620.69** | 77.61 |
| Location | 2 | 738.54 | 369.27 ^{NS} | 0.57 |
| Farming system | 1 | 1082.46 | 1082.46 ^{NS} | 1.66 |
| Lactation order | 3 | 37502.43 | 12500.81** | 19.16 |
| Error | 298 | 195000 | 654.36 | 1.00 |

** Significant at P<0.01, NS = Non-significant

Factors affecting calving interval

Least squares analysis of variance (Table-21) revealed that genetic constitution of the animals and order of lactation had significant ($P<0.01$) effect on calving interval. The effects of zone and farming system were not significant statistically. Least squares means for different levels of the factors affecting calving interval have been presented in table-19.

Genetic group

Genetic group had highly significant ($P<0.01$) influence on calving interval and its contribution to the total variation in calving interval was the highest which is accounted to be 77.61% (Table-21). As evident from table-19 and fig.-14, the Graded Murrah had the shortest calving interval (424.32 ± 2.60 days) which was significantly ($P<0.05$) lesser than the estimates of Diara and Non-descript buffaloes by 39.89 and 37.87 days respectively. Diara buffaloes had the longest inter calving period (464.21 ± 2.57 days) but did not differ significantly from Non-descript types. Calving interval is supposed to be influenced by non-genetic causes but in the present investigation the genetic divergence between 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) also reported the effect of genetic group on calving interval to be statistically significant in the case of crossbred cows and buffaloes in private dairy units. Significant effect of genetic group on calving interval in buffaloes maintained in private dairy units was also reported by Sinha (2006). But the longest and shorter calving intervals respectively in Non-descript and Graded Murrah reported by him was contrary to the findings of the present study.

Location

The animals located in different locations did not differ significantly with respect to their calving interval and the effect of location contributed to the total variation for this trait was only 0.57% (Table-21). The animals located in North-West zone of Patna had the longest inter calving period (452.17 ± 2.46 days) followed by those animals located in East (450.13 ± 2.75 days) and South West (448.50 ± 2.55 days) zones. Srivastava et al. (1988), Rao *et al.* (2000), Priya Raj (2002) and Kumar (2004) also reported this effect to be non-significant in cows and buffaloes maintained in private dairy units.

Farming system

The farming system did not have significant influence on calving interval and the contribution of the farming system to the total variation was reckoned to be 1.66% (Table-21). As evident from table-19, the animals maintained in the units involved dairy farming alone exhibited lower calving interval (448.34 ± 2.07 day) than the animals managed in the units integrated with agriculture farming (452.14 ± 2.18 days). However, the animals maintained under two different farming systems did not differ significantly with respect to this traits. Johari and Bhatt (1979) reported highly significant effect of farms and periods on calving interval in buffaloes.

Parity

As evident from table-21, the influence of order of lactation on calving interval was highly significant ($P < 0.01$) and its contribution to the total variation for this trait was next to the effect of genetic group, which is

accounted to be 19.16%. A definite trend was observed in the variation of calving interval from parity to parity. The average first calving interval was found to be longest (466.70 ± 2.74 days) followed by second (453.98 ± 2.61 days) and third (438.56 ± 2.96 days) calving intervals (Table-19). The average estimates of calving interval in second and third parities were found to be decreased significantly ($P < 0.05$) by 12.72 and 28.14 days respectively than the first calving interval. The fourth calving interval was found to be increased by 13.16 days than the third parity but did not differ significantly. The significant effect of parity on calving interval was also reported by Singh (1992) and Kumar (2004) in cows and buffaloes maintained in private dairy units. The trend of decreasing calving interval from first to third parity as observed in the present study was also reported by Singh (1992). However, Siddiquie *et al.* (1984), Tailor and Jain (1986) and Rahejha (1992) reported non-significant effect of parity on calving interval.

CONSTRAINTS PERCEIVED BY THE OWNERS OF PRIVATE DAIRY UNITS

Table-22 : Constraints perceived by the owners of dairy units in and around Patna in rearing high yielding buffaloes.

| 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. | Uneconomical male calves | X |
| 11. | Non-remunerative price of milk | XI |

In this study the khatal owners, in and around Patna, were interviewed to enumerate the constraints pertaining to breeding, feeding, management and disease control of their buffaloes in order of priority. The types of constraints varied from one dairy unit to another depending upon location of the units, and farming system. The common constraints, as perceived and reported by the owners of different dairy units, were identified and ranked on the basis of frequency of the dairy units owners expressing the same and that has been depicted in table-22. High cost of high yielding buffaloes ranked 1st in the list of constraints as perceived by the dairy units. It is mainly because of non-availability of good dairy buffaloes in the locality which has been ranked 3rd constraint in the list. Indeed, as compared to the other leading milk producing states of the country, the number of high yielding buffaloes are lesser in Bihar and that is why, in the local cattle market the population of potent animals is very thin. Resultantly, khatal owners had to procure high yielding buffaloes from outside the state, mostly from Haryana and Punjab, and making the animals costly.

The buffaloes in and around Patna, in general, were not provided prescribed surface area according to the scientific norms. It is because the cost of the land in and around Patna had gone very high and it was not within the approach of khatal owners to have sufficient land for building the byres. Besides, the khatal owners were utilizing the small piece of land made for house construction on rent basis for maintaining the buffaloes. All these led to improper and unhygienic housing for the animals.

"High incidence of repeat breeding" ranked as 4th constraint in the study. 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 sexual health of buffaloes.

Non-availability of green fodders throughout the year ranked as 5th constraint in this study which is directly correlated with high incidences of repeat breeding. High cost of feeds and fodders ranked as 6th constraints. High cost of veterinary medicines which ranked as 7th constraint might be possibly, one of the important reasons for providing the treatment in general and repeat breeding in particular to the animals. The owners of different dairy units have also reported the poor results of A.I. which ranked 8th constraint. This might be, possibly, due to lapses in timely detection of heat and timely insemination with quality semen by trained personnels which need to be improved with better managerial practices.

Lack of financial credit facilities ranked as 9th constraint in this study. It could plausibly be explained as there were several financial agencies, but there were certain terms and conditions of financing an 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 insured.

The dairy farmers perceived that the male calves are uneconomical as they do not fetch lucrative amount of money, hence uneconomical male calves ranked as 10th constraint in the study .

Non-remunerative price of milk was noted as the last constraints reported by dairy farmers in and around Patna. However, in Patna there was large number of consumers of milk at considerate price than those in rural areas which might be the reason for ranking this constraint as the last

among the all. 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, Bhoite and Sinde (1987), Singh and Thomas (1992), Raju *et al* (1993), Velmurugor (1998), Yedukondalu *et al.* (2000), Sawarkor *et al* (2001) and Mishra and Pal (2003) have made similar studies in different agro-climatic and socio-economic echo-systems of the country. The different constraints identified and recorded in this study have 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

A recent experiment was conducted on 60 randomly selected
consisting of 116 Graded Murrah, 79 Dair type and 121 Non
a. field cows utilizing the procedure of "Stratified random
in proportional allocation" (Snedecor & Cochran, 1967) in an
following manner:

The following parameters of some of the milk
The value is unorganized form

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The present experiment was conducted on 60 randomly selected dairy units consisting of 116 Graded Murrah, 70 Diara type and 121 Non-descript type buffalo cows utilizing the procedures of "Stratified random sampling with proportional allocation" (Snedecor & Cochran, 1967) in and around Patna with the following objectives :

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

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 to suggest a suitable package of dairy practices for profitable milk production. The morphometric traits included in the study were Height at Withers (HAW, cm), Body length (BL, cm) and Chest Girth (CG, cm) as well as body weight 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 at 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 intervals (CI, days).

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

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, all the milk production efficiency traits and reproduction efficiency traits, whereas Duncan's Multiple Range Test (DMRT) as modified by Kramer (1957) was used for pair-wise comparison of least squares means at 0.05 level of probability.

Graded Murrah had significantly ($P < 0.05$) higher estimates of all the morphometric traits (HAW, BL and CG) than the Diara and Non-descript types, whereas, Diara buffaloes had superiority over Non-descript types for height at wither and chest girth. The average estimates of height at wither, body length and chest girth of Graded Murrah were 132.113 ± 0.187 , 138.598 ± 0.235 and 199.153 ± 0.0653 cm respectively. Therefore, the size of

Diara buffaloes was in between Graded Murrah and Non-descript types. The farming system and the order of lactation had significant ($P<0.05$) influence on HAW, BL and CG whereas location of animals did not influence these traits. The animals managed under mixed farming system had significantly ($P<0.05$) higher estimates of morphometric traits, than those maintained in the units involved dairying alone. The animals of first order of lactation had the lowest magnitudes of all the morphometric traits and significantly ($P<0.05$) increased upto third parity indicating that the skeletal maturity of the buffaloes might be attained at the age of 3rd parity.

The average estimates of body weight of Graded Murrah, Diara and Non-descript types were found to be 508.972 ± 3.36 , 461.798 ± 3.32 and 483.857 ± 3.30 kg respectively. The three genetic groups of buffaloes differed significantly ($P<0.05$) among themselves with respect to their body weight, and Diara buffaloes had significantly ($P<0.05$) lower body weight than the Graded Murrah and Non-descript types.

Farming system and lactation order had significant ($P<0.01$) influence on body weight. The animals maintained under mixed farming system were significantly ($P<0.05$) heavier than those managed in the units involved dairying alone. Like morphometric traits the average body weight of the animals was the lowest at first parity and then increased significantly ($P<0.05$) in subsequent parities. The animals achieved highest body weight at third parity indicating that skeletal maturity of the animals attained at this age when animals are in third parity.

The average lactation milk yield (LMY) of Graded Murrah, Diara and Non-descript types were found to be 1395.82 ± 9.13 , 1347.44 ± 9.02 and 1106.85 ± 8.97 kg respectively. LMY was significantly more in Graded Murrah than the Diara and Non-descript types and Diara buffaloes also

produced significantly ($P<0.05$) much more quantity of milk than the Non-descript types. Location of herd, farming system and lactation order had significant ($P<0.05$) influence on LMY. The highest and lowest milk yields were observed in South-West and North-West Patna respectively. The buffaloes maintained in the units integrated with Agriculture farming yielded more milk than those maintained in the units involved in dairying alone. The milk yield was found to be lowest in first parity and then increased significantly ($P<0.05$). The animals in third parity yielded highest quantity of milk.

The least squares means of lactation length in Graded Murrah, Diara and Non-descript buffaloes were observed as 293.92 ± 2.91 , 312.59 ± 2.16 , 312.11 ± 2.15 days respectively. The genetic group and lactation order had significant ($P<0.05$) effect on LL whereas location of herds and farming system did not influence these traits. Graded Murrah had significantly ($P<0.05$) longer LL than the Diara but Non-descript buffaloes did not differ significantly ($P<0.05$) in respect to this trait. The animals in first and second parity had significantly longer LL than those in third and fourth parities but did not differ significantly among themselves.

The least squares means of peak yield in Graded Murrah, Diara and Non-descript buffaloes were found to be 8.45 ± 0.11 , 7.51 ± 0.11 and 6.80 ± 0.11 kg respectively. The genetic group, farming system and lactation order had significant ($P<0.05$) influence on peak yield, whereas the effect of location was non significant. Graded Murrah had significantly ($P<0.05$) higher peak yield than Diara and Non-descript types by 0.94 & 1.65 kg and Diara buffalo also had significantly ($P<0.05$) higher peak yield than Non-descript types. Animals maintained in mixed farming system had significantly ($P<0.05$) higher peak yield than those maintained in units

involved in dairying alone. Like lactation milk yield, the lowest peak yield was obtained in first lactation and then increased significantly in subsequent lactations. The highest average peak yield was shown by the animals in third parity.

Least squares means for days to attain peak milk yield in Graded Murrah, Diara and Non-descript buffaloes were found to be 37.81 ± 0.36 , 42.37 ± 0.36 and 45.53 ± 0.36 days respectively. The genetic group had significant ($P < 0.05$) influence on days to attain peak yield (DAPY) and Graded Murrah attained peak yield at the earliest period followed by Diara and Non-descript types. The three genetic groups of buffaloes differed significantly ($P < 0.05$) among themselves in respect to this trait, however, location of herd, farming system and order of lactation did not influence DAPY significantly.

The average estimates of milk yield per day of LL (MY/LL) of Graded Murrah, Diara and Non-descript buffaloes were obtained as 4.76 ± 0.04 , 4.31 ± 0.04 and 3.60 ± 0.04 kg respectively. The genetic constitution of the animals, location of the herds, farming system and order of lactation had significant influence on MY/LL. Graded Murrah had significantly ($P < 0.05$) higher MY/LL than Diara and Non-descript buffaloes and Diara buffaloes also had significantly ($P < 0.05$) higher MY/LL than the Non-descript types. The animals located in South-west zone of Patna had significantly ($P < 0.05$) higher MY/LL than those located in North-west Patna but did not differ significantly ($P < 0.05$) from those in East Patna. The animals maintained in the units integrated with agriculture farming had significantly ($P < 0.05$) more MY/LL than those maintained in the units involving dairying alone which reflecting difference between two kinds of farming system. Like LMY, the milk yield per day of lactation

length was found to be lowest in first lactation and then increased gradually and significantly ($P<0.05$) in subsequent lactations. The highest MY/LL was observed in third lactation and then started declining from fourth parity.

Least squares means for milk yield per day of calving interval (MY/LL) in Graded Murrah, Diara and Non-descript buffaloes were reckoned to be 3.28 ± 0.02 , 2.86 ± 0.02 and 2.39 ± 0.02 kg respectively. The genetic constitution of the animals, location of the Khatahs, farming system and lactation order had significant effect on MY/CI. Graded Murrah had the highest MY/CI followed by Diara and Non-descript buffaloes and these three genetic groups differed significantly ($P<0.05$) among themselves with respect to this trait. Animals located in South-west zone had significantly ($P<0.05$) more MY/CI than those located in North-west Patna but did not differ significantly from those located in East Patna. Mixed farming system had superiority over those units involving dairying alone in respect to this trait. The lowest and highest MY/CI were observed in first and third parity respectively. The MY/CI in second, third and fourth parities increased significantly over the first parity, and MY/CI in third and fourth parities increased significantly ($P<0.05$) over second parity.

Least squares means for milk production efficiency per kg of body weight at calving (MPEK) in Graded Murrah, Diara and Non-descript buffaloes were observed to be 2.71 ± 0.02 , 2.90 ± 0.02 and 2.24 ± 0.02 kg respectively. The genetic constitution of the animals, location of the herds and order of lactation had significant ($P<0.05$) influence on MPEK, whereas the effect of farming system was non-significant. Diara buffaloes had significantly ($P<0.05$) higher MPEK than the Graded Murrah and Non-

descript types, and Graded Murrah had superiority over Non-descript types. This indicated that the Diara buffaloes were the most efficient milk producer followed by Graded Murrah and Non-descript types. Animals located in South-west Patna had significantly ($P<0.05$) higher MPEK than those located in North-west Patna and equally efficient to those located in East Patna. The animals in third parity had significantly ($P<0.05$) higher MPEK than those in first and second parity but did not differ significantly from fourth parity indicating that animals in third parity were the most efficient milk producer.

Least squares means for milk production efficiency per kg body weight per day of lactation length (MPEKD) in Graded Murrah, Diara and Non-descript buffaloes were found to be 9.20 ± 0.093 , 9.30 ± 0.092 and 7.20 ± 0.092 gms respectively. The genetic constitution of the animals, location of the animals and lactation order had significant ($P<0.05$) influence on MPEKD, whereas farming system did not play significant role on this trait. Diara buffaloes had significantly ($P<0.05$) higher MPEKD than the Graded Murrah and Non-descript type buffaloes indicating Diara buffaloes were the most efficient milk producer followed by Graded Murrah and Non-descript types. Animals located in South-west Patna had significantly ($P<0.05$) higher MPEKD than those located in North-west Patna but did not differ significantly ($P<0.05$) from those located in East Patna. The buffaloes in third parity had significantly ($P<0.05$) higher MPEKD than those in first and second parities. The animals in fourth parity though had lower MPEKD than those in third parity but did not differ significantly. This indicated that the buffaloes in third parity were most efficient milk producer.

Least squares means of Dry period in Graded Murrah, Diara and Non-descript buffaloes were observed as 130.48 ± 1.32 , 151.60 ± 1.30 and 150.93 ± 1.30 days respectively. The genetic group and order of lactation had significant ($P < 0.05$) effect on dry period, whereas the effect of location of the herds and farming system was not significant. Graded Murrah had significantly ($P < 0.05$) shorter dry period than the Diara and Non-descript types. Buffaloes in first parity had significantly ($P < 0.05$) longer dry period followed by those in second and third parity .

Least squares means of calving interval in Graded Murrah, Diara and Non-descript buffaloes were observed to be 424.32 ± 2.60 , 464.21 ± 2.57 and 462.19 ± 2.55 days respectively. The genetic constitution of the animals and order of lactation had significant ($P < 0.05$) influence on calving interval, whereas the location and farming system had no significant influence. Graded Murrah had the shortest calving interval which was significantly ($P < 0.05$) shorter than Diara and Non-descript types whereas Diara and Non-descript buffaloes did not differ significantly with respect to this trait. Like Dry period, the buffaloes in first parity had the longest calving interval and those in third parity had the shortest calving interval, the difference was statistically significant.

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 can be concluded that the Diara buffaloes were significantly different from Graded Murrah and Non-descript types in respect to morphometrics, milk production and milk production efficiency traits. Diara buffaloes though had significantly ($P<0.05$) lower lactation milk yield and peak milk yield in comparison to Graded Murrah but were more efficient milk producer than Graded Murrah due to their (Diara) lower body weight. Diara buffaloes also had superiority over Non-descript types in respect to lactation milk yield, peak yield, days to attain peak yield and milk production efficiency traits. Therefore similar type of work may be repeated in the entire Tal and Diara areas of the river Ganges, Gandak and Sone pertaining to Bihr to identify and enumerate the number of Diara buffaloes so that a suitable breeding plan can be chalked out for improvement of Diara buffaloes and to improve the livelihood of the dairy farmers in the state.

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