PERFORMANCE OF RATHI CATTLE UNDER ORGANIZED FARM MANAGEMENT CONDITIONS

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M.V.Sc.

THESIS

DOCTOR OF PHILOSOPHY
(Livestock Production and Management)

2013

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THESIS

Submitted to the
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In partial fulfillment of the requirements for
the degree of

DOCTOR OF PHILOSOPHY
(Livestock Production and Management)

BY

CHHOTE SINGH DHAKA
M.V.Sc.

2013

Rajasthan University of Veterinary and Animal Sciences College of Veterinary and Animal Science, Bikaner

CERTIFICATE - I

Date……

This is to certify that **Mr. Chhote Singh Dhaka** has successfully completed the **Comprehensive Examination** held on _____ as required under the regulations for the degree of **Doctor of Philosophy of Veterinary Science**.

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This is to certify that the thesis entitle "**Performance of Rathi Cattle Under Organized Farm Management Conditions"** submitted for the degree of **Doctor of Philosophy of Veterinary Science** in the subject of Livestock Production and Management of the Rajasthan University of Veterinary and Animal Sciences, Bikaner embodies bonafide research work carried out by Mr.Chhote Singh Dhaka under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during this work have been fully acknowledged. The draft of the thesis was also approved by the advisory committee on _____.

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Livestock Production and Management after recommendation by the external examiner was defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination on his thesis has been found satisfactory; we therefore recommend that the thesis be approved.

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1. INTRODUCTION

India is highest milk producing country in the world with 112.5 million tones production of milk annually (Dairy India 2010). Cattle population of India is 185.18 million (18th livestock census, Govt. of India, 2007). This achievement is mainly attributed to increased proportion of crossbred and well defined Indian milch breeds of cattle and buffaloes. The major contributor towards overall milk production has been northern region followed by western, southern and eastern region (Baghel *et al.*, 2005).

In India, animal husbandry is an integral part of the agriculture and among livestock, cattle occupy central position and considered as backbone of rural population by providing nutritional and livelihood security. There are 33 well-defined breeds of cattle apart from several nondescript types and some lesser-known breeds (Tikam Chand, 2011). The cattle and buffalo account for more than two third of the total output value of the livestock sector. Various indigenous breeds of cattle in the country are the result of thousands of years of selection, evolution and development of the wild species in the process of domestication to the local agro climatic conditions. These breeds are now losing ground due to intense competition from other breeds and risk of economic viability under the present system of management (Singh, 2008). Animal husbandry and dairy development plays a prominent role in the rural economy through supplementing the income of rural households, particularly, the landless, small and marginal farmers in India. It also provides subsidiary occupation in semi urban areas and more so for people living in hilly, tribal and drought-prone areas where crop output may not sustain the family. Rajasthan has a geographic area of 3,42,239 sq. km, and constituting 10.41 % of the country's geographic area. The total human

population of Rajasthan in 2011 is 68.6 million (5.67 % of the country's population). The estimate of milk production was 9.49 million tons, of milk in 2007 (GOR, 2007)

Rajasthan has got 6.56 % of total cattle population of India. Among different species of livestock, the proportion of cattle, buffalo, sheep and goat is 20.98, 19.51, 19.07 and 36.98 percent, respectively. The population of indigenous cattle has increased by 8.79 percent between the years 2003 and 2007 after a previous decrease of 12.9 percent (All India Summary Report of 18th Live stock Census, Govt. of India).

Rajasthan has a wide variety of indigenous cattle breeds. Because of mechanizations of agriculture and introduction of various means of transportation, some indigenous breeds are under threat of existence while, others are in process of replacement by certain high producing strains (Mathur, 2001).

The northwestern region of Rajasthan being very hot and dry during summer with meager rainfall and frequent failure of monsoon is unsuitable for agriculture. Due to harsh and uncertain agro-climatic conditions, the people of the area survive mainly on animal husbandry, especially on dairy cattle and sheep/goat rearing. The majority of cattle population in north – western part of Rajasthan especially in Bikaner and Sriganganagar districts, is represented by Rathi cattle. By virtue of its good milk potential and adaptability in the desert and draught prone areas, it has drawn attention of animal breeders.

Rathi cattle take its name from a pastoral tribe called "*Raths*" who lead a nomadic life. These nomads maintain large herds of Rathi cattle on free grazing under arid and semi–arid region of northwestern Rajasthan. As per the information collected from the breeding tract, Vij *et al.* (1992) reported that Rathi cattle are a mixture of Sahiwal, Red Sindhi, Tharparkar

and Dhani breeds with a preponderance of Sahiwal blood due to migration of cattle of this area to Punjab and sindh in famine conditions for centuries. Being evolved by above breeds and constant selection by *Raths* through their traditional skill of rearing, Rathi cattle should be able to do fairly well in most parts of the country with varied agro-climatic conditions.

Rathi cattle is a distinct, relatively unknown breed that possesses good potential with high degree of variability for milk production and has not yet been fully explored for its production potential. There is need to exploit the genetic potential of this breed that is well known for its hardiness to withstand the harsh agro-climatic conditions especially in the drought prone area *viz* arid and semi arid zone. Rathi animals can produce to their full potential even when maintained on dry fodder available in arid regions. Genetic improvement of Rathi cattle through selective breeding is of paramount importance for conservation, propagation and improvement of this valuable germplasm as a part of national heritage.

The heredity and environment are the two fundamental factors contributing to the variability in the measures of economic traits. Environment includes all the non-genetic/ environmental influences to which the animal has been subjected such as feeding, health care, management and climatic conditions. Study of environmental influences becomes essential to account for their effect, in framing the scientific breeding /managerial programs for any dairy farm.

To start an extensive and efficient breeding program for Rathi cattle, it is necessary to have the phenotypic and genetic parameters of important economic traits for bringing about improvement in these traits and also for choosing appropriate selection program. It became essential to know as to how much variation in these traits is of genetic nature or of environmental nature and how the traits are associated with each other phenotypically as well as genetically.

To improve the mean productivity and net profit from a dairy enterprise, apart from managemental factors, it is also necessary that the breeding sires of high genetic merit are made available. Relative contribution of sires to genetic gain is more than that of dams as a bull can have many more offsprings as compared to a cow. No breeding program can succeed unless genetically superior sires are identified and extensively used to bring about genetic improvement because high selection intensity can be practiced among bulls.

The Rathi breed of cattle is the main stay of the dairy husbandry in north- western Rajasthan. Its hometract is Loonkaransar, Pugal, Dungargarh and Bikaner tehsils of Bikaner district: Nohar and Sangaria tehsils of Hanumangarh district and Karanpur, Raisinghnagar, Anoopgarh, Suratgarh tehsils of Sriganganagar district. Rathi animals are red, black, dark brown and spotted in colour, having short to medium stature. The average milk yield in lactation (300) days is about 1918 ± 146.44 liters (Annual report 2006-07 DOR Veterinary and Animal Science, Bikaner) .The average lactation milk yields of Sahiwal herds, the highest lactation milk production in certain cows is more than 4500kg (Joshi *et al*., 2001). In Rathi cattle overall weighted average milk yield, age at first calving ,lactation length and calving interval at various herds is around 1900 kg, 36 months, 315 days and 420 days, respectively .Though this breed is the main source of milk supply in the arid region of Bikaner, yet it has not been recognized as a true breed. By and large it has remained practically neglected as compared to other cattle breeds of the country by national and international research agencies despite its good economic status. This yawning gap unfolds immense opportunity for the evaluation and utilization of persistency as an indicator/selection criterion in this breed.

Curve of lactation yield in cattle generally show first ascending, then stabilized and lastly descending pattern, while attaining the peak yield during the second or third month. The environmental factors like period, season of calving, order of lactation and their interactions may have significant effect on persistency of lactation in Rathi cattle.

Highly persistent animals are found to produce more milk, longer productive life and are considered as efficient producers. It has, of late, acquired added importance to estimate the degree with which the level of milk yield is maintained or what is the degree with which the level of milk yield is maintained or what is termed as the persistency of milk yield.

Since the maintenance of a dairy cattle involves efficient management by the manager on the performance of his herd as influenced by different physical, animal, feed, economics and other factors .This implies that the manager should be conversant with the various factors affecting milk production, reproduction and health status of the herd .Thus the evaluation of the influence of factors pertinent to improved management is of great relevance to the manager in deciding weather a particular managemental practice/system has to be discontinued ,modified or a new practice has to be implemented.

Reproductive efficiency of a cow is measured through age at first calving, calving interval, service period while the productive efficiency is measured through lactation length, dry period and milk yield(Hare *et al.* 2006). The lifetime performance traits, *viz.* herd life, number of lactation, lifetime milk yield, days in milk, etc. are indicative of lifetime production efficiency.

The information on these aspects is vital for planning and monitoring breeding program for increased profitability from Rathi cows. It is, therefore, important to determine the variability in these economically important traits and their components to explore profitability through genetic improvement.

Keeping in view, the poor status of knowledge in Rathi breed of cattle, the present study was undertaken to abridge this yawning research gap with the following objectives:-

1. To evaluate milk production, its persistency and reproduction traits of Rathi cattle
2. To study effect of environmental and managemental factors affecting production and reproduction traits.
3. To study relationship among production and reproduction traits.
4. To suggest various managemental practices to improve production and reproduction traits of Rathi cattle.

2. REVIEW OF LITERATURE

It is mandatory on the part of any research to go in depth of the earlier studies conducted in the field of investigation, which gives the comprehensive knowledge about the work done and findings obtained in past. It gives an immense help and provides an insight to the researcher to plan and execute the study. Very few studies have been traced out which have some direct relevance to the problem under investigation. Research work on Rathi cattle in literature is very scanty and limited, especially on the aspects considered in present investigation; therefore, review has been extended for other breeds of dairy cattle, viz. Hariana, Red Sindhi, Tharparkar, Sahiwal and their crossbreds etc.

Keeping in view the objectives of the study, the available relevant literature has been reviewed and presented under the following-sub heads:

2.1. Production Traits

2.2 Reproduction Traits

2.3 Relationship among Production and Reproduction Traits.

2.4 Managemental Practices

2.1. Production Traits

2.1.1. Lactation Yield

Lactation yield in Rathi cows was reported to be as low as 1062.7 ± 29.61 litres by Chourasia *et al.* (1983) and as high as 1770.8 ± 57.3 litres by Joshi (1989),1659.06±28.96 litres by Gahlot et. al. (2001). Nehra (2004) reported lactation yield in Rathi cattle to be 1719.8 litres. The variability in lactation yield indicates the scope of genetic improvement of Rathi cattle for its milk production efficiency through selection. Lactation yield is also known to be influenced by various managemental and environmental factors. The average lactation yield as reported by different workers is presented in Table 2.1and standard lactation of milk yield in table 2.2.In standard lactation of milk yield low production was reported by Gahlot *et al*. (1991) as 1535.5 ± 18.2 litres, as 1136.7 by Bhat (1997) and as 1660.63 ± 33.984 litres by Singh (2012) in Rathi cattle and 720.59 litres Balaine (1971) and 1436.25 litres by Singh and Tomar (1986) in Hariana cattle

2.1.1.1 Effect of Period of Calving

Gahlot (1972) reported that the lactation yield was affected significantly by year of calving in Rathi cattle. Similarly, Nagpal (1968), Bhat *et al.* (1980), Bhatnagar *et al.* (1982), Taneja *et al.* (1982), Panneerselvon *et al. (*1990), Rahumathulla *et al.* (1994), Vij *et al.* (1992b), Kachwaha (1993) and Yadav *et al. (*1994a) also reported similar results for lactation yield in different breeds of cattle. Rehman *et al.* (2008) in Sahiwal cattle, Gahlot *et al.* (2001) and Tikam Chand (2011) in Tharparkar cattle and Kaushik *et al*. (1994) in Hariana cattle respectively reported similar findings.

On the contrary to this a non-significant effect of year of calving on lactation yield was reported by Singh *et al*. (1997), Nehra (2004) and Kumar (2012) in Rathi cattle and Gurnani *et al.* (1971) in Tharparkar cattle and Singh *et al.* (1973) in Sahiwal and Dhaka (1997) in Hariana cows.

Table 2.1. Average estimates of lactation yield (litres) in different breeds of cattle.

Breed	**Parity**	**Mean± S. E.**	**References**
Rathi	Overall	1533.60 ± 32.50	Ohri and Singh (1970)
Rathi	1st	1420.60 ± 79.10	Ohri and Singh (1970)
Rathi	Overall	1630.70 ± 30.30	Gahlot (1972)
Rathi	1st	1488.90 ± 52.40	Gahlot (1972)
Rathi	Overall	1598.80 ± 54.80	Saraswat (1980)
Rathi	Overall	1062.70 ± 29.60	Chourasia *et al.* (1983)
Rathi	Overall	1770.80 ± 57.30	Joshi (1989)

Rathi	Overall	1705.80 ± 44.32	Nehra(2004)
Rathi	Overall	1720.24+49.793	Singh (2012)
Sahiwal	Overall	1861.50	Taneja & Chawla (1978)
Sahiwal	Overall	1293.00 ± 17.00	Deb *et al.* (1981)
Sahiwal	1st	1259.0 ± 44.0	Deb *et al.* (1981)
Sahiwal	Overall	1480.00	Parmar & Jain (1986)
Sahiwal	1st	1388.80 ± 20.38	Singh *et al.* (1999)
Red Sindhi	Overall	1391.00	Malhotra & Singh (1980)
Red Sindhi	1st	1175.70	Ghose *et al.* (1980)
Tharparkar	1st	2166.75±28.21	Reddy and Bhatnagar (1971)
Tharparkar	Overall	2112.82±20.72	Reddy *et al.* (1978)
Tharparkar		2177.00±30.43	Gupta and Bhatnagar (1979)
Tharparkar	1st	2011.20±62.80	Basu *et al.* (1982a)
Tharparkar	1st	2289.90	Taneja and Bhatnagar (1985)
Tharparkar	1st	1095.70 ± 26.15	Panneerselvon *et al.* (1990)
Tharparkar	Overall	1933.30 ± 13.59	Kachwaha (1993)
Tharparkar	Overall	1424.20 ± 21.05	Yadav *et al.* (1994b)
Tharparkar	1st	1829.10 ± 32.86	Rahumathulla *et al.* (1994)

Tharparkar	Overall	2064.57 ± 18.02	Tikam Chand (2011)
Jersey x Hariana	Overall	1968.80	Chopra (1990)

Table 2.2 Average estimates of standard lactation milk yield (litres) in different breeds of cattle.(nos in parenthis)

Breed	Pairty	Mean±S.E.(n)	References
Rathi	Overall	1621.5±39.4(245)	Joshi (1989)
Rathi	Overall	1535.5±18.2(622)	Gahlot *et al.* (1991)
Rathi	Overall	1602.0±20.0(325)	Gahlot *et al.* (1993)
Rathi	1st	1388.0±44.0(63)	Gahlot *et al.* (1993)
Rathi	2nd	1580.0±42.0(79)	Gahlot *et al.* (1993)
Rathi	3rd	1614.0±44.0(94)	Gahlot *et al.* (1993)
Rathi	4th	1728.0±57.0(62)	Gahlot *et al.* (1993)
Rathi	5th	1771.0±68.0(37)	Gahlot *et al.* (1993)
Rathi	Overall	1612.1±19.14	Nehra (2004)
Rathi	Overall	1660.63±33.984	Singh (2012)
Sahiwal	Overall	1703.7(475)	Taneja & Chawla (1978)
Sahiwal	Overall	1602.5	Basu *et al. (*1979)
Sahiwal	1st	2022.0±38.87(559)	Chawla and Mishra (1982)
Red Sindhi	Overall	1818.0±35.9(179)	Chopra *et al.* (1973)

Red Sindhi	1st	1712.00±50.1	Chopra *et al.* (1973)
Red Sindhi	1st	1534.9±32.2(219)	D'Souza *et al.* (1979)
Red Sindhi	1st	1048.3±30.5(369)	Singh *et al.* (1982)
Tharparkar	Overall	1907.2±23.51	Kachwaha (1993)
Tharparkar	Overall	1420.5±20.82	Yadav *et al.* (1994a)
Tharparkar	1st	1019.5±20.27	Panneerselvon *et al.* (1990)
Tharparkar	1st	1721.0±27.27	Rahumathulla *et al.* (1994)

Period of calving had a significant effect on milk yield in crossbred cattle (Thomas *et al.*1987; Mondal,1989; Gahlot *et al.*1991and Jadhav *et al (*1992)

In Rathi cows, the effect of period of calving on 300 days yield was observed to be significant by Sharma and Singh (1975), Gahlot *et al.* (1993). Similarly Panneerselvon *et al.* (1990) and Pareek (1991) in Tharparkar and Singh and Nagarcenkar (1997) in Sahiwal cattle observed significant effect of period of calving on three hundred days milk yield. Parekh and Sahu (1978), and Nehra (2004) did not find any relation of this parameter with period of calving.

2.1.1.2 Effect of Season of Calving

A lot of research workers observed a definite seasonal trend in milk yield for the animals calving in different seasons. The influence of winter on producing ability of animals was positive and of higher magnitude in all the lactations due to availability of green fodder in abundance and animals had sufficient time for rumination and less disturbances due to managerial practices because of shorter day length. The metabolic activity is at peak during winter season. Effect of month of calving was reported to be non-significant by Singh(1977) and Basu *et al.* (1979). Gahlot (1986) reported significant effect of season on 300 days of milk yield in Rathi and Rathi x Red-Dane crosses. Parmar and Johar (1982a) found the highest yield in Tharparkar cattle in rainy season calvers.

In a study to investigate the effect of season of calving on lactation yield, a significant effect was observed by Gahlot (1972), Nagpal and Bhatnagar (1972), Rao and Dommerholt (1981) and Parmar and Johar (1982b) and similarly, Sennayan *et al.* (1987), Dalal *et al.* (1991), Vij *et al.* (1992a), Kachwaha (1993), Rahumathulla *et al.* (1994) and Yadav *et al.* (1994a) also found that lactation yield in Tharparkar cattle was significantly influenced by season of calving.

The effect of season of calving was found to have significant effect on three hundred days yield as revealed by Gahlot (1986) in Rathi cows. Joshi (1989) in Rathi cows and Singh and Nagarcenkar (1997) in Sahiwal cattle.

In contrast, Nehra (2004) in Rathi and Sharma *et al.* (1972), Bhat *et al.* (1980), Bhatnagar *et al.* (1982a), Panneerselvon *et al.* (1990) and Vij *et al.* (1992b) reported that lactation yield is not affected by season of calving in Tharparkar cattle. Similar results were reported by Beniwal (1993) in Red Sindhi cows and its crosses, Kumar (2012) in Rathi cattle and Tikam Chand (2011) in Tharparkar cows.

2.1.1.3 Effect of Parity

Singh and Dave (1989) and Khanna and Bhatt (1972) observed increasing trend in milk yield of crossbreds with increase in order of lactation upto 4th and 5th lactation. Similarly Askar *et al.* (1966) observed that milk yield increases to a maximum in the 4th lactation in cross bred cattle. Gahlot *et al.* (1991) reported significant effect of parity on milk production in Rathi and Rathi x Red-Dane crosses. Parmar *et al.* (1984) reported significant effect of parity on milk yield in zebu breeds.

Ohri and Singh (1971) reported that the lactation yield in Rathi cattle increased from first to fourth lactation and thereafter declined. The maximum production was attained in the fourth lactation with an increase of 16 per cent from the first lactation. The same results were observed by Gahlot (1990), Vij *et al.* (1992b), Yadav *et al.* (1994a) and Tikam Chand (2011) in zebu cattle.

The significant effect of parity on lactation yield was also reported by Gahlot (1972) and Chourasia *et al.* (1983) in Rathi cattle. However, Saraswat (1980) and Singh and Raut (1980) observed non-significant effect of sequence of calving on lactation yield in Rathi cattle. Similar results were observed by Bhatnagar (1982a) and Parmar and Johar (1982a) and Reddy and Nagarcenkar (1988b)

2.1.1.4 Effect of Farm

Farm did not influence the lactation yield. The first lactation yield was estimated to be 1613.1 ± 32.41 and 1705.8 ± 44.32 liters at Nohar and Bikaner farm respectively. The pooled lactation yield was observed to be 1733.2 ± 19.76 and

1706.4 ± 26.47 litres for Nohar and Bikaner farms, respectively, indicating non-significant variation in pooled lactation yield (Nehra, 2004). Similar results were observed by Ram and Singh (1975).

2.1.2 Peak Yield

Peak yield is defined as the maximum daily, maximum weekly or monthly yield. Peak yield is an important economic trait of dairy animals. It is being used as a selection criterion particularly under village conditions due to non -availability of total production reports and can also be used as an early measure of selection and culling of farm animals. Averages of peak yield of crossbred cattle are presented in Table 2.3

2.1.2.1 Effect of Period of Calving

Gill (1969), Gill *et al.* (1970) reported that in Hariana cattle the effect of period of calving had significant effect on peak yield in all lactations. Taneja and Sikka (1981), Yadav *et al.* (1994a), Gaur and Raheja (1996) observed significant effect of period on peak yield in different zebu breeds of dairy cattle. Similar results were observed by Hingane (1980) in Hariana cattle, Vij *et al*. (1992) and Tikam Chand (2011) in Tharparkar Cattle.

Table 2.3 Average estimates of peak yield in different breeds of cattle

Breed	**Average Peak yield (Litres)**	**References**
Haryana	6.43± 0.02 5.51±0.73 14.46	Singh and Desai (1961) Kashmiri (1977) Raheja and Balaine (1982)
Rathi	8.4± 0.10 6.33 9.47	Ohri and Singh (1970) Saraswat (1980) Joshi (1989)
Red Sindhi	8.72± 0.16 11.38±0.35	Krishna and Desai (1969) Chauhan *et al.* (1976)
Sahiwal	8.3 11.44±0.20	Batra and Desai (1969) Chauhan *et al.* (1976a)
Tharparkar	9.0±0.2 10.60±.20 7.85±0.24 11.89±0.17 12.20±0.07	Chauhan *et al.* (1976) Chauhan *et al.* (1976b) Ram and Singh (1975) Pareek (1991) Kachwaha (1993)

Peak yield in Rathi cattle was found to be 6.33 litres by Saraswat (1980) and 9.47 litres by Joshi (1989).

Contrarily, Branton and Miller (1959) observed non- significant effect of period of calving in Holstein- Friesian cows on peak yield. Sharma *et al.* (1982) in crossbred cows also observed non-significant effect of year of calving on peak yield. However, Nehra (2004) and Kumar (2012) in Rathi cattle and Joshi (1989) also observed non-significant effect of period of calving on peak yield in Rathi and its crosses.

2.1.2.2 Effect of Season of Calving

Significant effect of season of calving on peak yield in different breeds of cattle was reported by Dutt and Singh (1961), Vij and Basu (1986), Biradar (1990) and Gaur and Raheja (1996).They found that winter calvers had the highest average peak yield and autumn calvers the lowest. Similar results were observed by Rao and Dommerhit (1981), Viz *et al.* (1992b) and Tikam Chand (2011) in Tharparkar cattle and Hingane (1980) in Hariana cattle.

Contrary to above findings a non-significant effect of season of calving on peak yield had been reported by Branton and Miller (1959), Gill *et al.* (1970). Nehra (2004) and Kumar (2012) in Rathi cattle, Joshi (1989) in Rathi and its crosses and Sharma (1972) in Tharparkar cattle.

2.1.2.3 Effect of Parity

Non-significant effect of parity on peak yield was reported by Yadav *et al.* (1992a) in Sahiwal cattle. Similar results were also observed by Raizada (1971). Contrarily, significant effect of parity on peak yield was reported by Gill (1969),

Chauhan *et al.* (1976) Vij *et al.* (1992), Yadav *et al.* (1995) and Kumar (1997) in zebu breeds and Ram(1974) and Parmar *et al.* (1997) in crossbreds.

2.1.2.4 Effect of Farm

Hingane (1980) in Hariana and Vij *et al.* (1992) showed same trends. Singh (2012) observed peak yield significantly higher in Rathi cattle at Bikaner farm than Nohar farm. Whereas, Naidu and Desai (1966) reported significant effect of farm in northern and southern zone of the country.

2.1.3. Lactation Length

Lactation length is an important economic trait as it reflects the periodicity of milk production and influence the milk yield to a greater extent. Lactation length of 300 or 305 days has been considered as optimum. Lactation length in Rathi cattle was reported to be 305.95 ± 6.64 days by Joshi (1989). Nehra (2004) reported lactation length in Rathi cattle to be 295.5 days. Some of the results reported by different workers on lactation length are presented in Table 2.4

The duration of lactation influences the milk yield, larger the length more will be the milk yield but at the same time higher length leads to increase in the calving interval adversely affecting the breeding efficiency and the milk production per day. Therefore the lactation length of 300 or 305 days is considered to be optimum. .Average lactation length of indigenous cattle is generally lower than 300 days.

2.1.3.1 Effect of Period of Calving

As reported by Sandhu *et al.* (1973b) Singh *and* Gurnani (2003) the period of calving did not influence the lactation length significantly in Karan Fries cattle. This result is similar with Gahlot (1972) in Rathi cattle , Chawla and Mishra (1982) in Sahiwal cattle and Tikam Chand (2011) in Tharparkar cattle and Gupta (1980) in buffalo.

Bhat *et al.* (1980) observed significant effect of year of calving on lactation length in Tharparkar cattle., Gupta and Johar (1982), Gupta *et al.* (1986) and Vij *et al.* (1992), Kachwaha (1993) reported similar findings by Ram *et al, (*1979), Panneerselvon *et al. (*1990), Pareek (1991) and Tikam Chand (2011) in Tharparkar cattle. Period of calving was found to be non-significant on lactation length Period of calving was found to be non-significant on lactation length

Table 2.4 Average estimates of lactation length in days for different breeds of cattle.

Breed	**N**	**Mean± S. E.**	**References**
Rathi	329	308.00 ± 4.60	Ohri and Singh (1970)
Rathi	277	351.80 ± 3.90	Gahlot (1972)
Rathi	160	431.00 ± 9.60	Singh and Raut (1980)
Rathi	46	311.10 ±21.70	Chourasia *et al.* (1983)
Rathi	245	305.95 ± 6.64	Joshi (1989)
Sahiwal	442	292.00	Kumar and Narain (1979)
Sahiwal	20	354.40	Ghose *et al.* (1980)

Sahiwal	478	322.00 ± 4.50	Chawla and Mishra (1982)
Sahiwal	-	200.00	Parmar and Jain (1986)
Sahiwal	448	274.12 ± 3.23	Singh *et al.* (1999)
Sahiwal	-	295.71±2.61	Gandhi *et al.* (2009)
Red Sindhi	55	303.90	Ghose *et al.* (1980)
Red Sindhi	123	287.00	Malhotra and Singh (1980)
Red Sindhi	-	345.00	Rao and Patro (1984)
Red Sindhi	309	348.80 ± 8.80	Beniwal (1993)
Red Sindhi	-	242.60	Gupta and Tripathi (1994)
Tharparkar	-	240.25±6.61	Johar and Taylor (1971)
Tharparkar	-	284.57 ± 5.53	Panneerselvon *et al.* (1990)
Tharparkar	-	310.85	Pareek (1991)
Tharparkar	-	296.90± 6.52	Vij *et al.* (1992)
Tharparkar	-	292.90 ± 4.30	Rahumathulla *et al.* (1994)
Tharparkar	-	259.70 ± 2.56	Yadav *et al.* (1994a)
Tharparkar	1025	288.68 ± 3.14	Tikam Chand (2011)
Hariana	601	268.00 ± 2.15	Dalal (1997)
Hariana	624	259.46 ± 2.35	Singh (1998)
Hariana	634	260.01 ± 8.49	Kaushik (2000)

Hariana	512	274.42 ± 8.03	Dhaka *et al.* (2002)

2.1.3.2 Effect of Season of Calving

Gupta and Johar (1982), Gupta *et al.* (1986), Joshi (1989) and Panneerselvon *et al.* (1990) and Nehra (2004) reported significant effect of season of calving of Tharparkar and Rathi cows on lactation length. Similarly Vij *et al.* (1992a) and Kachwaha (1993) also found significant effect of season.

Contrarily, Sharma *et al.* (1972), Ram *et al.* (1979), Pareek (1991) and Tikam Chand (2011) in Tharparkar cattle found non-significant effect of season of calving on lactation length.

2.1.3.3 Effect of Parity

Dutt *et al.* (1974), Ram *et al.* (1979), Parmar and Johar (1982b) found significant effect of parity on lactation length in Tharparkar cattle. Similar reports were given by Sennayan *et al. (*1987), Pandey and Tomar (1990), Pareek (1991), Vij *et al.* (1992b) and Kachwaha (1993) and Nehra (2004) was reported significant effect of parity in Rathi cattle.

Gahlot (1999) in Tharparkar cattle observed that cows in first parity had significantly longer duration of lactation length than those calving in rest of the parities. In Rathi cows, Gahlot (1972), Singh and Raut (1980) and Chourasia *et al.,* (1983) did not find significant effect of parity on lactation length.

2.1.3.4 Effect of Farm

The Lactation length was significantly influenced by farm Nehra (2004) reported lactation length of the Rathi cattle at Nohar farm was significantly lower than lactation length of the Rathi cattle at Bikaner

farm. Whereas Naidu and Desai (1966) observed non-significant effect of farm in northern and southern zone of country.

2.1.4. Dry Period

Dry period is the period from date of drying of an animal to subsequent calving which affects the economy of milk production by influencing the calving and breeding efficiency. Although a longer dry period is not desirable, yet an optimum dry period is required for the rejuvenation of cow for next lactation. Chaurasia *et al.* (1983) reported the dry period in Rathi cattle as 234.4 days whereas Nehra (2004) observed it to be 180.10 ± 6.79 days. Dhaka *et al.* (2002) found dry period in Hariana cattle as 211.47 ± 9.74 days, Pandey et al. (1978) found dry period in Tharparkar cattle as 147.62n ± 3.47 days, D'souza et al (1979) in Red-Sindhi cattle as 159.0 days. The duration of dry period as reported by different workers is presented in Table 2.5

Panneerselvon *et al.,* (1990) reported higher estimate of dry period as 250.14 days in Tharparkar cattle, while Gahlot (1999) observed it as 100.93 days. Dubey and Singh (2005) in Sahiwal cattle and its crosses found 165.49 ± 5.64 days dry period. In Chilean Holstein cattle, Melendez and Pinedo (2007) found dry period to range from 70.1 ± 0.55 to 81.9 ± 0.92 days (Average 76.00 ± 0.40 days).

Table 2.5 Average estimates of dry period in days in different breeds of cattle.

Breed	N	Mean ± S. E.	References
Rathi	280	174.40 ± 5.00	Ohri and Singh (1970)
Rathi	277	178.50 ± 6.10	Gahlot (1972)
Rathi	123	198.00 ± 11.60	Singh and Raut (1980)
Rathi	39	234.40 ± 18.40	Chourasia *et al.* (1983)
Rathi	281	180.10 ± 6.79	Nehra (2004)
Sahiwal	-	142.76	Basu and Ghai. (1979)
Sahiwal	440	239.67 ± 5.57	Singh *et al.* (1999)
Red Sindhi	-	159.00	D'Souza *et al.* (1979)
Red Sindhi	-	134.00 ± 4.90	Chawla and Mishra (1982)
Tharparkar	-	190.70	Sharma *et al.* (1979)
Tharparkar	-	119.90 ± 11.50	Tomar (1988)
Tharparkar	-	250.14 ± 13.49	Panneerselvon *et al.* (1990)
Tharparkar	644	103.38 ± 1.43	Kachwaha (1993)
Tharparkar	-	162.30 ± 8.60	Rahumathulla *et al.* (1994)
Tharparkar	908	139.80 ± 3.66	Tikam Chand (2011)

Tharparkar	621	194.58 ± 5.75	Kumar (2012)
Hariana	547	243.00 ± 11.00	Pundir (1995)
Hariana	588	192.00 ± 3.77	Dalal (1997))
Hariana	634	221.02 ± 12.69	Kaushik (2002)
Hariana	512	211.47 ± 9.74	Dhaka *et al.* (2002)
Chilean Holstein		76.00 ± 0.40	Melendez and Pinedo (2007)

2.1.4.1 Effect of Period of Calving

A significant effect of period of calving on dry period was reported by Nehra (2004) in Rathi cattle, Basu *et al.* (1979) in Red Sindhi, Kachwaha (1993) and Tikam Chand (2011) in Tharparkar cattle. However contrary to this, Gahlot (1972) in Rathi cattle, Chawla and Mishra (1982) in Sahiwal cattle and Dahiya (2002) in Hariana breed of cattle reported non-significant effect of year of calving on dry period. Prakash and Tripathi (1990) also observed that year of calving had significant effect on dry period.

2.1.4.2 Effect of Season of Calving

Nagarcenkar and Rao (1982) observed that season of calving had statistically significant ($p \leq 0.01$) effect on dry period. Similar findings were also reported by Deshpande *et al.* (1992) and Kumar (1997). A significant effect of season of calving on dry period was also reported by Basu and Ghai (1979) in Sahiwal crossbreds, Kachwaha (1993), Panneersevlon (1990) and Gahlot (1999) in Tharparkar and Dahiya (2002) in Hariana breed of cattle.

On the contrary Nehra (2004), Gahlot (1972), and Singh and Dubey (2005), Chawla and Mishra (1982), Singh and Gurnani (2003), and Tikam Chand (2011) in Rathi, Sahiwal, Karan Fries and Tharparkar cattle, respectively reported no significant effect of season of calving on dry period. These divergent findings suggested that the criteria for classification of seasons were different in different studies. Further the availability of green fodder from season to season and overall management practices followed at various farms might have resulted into such differences reported by various researchers.

2.1.4.3 Effect of Parity

Taneja *et al.* (1978) studied the performance of Friesian and Jersey crosses with Kankrej cattle under hot humid climate of Gujrat and found that the effect of parity for dry period was non-significant. Similar findings were also reported by Dalal *et al. (1993),* Chopra (1998), Thakur and Singh (2000b) and Nehra (2004)

In contrary to the above findings Deshpande *et al. (1992)* in Sahiwal cattle, Kumar (1997) in Tharparkar and Mane and Deshpande *(*1998) in Khillari cattle observed significant effect of lactation order on dry period.

2.1.4.4 Effect of Farm

Farm did not influence the dry period of Rathi cattle. Nehra (2004) reported non-significant effect of both Nohar and Bikaner farm While significant effect was reported by Singh (2012) in Rathi cattle and Tikam Chand (2011) and Gahlot (1999) in Tharparkar cattle.

2.1.5 Days to Attain Peak Yield

It may be defined as the number of days from the date of calving to the date when the peak yield (maximum yield per day) is attained by a cow. Chauhan *et al.* (1976b), Sikka and Taneja (1981), Nivsarkar *et al. (*1992) and Vij *et al. (*1992) reported average of 33.00-39.15 days to attain peak yield in different breeds of cattle. Tomer *et al.* (1996) also reported

43.89±3.81 days in Holstein Friesian x Sahiwal half-breds and Kumar (1997) reported 58.38±1.38 days in Tharparkar cattle for attaining peak yield.

Chhikara (1993) observed significant effect on days to attain peak yield in Murrah buffaloes. Garcha and Tiwana (1980) collected the data over duration of 12 years which was divided into six periods of 2 years each and found significant (P≤0.05) effect of period of calving on days to attain peak yield. Yadav *et al.* (1995) and Kumar (1997) also reported significant effect of periods on days to attain peak yield in zebu cattle.

Table. 2.6 Average estimations of Days to Attain Peak Yield in different breeds of cattle

Breed	Days to Attain Peak Yield (days)	Reference
Holstein Friesian	33-00 to 39.15	Chauhan *et.al*.(1976b) Sikka and Taneja (1981) Nivsarkar *et al.(* 1992)
Tharparkar	33.00 to 39.15	Vij *et al.*(1992)
H.F.X Sahiwal halfbreds	43.89 + 3.81	Tomar *et al.*(1996)
Tharparkar	58.38+1.38	Kumar (1997)

2.1.5.1 Effect of Period of Calving

However, Sikka and Taneja (1981) and Yadav *et al.* (1994b) observed no effect of period of calving on days to attain peak yield in Tharparkar and Hariana cattle, respectively. Chowdhary and Chaudhary (1981) reported non-significant influence of year of calving on days to attain peak yield. These results were further supported by the findings of Biradar (1990) in Surti buffaloes, Gajbhiye and Tripathi (1988) and Neog *et al.* (1993) in Murrah buffaloes and Yadav and Rathi (1992b) reported non-significant effect in dairy cattle.

2.1.5.2 Effect of Season of Calving

Garcha and Tiwana (1980) observed significant effect of season of calving on days to attain peak yield. They further stated that the summer calvers (June-August) required minimum number of days to attain peak yield while winter calvers (December-February) required maximum days to attain peak yield. Highly significant effect of season of calving on days to attain peak yield has also been reported by Jadhav *et al.* (1992), Yadav *et al.* (1995) and Kumar (1997) in dairy cattle. Biradar (1990) and Chhikara (1993) showed that winter calvers attained peak yield earlier followed by post monsoon, summer and monsoon calvers.

Sikka and Taneja (1981) observed non-significant effect of month of calving on days to attain peak yield in Tharparkar cattle. Neog *et al. (*1993) divided years into two seasons and did not observe appreciable influence of season of calving on days to attain peak yield, however, both these groups of workers further stated that buffaloes calved during least calving season (January - June) took less days to attain peak yield as compared to most calving season. Yadav and Rathi (1992b), Chaudhary and Choudhary (1981) and Gajbhiye and Tripathi (1998) reported non-significant effect of season in buffaloes and also reported non-significant effect of season of calving on weeks to attain peak yield in Hariana cattle.

2.1.5.3 Effect of Parity

Sikka and Taneja (1981) reported that effect of parity was non-significant on days to attain peak yield in Tharparkar cattle. Chowdhary and Chaudhry (1981) and Chhikara (1993), Yadav and Rathi (1992b), Yadav et al. (1995) and Kumar (1997) observed non-significant influence of sequence of lactation on days to attain peak yield. Significant ($P \leq 0.05$) influence of parity on days to attain peak yield was reported by Garcha and Tiwana (1980). Both these groups of workers further observed that buffaloes during sixth parity required less number of days to attain peak yield. Gajbhiye and Tripathi (1988) and Biradar (1990) also found significant effect of parity on days to attain peak yield. All these four groups of workers also pointed out that buffaloes during first parity required maximum number of days to attain peak yield.

2.1.5.4 Effect of Farm

Chhikara (1993) observed non-significant effect of farm on days to attain peak yield in Tharparkar cattle. Whereas Nehra (2004) and Singh (2012) observed significant effect of farm in Rathi cattle

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

Milk yield per day of lactation length may be defined as the quantity of milk production in litres per day by a cow / buffalo in a complete lactation. The dairy animal is always purchased on the basis of average daily milk yield. The milk yield per day of lactation length ranged from 4.17 to 6.54 litres per day in Tharparkar cattle (Narain and Garg (1972) and Vij *et al.*, (1992).

Significant effect of period of calving on milk yield per day of lactation was reported by Vij *et al.* (1992b) and Tikam Chand (2011) in Tharparkar cattle. Contrarily non-significant effect (P≤0.05) of period of calving on milk yield per day of lactation in Rathi and Tharparkar cows was reported by Yadav *et al.,* (1994b)

Milk yield per day of lactation length in Rathi cow was reported to be 5.78 ± 0.11 litres by Joshi (1989). The averages of milk yield per day of lactation length in different breeds of cattle are presented in Table 2.7.

Table2.7. Average estimates in Milk Yield per day of lactation length in different breeds of cattle.

Breed	Parity	MY/LL (litres/day)	References
Rathi	Overall	4.90 ± 0.10	Ohri & Singh (1970)
Rathi	1st	4.40 ± 0.10	Ohri & Singh (1971)
Rathi	2nd	4.90 ± 0.10	Ohri & Singh (1971)
Rathi	3rd	4.80 ± 0.10	Ohri & Singh (1971)
Rathi	4th	5.20 ± 0.20	Ohri & Singh (1971)
Rathi	5th	5.20 ± 0.20	Ohri & Singh (1971)
Rathi	Overall	5.78 ± 0.11	Joshi (1989)
Rathi	1st	5.08± 0.95	Gupta (1993)
Sahiwal	Overall	5.66	Kumar & Narain (1979)
Red Sindhi	-	5.21	Narain & Garg (1972)
Red Sindhi	-	4.75	Narain & Garg (1972)
Red Sindhi	Overall	4.67	Malhotra & Singh (1980)
Tharparkar	1st	5.66 ± 0.19	Vij *et al.* (1992)
Tharparkar	Overall	6.54 ± 0.16	Vij *et al.* (1992)
Tharparkar	Overall	5.42 ± 0.06	Yadav *et al.* (1994b)
Tharparkar	Overall	7.44± 0.08	Tikam Chand (2011)

Tharparkar	Overall	7.45± 0.08	Kishore (2012)

2.1.6.1 Effect of Period of Calving

Vij and Basu (1986) observed that year of calving had significant (P≤0.05) influence on milk yield per day of lactation length while analysing data of 10 years on crossbred cattle. These results were further supported by the findings of Juneja (1987), Hayatnagarkar *et.al* (1990) and Thakur and Singh (2000b) in crossbred and Yadav *et al.* (1992), Murdia and Tripathi (1991), Murdia and Tripathi (1992), Yadav *et al.* (1995) and Kumar (1997) in zebu cattle who also reported significant (P≤0.05) effect of year of calving on milk yield per day of lactation length.

On the contrary, Yadav *et al.* (1994b) in Tharparkar cattle and Neel Kant and Prasad (1997) and Thakur and Singh (2000) in crossbred cattle and Bhatnagar (1986) in Karanswiss observed that period of calving had non-significant effect on milk yield per day of lactation length.

2.1.6.2 Effect of Season of Calving

Sharma *et al.* (1972) reported non-significant effect of month and season of calving in Tharparkar cows on milk yield per day of lactation length. Juneja (1987) observed non-significant effect of season of calving on milk yield per day of lactation length in crossbred cattle. The workers divided the year into two seasons and found higher milk yield per day of lactation length of 7.0 kg /day for most calving season which was not significantly different from least calving season

(6.8kg/day). These results were further supported by the findings of Yadav and Rathi (1992), Yadav et al (1995) and Yadav (1988) in zebu cattle Thakur and Singh (2000a) in crossbred cattle and Singh *et al.* (1989) in buffaloes. Significant effect of season was found by Hayatnagarkar et al. (1990), Yadav et al. (1994) and Katkade et al. (1995) in dairy cattle. .

2.1.6.3 Effect of Parity

Khanna and Sharma (1988) observed that milk yield per day of lactation length increased upto the 3rd lactation, decreased in 4th and thereafter again increased in 5th and 6th lactation in Tharparkar cattle. Nivsarkar *et al.* (1992) studied the effect of parity on milk yield per day of lactation length and the milk yield per day of lactation length increased from first to 5th lactation and declined thereafter reported.by Deshpande *et al.* (1992) and Dalal *et al.* (1993) in Gir and Sahiwal cattle, respectively.

Significant (P≤0.01) effect of sequence of lactation on wet average was observed by Palia and Arora (1963) in Jersey cattle under temperate climate. These results were confirmed by the findings of Murdia and Tripathi (1992), Yadav *et al.* (1992,1994,1995), Katkade *et al.* (1995), Kumar (1997) , Mathur and Chahal (1997), Gahlot (1997) and Nehra (2004).

However, non-significant influence of parity on average daily yield at first, second and third lactation of buffaloes was observed by Singh and Yadav (1987a). The work of Singh and Yadav (1987b) is also in congruence with earlier reports, who also observed non-significant effect of parity on milk yield per day of lactation length of buffaloes and Hariana cattle, respectively.

2.1.6.4 Effect of Farm

Effect of farm was found to be significant by Palia and Arora (1963) in Jersey cattle and Singh *et al*. (1988a) in Sahiwal and its crosses with Jersey. Similar results were also found by Singh and Desai (1961) and Naidu and Desai (1966) in northern and southern zone of the country in zebu cattle.

2.1.7 Persistency

Persistency is the ratio of standard lactation milk yield and peak yield. Various measures of persistency have been defined by Johanson and Hanson (1940), Ludwick and Peterson (1943) and Weller *et al. (*1986). Persistency is the ratio of standard lactation milk yield and peak yield. Bhutia and Pandey (1989) and Singh (1999) also used this method for assessing persistency of milk yield in crossbred cattle. Estimates of persistency (Mean ± SE) of milk yield by different methods are tabulated in Table 2.6. The estimates differed very much from 0.810 ± 0.02 litres (method of Ludwick and Peterson, 1951) to 192.14 ± 6.94 litres (method of Rao and Sundaresan, 1982) due to the different methods of estimation. In the present study, method of Rao and Sundaresan an (1982) was followed.

Table 2.8 Average estimates of persistency of milk yield in dairy cattle in litres.

Breed	No. of observation	Methods of Measure of persistency	Mean+SE	Reference
Hariana	521	Mahadevan (1951)	2.267 ± 0.042	Gill (1969)

Tharparkar	155	Ludwick and Peterson (1943)	0.810 ± 0.020	Gupta and Johar (1982)
Gir	593	Pradhan and Dave(1973)	97.67 ± 0.10	Singh *et al.* (1995)
Jersey x Hariana	186	Rao and Sundaresan (1982)	184.42 ±5.22	Singh *et al.* (1999)
Jersey x Hariana x Friesian	89	Rao and Sundaresan (1982)	192.14± 6.94	Singh *et al.* (1999)

2.1.7.1 Effect of Period of Calving

The effect of period of calving is due to change in environment from year to year. This change occurs due to change in climate,

feeding, management and genetic constitution of the herd over the years. Branton and Miller (1959) and Gill (1969) reported that the differences among periods were found to be significant (P≤0.05) for the persistency of milk yield in Friesian and Hariana cows, respectively. Bhat *et al. (*1982) pointed out that effects due to year of calving were significant on persistency

of milk yield measured by methods of Ludwick and Peterson (1943) and Mahadevan (1951) as ratio of average daily yield till peak yield to the average daily yield in remaining part of lactation. Whereas, the year effect was not significant on persistency of milk yield measured by method of Johanson and Hanson (1940). They felt that significant effect of year on persistency could be due to differences in the levels of management, changes in herd size and changes in the level of production as a result of differences in the climatic factors over the years. Yadav *et al.* (1994), Kumar (1997) and Singh *et al.* (1995) also found significant effect of periods on persistency in dairy cattle and Dhaka *et al.* (1994) in buffaloes.

However Koley *et al.* (1979) worked out non-significant influence of year of calving on persistency of milk yield in Jersy x Hariana crossbred cows. Non-significant effect of period of calving was also observed by Gupta and Johar (1983), Khan and Johar (1985) in crossbred cattle, Gupta and Johar (1982) and Kumar (1997) in Tharparkar cattle.

2.1.7.2 Effect of Season of Calving

The effect of season of calving on persistency of lactation had been studied by Gaines (1927) in Guernsey cattle; Branton and Miller (1959) in Holstein cows .These workers reported that season of calving had significant ($P \leq 0.05$) effect on persistency of milk yield. They further pointed out that persistency was higher in cows calving during winter season than those calving in other seasons. Askar *et al.* (1959) and Singh *et al.* (1965) in Hariana cattle found that persistency was higher in cows calving during summer season than those calving in winter season. Similarly, Rao and Sundaresan (1982) observed that season of calving had significant ($P \leq 0.05$) effect on persistency in Friesian x Sahiwal crossbred cows. They further reported that the monsoon calvers (July-Sept.) started their lactation at a relatively lower level but had the highest

persistency due to the influence of succeeding seasons (post monsoon and winter), which are congenial in climate and fodder availability.

Anakawiang (1963), while studying the records of Sahiwal, Tharparkar and Red Sindhi cattle in India could not find any significant (P≤0.05) effect of season of calving on persistency, but persistency was found to be slightly better in cows calving during winter season than those calving during summer season. Similarly, Gill (1969) also reported non-significant effect of season of calving on persistency in Hariana cattle. These findings were confirmed by the results of Koley *et al. (*1979) in Jersey x Hariana crosbred cows, Gupta and Johar (1982) in Tharparkar cattle, and Rathi cows.

2.1.7.3 Effect of Parity

Variation in persistency values has been studied either in terms of age at calving of the animal or parity. Ludwick and Peterson (1943) in Guernsey, Holstein and Jersey cattle; Mahadevan (1951) in Ayrshire cattle, Corley (1956) in Holestein and Jersey cattle, and Cianci (1963) in Dutch Friesian cattle found that persistency values measured by different methods decreased by about 8 to 10 per cent from the first to the second lactation These findings were confirmed by the results obtained by Anakawiang (1963) in Sahiwal, Tharparkar and Red Sindhi cattle. But these workers reported a decrease of 6 to 12 per cent in persistency values from first to second lactation.

Gill (1969) and Garcha and Tiwana (1980) revealed that parity had a highly significant (P≤0.01) effect on persistency. Bhat *et al.* (1982) investigated the order of lactation and found that it had significant effect on persistency of milk yield. They

further reported that the values of persistency in the first lactation were higher than in the succeeding lactations. Rao and Sundaresan (1982) also reported significant effect of parity on persistency.

Singh and Shukla (1985) investigated the data on 595 normal lactations of 225 cows in first six lactations and found that parity had a highly significant (P≤0.01) effect on persistency on milk production. They also found that the persistency value of first lactation was significantly higher than that of all other lactations, except the second.

Asker *et al.* (1959) reported higher values of persistency in fourth and fifth lactation in Friesian, native and half bred cattle, but the differences in persistency due to lactation number were non-significant. Similarly Anakwiang (1963) observed that lactation number had statistically non-significant effect on persistency in Sahiwal, Tharparkar and Red Sindhi cattle.

Narain *et al.* (1981) analysed the records pertaining to 736 first to fifth lactations of Sahiwal cattle and observed that the effect of lactation order on persistency was statistically not significant. Similarly, Yadav *et al.* (1992a) in Sahiwal cows, Yadav (1988) in Hariana cattle, Yadav *et al.* (1994b) and Kumar (1997) in Tharparkar cattle found that the effect of lactation number on persistency of milk yield was statistically non-significant.

2.1.7.4 Effect of Farm:

Narain *et al.* (1981) in Sahiwal cattle and Kumar (1997) in Tharparkar cattle observed no significant effect of farm on parity.

2.2 Reproduction Traits

2.2.1 Gestation Period

2.2.2 Service Period

2.2.3 Calving Interval

2.2.1 Gestation Period

Gestation period may be defined as the period between date of conception and date of subsequent parturition. Optimum gestation length would be of economic importance in normal parturition and for maintaining short calving interval. The average gestation length was almost uniform for successive calvings and ranged from 287.86 days for the second calving to 289.59 days for 3rd calving. Average gestation period pooled over all the calvings was 287.60 days (Nivsarkar *et al.* (1992). Average of gestation length in different breeds of cattle given by various workers has been presented in Table 2.9.

Table 2.9 Average estimates for gestation period in different breeds of cattle

Breed	Gestation Period (Days)	References
Red Sindhi x Jersey	276.00±16.20	Mishra and Mishra (1987)
Jersey x Hariana	280.20± 6.20	Mishra and Mishra (1987)
Jersey	272.00±0.73	Das *et al. (*1990)
Friesian	266.00±47.70	Juneja *et al. (*1991)
Jersey	263.80±47.30	Juneja *et al. (*1991)
Tharparkar	287.15±0.34	Choudhary and Sinha

		(1951)
Tharparkar	286.63	Sharma *et al.* (1979)
Tharparkar	287.36±1.70	Vij *et al. (*1992)
Tharparkar	287.60	Nivsarkar *et al. (*1992)
Tharparkar	286.71±0.16	Kachwaha (1993)
Tharparkar	286.97±0.10	Kumar *et al. (*1999)
Friesian X Brown Swiss X Ongole	279.65±1.30	Sharma *et al.* (1988)
Jersey X Friesian X Ongole	276.15±2.50	Sharma *et al.* (1988)

2.2.1.1 Effect of Period of Calving

Gaur and Raheja (1996) in dairy cattle and Dutt *et al. (*1991) in buffaloes found significant effect of period of calving on gestation period. However, gestation period was not significantly influenced by year of calving as reported by Sharma *et al. (*1979) and Das *et al. (*1990) in dairy cattle.

2.2.1.2 Effect of Season of Calving

Chaudhary and Sinha (1951) and Das *et al.* (1990) reported significant effect of season of calving on gestation length of dairy cattle Similar findings were also reported by Chhabra and Goswami (1980) and Kumar (1997). However Katiyar *et al.*

(1997) in Sahiwal and Kumar (1999) in Tharparkar cattle found non-significant effect of season of calving on gestation period.

2.2.1.3 Effect of Parity

Chabra and Goswami (1980), Vij *et al.* (1992) and Katiyar *et al. (*1997) in Sahiwal cattle found non-significant effect of parity on gestation period. However Das *et al.* (1990) and Kumar (1997) reported significant influence of lactation order on gestation period.

2.2.1.4 Effect of Farm

Significant effect of farm on gestation period was observed by Gaur and Raheja (1996) in dairy cattle .Sharma *et al. (*1979), Das *et al.* (1990) and Nehra (2004) in dairy cattle observed non-significant effect of farm on gestation period.

2.2.2 Service Period

Service period may be defined as the period between the date of calving and date of subsequent conception .It is not only a physiological function but is also greatly dependent upon some managerial practices such as heat detection, artificial insemination on right time and weaning.

In other words it is the interval between date of calving and fertile service that causes variation in service period and calving interval and thereby influences breeding efficiency of a dairy cow. The average service period as reported by different workers is summarized and presented in Table 2.10

First service period ranged between 90.6 and 186.7 days in Tharparkar cattle Basu and Reddy, (1979) whereas Sharma *et al.* (1979) reported a declining trend of service period from 166.35 days in first lactation to 111.02 days in the fifth lactation and thereafter it increased gradually while overall pooled average was 127.52 days.

2.2.2.1 Effect of Period of Calving

Reproductive performance of Tharparkar crosses was evaluated by Nagarcenkar and Rao (1982) who reported significant effect of period of calving on service period. Sandhu *et al.* (1973a), Das *et al.* (1990) and Chopra (1998) in crossbred cattle, Gaur and Raheja (1996), Mane *et al. (*1998), Nehra (2004) and Tikam Chand (2011) in zebu cattle reported that service period was significantly influenced by period of calving.

However, Basu *et al.* (1979), Sharma *et al. (*1979) and Dahiya (2002) in zebu cattle, and Singh *et al.* (1999) and Mishra *et al.* (1980) in crossbred cattle reported non-significant effect of period of calving on service period.

Table 2.10 Average estimates of service period in days for different breeds of cattle.

Breed	N	Mean±S.E.	References
Rathi	280	207.80±6.50	Ohri and Singh(1970)
Rathi	281	224.60±7.55	Nehra (2004)
Sahiwal	272	188.00±4.70	Chopra *et al. (1973)*
Sahiwal	334	156.2±8.7	Sharma and Bhatnagar (1975)
Sahiwal	401	222.72±0.05	Singh *et al.* (1999)
Tharparkar	644	132.91±1.80	Kachwaha (1993)
Tharparkar	772	132.29±9.37	Gahlot *et al. (2002)*
Tharparkar	908	152.04±4.58	Tikam Chand (2011)
Tharparkar	-	182.75	Kumar(1982a)
Tharparkar	-	203.60±19.5	Tomar (1988)
Hariana	410	270±7.7	Pundir and Raheja (1994)
Hariana	588	192±3.77	Dalal(1997)
Hariana	617	192.90±9.72	Dahiya (2002)
Hariana	512	197.25±12.22	Dhaka *et al. (2002)*
Red Sindhi	334	156.2±8.7	Sharma and Bhatnagar (1975)
Red Sindhi	219	153.8	D'Souza *et al.(1979)*
Red Sindhi	309	178.5±11.51	Beniwal (1993)

2.2.2.2 Effect of Season of Calving

Significant effect of season of calving on service period was observed by Nagarcenkar and Rao (1982), Murdia and Tripathi (1993). Jadhav *et al. (*1992) and Mishra *et al. (*1987) in crossbred cows, and Beniwal (1993) in Red Sindhi and its crosses, Kachwaha (1993) in Tharparkar, Nehra (2004) in Rathi cattle. On the other hand, Rao and Patro (1984), Yadav and Sharma (1985). Nivsarkar *et al.* (1988), Singh *et al.* (1996), Vij *et al.* (1992) and Tikam Chand (2011) in Tharparkar, and Singh (1998) in Hariana cattle reported non-significant effect of season of calving on service period in different breeds of dairy cattle.

2.2.2.3 Effect of Parity

Nivsarkar *et al. (*1992) in Tharparkar cattle reported a gradual declining trend in service period from 168.3 days in first to 134.10 days in 6^{th} parity and thereafter it increased. However, Basu and Gupta (1974), Basu *et al.* (1979) and Reddy and Basu (1986), Chhikara (1993) and Chopra (1998) reported non-significant effect of parity on this trait in Indian dairy cattle breeds. Similar report observed by Dhaka (1993) in Murrah buffalo of the effect of parity. Opposite to these findings, Das *et al.* (1990), Katiyar *et al.* (1993), Parmar *et al.* (1997) and Mane *et al.* (1998) reported significant effect of parity on service period in different breeds of cattle.

Service period in Red Sindhi cattle was reported in the range of 150-170 days by most of workers (Sharma and Bhatnagar 1975, D'Souza *et al. 1979 and* Beniwal 1993). The range of service period in Tharparkar cattle has been observed to be from 172-252 days by different workers. In Hariana cattle most of workers Dalal (1997), Dahiya (2002) reported the service period to be around 190-200 days.

2.2.2.4 Effect of Farm

Nehra (2004) in Rathi cows and Tikam Chand (2011) in Tharparkar cattle reported significant effect of period of calving on service period. Contrarily, Basu *et al.* (1979) in Red Sindhi, Sahiwal and Tharparkar and Dahiya (2002) in Hariana cows observed non-significant effect of period of calving on service period.

2.2.3 Calving Interval

The calving interval is the period between two consecutive calving that is comprised of service period and gestation length or lactation length and dry period. Short calving interval along with early age at first calving is required to get more number of calves in the lifetime and higher lifetime milk production. It also minimizes cost of replacement in the herd. The average calving interval in Rathi cattle has been reported to be 505.6 days (Nehra, 2004). Kaushik, (2000) reported calving interval as 486.72 days in Hariana cattle. The calving interval repoted by various workers for Tharparkar cattle ranged from 407.55 ± 3.10 days (Parsad and Parsad, 1972), 455.60 ± 8.50 days (Rahumathulla *et al.,* 1994) to 528.02 ± 13.74 days (Panneerselvon *et al.*, 1990). In Chilean Holstein cattle, Calving interval was reported to range from 398 ± 1.37 to 416 ± 1.07

days (Melendez and Pinedo, (2007). The average calving interval reported in literature for various breeds is summarized in Table 2.11

Table 2.11 Average estimates of calving interval in days for different breeds of cattle.

Breed	**N**	**Mean± S. E.**	**References**
Rathi	280	485.60 ± 6.60	Ohri and Singh (1970)
Rathi	277	524.60 ± 8.50	Gahlot (1972)
Rathi	39	513.80 ± 31.50	Chourasia *et al.* (1983)
Rathi	281	505.60 ± 7.56	Nehra (2004)
Sahiwal	-	393.20	Basu *et al.* (1979)
Sahiwal	-	475.43	Gandhi and Gurnani (1988)
Sahiwal	441	513.81 ± 5.95	Singh *et al.* (1999)
Red Sindhi	-	350.22	Basu *et al.* (1979)
Red Sindhi	219	436.10	D'Souza *et al.* (1979)
Red Sindhi	123	447.00	Malhotra and Singh (1980)
Red Sindhi	-	496.91 ± 10.14	Patro and Rao (1983a)
Red Sindhi	317	470.50 ± 10.90	Beniwal (1993)

Tharparkar	-	407.55± 3.10	Parsad and Parsad (1972)
Tharparkar	-	444.91±5.11	Majumdar and Parsad (1974)
Tharparkar	-	456	Chhikara (1974)
Tharparkar	-	470.01	Kumar (1982b)
Tharparkar	644	416.34 ± 1.81	Kachwaha (1993)
Tharparkar	-	437.69 ± 4.29	Tikam Chand (2011)
Tharparkar	1385	414.16± 5.31	Kishore (2012)
Hariana	617	483.80 ± 9.33	Dahiya (2002)
Jersey	-	389.9	Hare *et al.* (2006)
Brownswiss	-	406.7	Hare *et al.* (2006)

2.2.3.1 Effect of Period of Calving

The significant effect of period of calving on calving interval was reported by Nehra (2004) in Rathi cattle , Kachwaha (1993), Singh *et al.* (1996), Kumar (1982b) and Tikam Chand (2011) in Tharparkar cattle, Govindiah *et al.* (1984) in Red Sindhi and Sahiwal crosses, and Dhaka *et al.* (1999) in Hariana cattle. However Gahlot (1972) in crossbred cattle and Nehra (2004) in Rathi cattle and Kumar (1982a) in Tharparkar cattle reported non-significant effect of period of calving on calving interval.

2.2.3.2 Effect of Season of Calving

Hingane (1980) in Hariana and Rahumathulla *et al.,* (1994) in Tharparkar cattle reported that calving interval was significantly influenced by season of calving. Conterary to these reports, Nehra (2004) in Rathi cattle and Singh *et al.* (1996) and Tikam Chand (2011) in Tharparkar cattle reported non-significant effect of season on calving interval.

2.2.3.3 Effect of Parity

Significant effect of order of lactation on calving interval was reported by Yadav *et al.* (1994), Yadav *et al.* (1995), and Parmar *et al.* (1997) in different breeds of cattle. Earlier Gupta and Johar (1982) found shortest calving interval during eighth parity and largest during sixth parity in Tharparkar cows. Chourasia *et al.* (1983) reported significant influence of parity on calving interval in Rathi Cattle whereas similar effects were observed by Vij *et al*. (1992b), Kachwaha (1993), Gahlot *et al.* (2002) in Tharparkar cattle.

How ever Ram *et al.* (1979), Basu *et al.* (1982b), Nagarcenkar and Rao (1982), Vij *et al.* (1991) and Nehra (2004) in zebu breeds reported non-significant effect of parity on calving interval.

2.2.3.4 Effect of Farm

Significant effect of farm was shown by Gaur and Raheja (1996) in Sahiwal cattle. However, Sharma *et al.* (1979), Das *et al.* (1990) and Nehra (2004) in Rathi cattle estimated non-significant effect of farm on calving interval.

2.3 Phenotypic Correlations

Phenotypic correlation is the association between two traits that can be directly observed. The phenotypic correlations among different economic traits is important in designing selection programmes and is useful in prediction of correlated response in other traits, if selection for one of these is practiced.

Phenotypic correlations as observed by various workers are presented in table no. 2.12

The broad trends that can be accessed from the consolidated review are:

The survey of results published in literature on phenotypic correlations between different production and reproduction traits revealed no consistent trend (Table 2.12) and mostly in positive direction. Lactation yield had medium and positive correlation with service period and calving interval, negative and low to medium with dry period, high and positive with lactation length and other production traits.

Medium to high phenotypic correlations are observed among service period, calving interval and lactation length.

Phenotypic correlations between dry period and lactation length were low to medium and usually in negative direction.

In general, the positive and high association among different production traits (except dry period) indicates the possibility of simultaneous improvement of the traits through selection.

Table 2.11 Phenotypic Correlation among different traits in different breeds of cattle

References	Phenotypic	Breed

Calving interval with lactation length		
Kaushik (2000)	0.44 ± 0.04	Hariana
Dalal (1997)	0.50 ± 0.03	Hariana
Nehra (2004)	0.39±0.055	Rathi
Beniwal (1993)	0.78 ± 0.018	Red Sindhi
Singh *et al.* (1999)	0.40 ± 0.043	Sahiwal
Dry period with lactation length		
Kaushik (2000)	-0.001 ± 0.05	Hariana
Dahiya (2002)	-0.07 ± 0.04	Hariana
Arora & Sharma (1981)	-0.30 ± 0.06	Hariana
Dalal (1997)	-0.10 ± 0.04	Hariana
Gahlot (1972)	0.06	Rathi
Nehra (2004)	-0.09±0.059	Rathi
Beniwal (1993)	-0.10 ± 0.030	Red Sindhi
Singh *et al.* (1999)	-0.17 ± 0.047	Sahiwal
Lactation length with yield/day of lactation length		
Joshi (1989)	0.02 ± 0.002	Rathi
Nehra (2004)	0.14±0.059	Rathi
Beniwal (1993)	-0.39 ± 0.025	Red Sindhi
Beniwal (1993)	-0.23 ± 0.029	Red Sindhi

Lactation yield with calving interval		
Arora & Sharma (1981)	0.31 ± 0.06	Hariana
Yadav (1988)	0.02 ± 0.04	Hariana
Dahiya (2002)	0.29 ± 0.40	Hariana
Gahlot (1972)	0.58	Rathi
Nehra (2004)	0.29±0.057	Rathi
D'Souza *et al.* (1979)	0.73	Red Sindhi
Beniwal (1993)	0.38 ± 0.028	Red Sindhi
Singh *et al.* (1999)	0.25 ± 0.046	Sahiwal
Gurnani *et al.* (1976)	-	Sahiwal
Lactation yield with dry period		
Arora & Sharma (1981)	0.04 ± 0.06	Hariana
Dalal (1997)	-0.10 ± 0.04	Hariana
Kaushik (2000	-0.13 ± 0.04	Hariana
Dahiya (2002)	-0.13 ± 0.04	Hariana
Hingane (1980)	0.80 ± 0.01	Hariana (GLF)
Hingane (1980)	0.90 ± 0.01	Hariana (PTF)
Ohri and Singh (1971)	0.01	Rathi
Ohri and Singh (1971)	0.74	Rathi
Joshi (1989)	0.70 ± 0.001	Rathi & crosses

Beniwal (1993)	-0.28 ± 0.029	Red Sindhi
D'Souza *et al.* (1993)	0.67	Red Sindhi
Service period with dry period		
Kaushik (2000)	0.82 ± 0.02	Hariana
Dahiya (2002)	0.81 ± 0.24	Hariana
Arora & Sharma (1981)	0.70 ± 0.04	Hariana
Dalal (1997)	0.78 ± 0.02	Hariana
Nehra (2004)	0.51±0.042	Rathi
Beniwal (1993)	0.47 ± 0.026	Red Sindhi
Beniwal (1993)	0.52 ± 0.025	Red Sindhi
Singh *et al.* (1999)	0.33 ± 0.047	Sahiwal
Service period with lactation length		
Kaushik (2000)	0.43 ± 0.04	Hariana
Arora & Sharma (1981)	0.49 ± 0.05	Hariana
Pundir (1991)	0.59	Hariana
Nehra (2004)	0.38±0.055	Rathi
Beniwal (1993)	0.07 ± 0.020	Red Sindhi
Singh *et al.* (1999)	0.41 ± 0.045	Sahiwal

2.4 Environmental and Managemental Factors affecting Production and Reproduction Traits.

Various non-genetic and genetic factors influence milk yield, peak yield lactation efficiency and other economic traits to a considerable extent. The non - genetic factors may be either of physical nature viz. climatic conditions, periodical and seasonal variations, physiological nature like age, body weight, parity of cow and health etc. or managemental factors viz. feeding, breeding, housing, disease control etc. These factors influences the performance both directly as well as indirectly.

Rehman and Khan (2011) studied on the environmental factors affecting performance traits of Sahiwal cattle in Pakistan. Data on 23925 lactations of 5897 Sahiwal cows in five government herds of Punjab (Pakistan) viz. Livestock Experiment Station (LES) Allahabad, LES Bahadurnagar, LES Fazalpur, LES Jahangirbad and LES Khizerabad (1964-2004) were collected to document the behavior of various productive and reproductive traits of Sahiwal cows with respect to herd, year and season of calving and parity. A linear model was used to determine the effects of various environmental factors on performance traits. (300-days milk yield, total milk yield, lactation length, dry period, calving interval and service period). All the productive and reproductive traits were affected ($P \leq 0.01$) by herd, year, season of calving and parity. Lactation length was important covariable for yield traits while yield was important for dry period, service period and calving interval. Maximum yield was recorded for 5^{th} parity cows. Calving interval differed by two months among herds. Cows calving in most frequent calving season (winter) produced more milk than summer calvers (1608.6 ± 12.91 kg vs 1474.1 ± 13.63 kg).

M'hamdi *et al.* (2007) studied the effects of environmental factors on milk yield, lactation length and dry period in Tunisian Holstein cows and reported management, nutrition, lactation turn or the age, year and season in which lactation started are the leading environmental factors affecting lactation performance in cattle. Beside these factors, the persistency level of the highest milk production period reached during lactation is a significant factor. Also, lactation performance in dairy cattle depends upon genetic and environmental factors. Genetic background, climate, diseases, feeding, year and season of

calving have been reported to affect milk production, lactation length and dry period. Breed, age, stage of lactation, parity and milking frequency also influenced performance of production. The persistency level of lactation milk production can be defined as the ability of keeping a high daily milk flow during lactation, in the milk productivity of lactation's first period's persistency level on the rest of the lactation as a measure of lactation curve diagram, the highest period productivity of the continuation level during lactation, continuation level of the highest productivity and after reaching the highest productivity the rate of decreasing seen on milk production in time. Milk yield is the most important single determinant of profit for the dairy cow. Moreover, effects of lactation number, age, and season and year of calving on milk yield and lactation length are well known. In addition, in breeding of dairy cows, the most important aims are to obtain a calf in a year and high milk yield from cows. To obtain a calf in a year from cows depends on some parameters of ideal limits (60 days dry period, 300 days lactation duration etc.).

Rehman *et al.* (2008) studied on factors affecting first lactation performance of Sahiwal cattle in Pakistan .To study the environmental and genetic factors affecting productive and reproductive traits, data on 5,897 cows from five main recorded herds (1964-2004) of Sahiwal cattle in Pakistan were used. A general linear model was applied on the data. The 305-days milk yield, total milk yield, lactation length, age at first calving, dry period, calving interval and service period averaged 1393 ± 12 kg, 1429 ± 11 kg, 235 ± 2, 1390 ± 4.244 ± 3.464 ± 3 and 178 ± 3 days, respectively. The 305-days and total milk yields were affected by herd, year, season of calving, all other first lactation traits were affected by herd, year, season of calving and lactation length and service period decreased and age at first calving increased by 2, 1 and 6 days per year, respectively. Herd differences for most of the traits were significant. Improved feeding and management may

improve performance traits of Sahiwal cattle. Accurate recording of pedigrees and performance traits would help improve genetic parameters. Variation among animals suggested that improvement in milk yield is possible in Sahiwal cattle.

2.4.1 Breeding Practices

Rao and Rao (1996), Ghosh and Chand (2000) observed the adoption of breeding practices and revealed that maximum of farmers did not adopt A.I. due to wrong notions in field conditions.

Kumar *et al.* (2001) found that the traditional owners of Sahiwal cows in Punjab followed 100 per cent natural service and 67.14 per cent bred their cows more than 180 days after calving and none of the respondents practiced pregnancy diagnosis and treatment of repeaters.

2.4.2. Feeding Practices

Kakoty (1975), Mikkilineni (1976), Singh and Dubey (1978), reported that adoption of balance feeding and cultivation of improved varieties of fodder was poor and most of farmers were low adopters of improved feeding management practices. Kurien (1984) concluded in his study that good quality fodder, regular feeding of green fodder is important for efficient production and reproduction of dairy animals. Mudgal *et al.* (2003) concluded that farmers did not feed balance ration to their animals and fed wheat straw with oil cakes as a concentrate without green fodder. They also reported that farmers were not using mineral mixture in the ration of animals in Madhya Pradesh.

Nishi *et al.* (2003) revealed that adoption index of feeding practices was 80.17 and 68.48 for beneficiaries and non-beneficiaries of intensive mini dairy project, respectively.

Malik *et al.* (2005) reported that milk production was the basis for feeding animals. Grazing of animals was practiced by most of the respondents. Feeding of salt to animals was very common. Whereas feeding of mineral mixture to animals was very rare.

Kumar *et al.* (2006) concluded that concentrate was offered to the lactating animals only during milking time, all the respondents grazed their cows and none of the respondents fed mineral mixture. They further noted that majority of the respondents 57.14 per cent fed 1-2 kg concentrate to the lactating animals and special feeding during advance stage of pregnancy was not followed

2.4.3 Housing Practices

Sandhu (1987), Bhatia *et al.* (1988), Malik and Nagpaul (1998) and Kumar (1999) reported in their studies that farmers in study area kept their cattle and buffaloes in separate located sheds, inside and near their dwellings.

2.4.4 Milking Practices

Dubey and Kumar (1981), Hazarika and Anand (1984), Varma (1989) and Dhiman *et al.* (1990) reported in their studies that farmers washed udder and teats before milking and 24 per cent practiced full hand method of milking in buffalo.

Singh and Singh (1999) reported that knuckling was the method of choice of milking without disinfecting the teats and udder. They further noted that calves were allowed to suckle before and after milking.

Kumar *et al.* (2006) reported that 75.71 per cent of the respondents milked their cows at separate and dry place and all the respondents allowed the calf for suckling before and after milking. They further noted that 84.28 and 95.71 per cent of the respondents cleaned the udder and teats and washed the hand before milking, respectively. Forty and sixty per cent respondents followed full hand and knuckling method of milking and for cleaning of milking pail 77.14 and 22.86 per cent use plain water and ash water, respectively (Without adding any antiseptic).

2.4.5 Health Care Practices

Dhiman (1988) investigated dairy cattle and buffalo management practices in the adopted and non-adopted villages of Hisar district (Haryana). He concluded that disease management practices like vaccination against hemorrhagic septicemia, rinder pest, deworming, control of ectoparasites, proper disposal of carcasses and control of flies and mosquitoes were followed by 72.00 per cent respondents in adopted villages and only 28.00 per cent in non-adopted villages.

Malik and Nagpaul (1998) observed that 83.33, 43.33 and 33.33 per cent of the respondents vaccinated their animals against HS, FMD and RP, respectively. They further reported that 88.88 per cent respondents followed isolation of sick animals from healthy animals, 80.00 per cent properly disposed off dead animals and 45.55 per cent followed deworming of

buffaloes, to control lice/ticks 65.00 and 35.00 per cent of the respondents applied insecticides and manual picking, respectively.

Sankhala *et al.* (2000) revealed that 68.65, 16.81 and 14.34 per cent of the respondents fall under low, medium and high level of adoption in health care practices, respectively.

Mathur (2001) revealed that 7.78, 7.04 and 6.30 per cent of the cattle keepers vaccinated their cattle against FMD, HS and BQ diseases. He further reported that majority of the respondents (61.11per cent) left the dead body of animal outside the village. 49.63 per cent of the respondents used gamaxine and ash of tobacco and only 1.85 per cent take veterinary aid to control external parasites.

Rathore *et al.* (2010) observed that sick animal treatment, 82.00 per cent cattle keepers preferred first quacks then veterinary doctor/stock man. Only 14.25 per cent of the respondent followed vaccination and deworming practices. Majority (65.50 per cent) of the cattle keepers isolated their sick animals from healthy animals. Water trough and manger was cleaned at weekly interval by 78.00 per cent respondents, while animal shed was cleaned daily by 91.50 per cent cattle keepers.

Sabapara *et al.* (2010a) surveyed that adoption of overall scientific breeding practices and vaccination programme were good but practices like measures to control ecto-parasites and endo-parasites, naval cord disinfection, availability of services of a qualified veterinarian were poor and needs to improve a lot.

3. MATERIALS AND METHODS

3.1 Experimental Material / Source of data

3.1.1 Location of the Herds

The performance records of Rathi cattle maintained at Livestock Research Station, Department of Animal Breeding and Genetics, College of Veterinary and Animal Science, Bikaner and Livestock Research Station, Nohar, District Hanumangarh were used for present investigation. The unit is located in arid region of North-Western Rajasthan under the administrative control of RAJUVAS, Bikaner. It is geographically located between 28^{o} 3'N latitude and 75^{o} 5'E longitude at 234.84 meters above the sea level and 300 meters away from the Ganganager-Jaipur Highway in Veterinary College campus of Bikaner city. The LRS,NOHAR is located in arid region of North-Western Rajasthan under the administrative control of Director Research, Rajasthan University of Veterinary and Animal Sciences, Bikaner.The farm is located at 29°15.6'N latitude and 74°45.7'E longitude in hot arid region where temperature ranges between 0ºC (degree Celsius) in winter and up to 49 ºC (degree Celsius) in summer.

3.1.2 History and Breeding Policy of Herd

Livestock Research Station, Bikaner was established in 1959 with the foundation stock of 121 Rathi cattle, which was further strengthened with the addition of more Rathi cattle in the subsequent years till 1986 from the nomadic cattle breeders of Rathi tract. Initially, the main objectives were the performance evaluation, breed characterization and improvement of

Rathi cattle, therefore, the selective breeding within natives was undertaken by acquiring the high producing Rathi cattle from nomadic breeders. In 1968 cross breeding along with selective breeding in Rathi cattle was also started with exotic inheritance of Red- Den bulls. Then from 1978 onward, pure breeding of Rathi cattle and their cross breeding with Red Dane bulls is carried on simultaneously till today.

Livestock Research Station, Nohar was established as cattle breeding farm by the Department of Animal Husbandry, Government of Rajasthan. Later in year 1983, it was transferred to Rajasthan Agricultural University, Bikaner with 121 Rathi cows to improve the well known prized Rathi milch breed of cattle on scientific lines. Now it is under Rajasthan University of Veterinary and Animal sciences, Bikaner, since 13.05.2010. Efforts have been made to improve the Rathi cattle germplasm of area by distribution of quality germplasm. To achieve the higher production of superior germplasm, selective breeding has been initiated in close herd. At the farm, mating was practiced at random and the care was taken to avoid breeding between close relatives.

3.1.3 Feeding

At both the farm, the animals were stall fed except for short period in rainy season during which the animals were sent for grazing. The standard feeding schedule based on age, production level, stage of pregnancy and other physiological conditions were followed. Roughage fed to all animals was chaffed. Common dry grasses are available at farm like Sewan, Anjan grass, Bhurat, Karad and chaffed wheat straw. Seasonal green fodder in the form of Jowar, Bajra, Berseem, Rijka, Jai, etc. was fed to animals due to availability of water of Indira Gandhi Canal (Rajasthan canal) in this tract.

The concentrate ration containing 15% DCP and 70% TDN was fed to milking animals at the rate of 0.5 kg per litre of milk produced over the above maintenance ration.

3.1.4 Housing and Management

All the animals at the farms were maintained under uniform managemental conditions. Animals were housed in free barn housing system with adequate sheds for shelter against sun, rain and extreme winter. For efficient management and care, animals were reared separately in different barns according to their age group. Young calves were kept in pucca calf pans till weaning. The breeding bulls were kept in individual bull pans and were regularly put on exercise at the farm.

Cows were milked twice a day and weaning was not practiced. The calves were allowed to suckle their dams. Each calf received approximately 450 liters of milk during standard lactation length of 300 days.

3.1.5 Health Care

Proper veterinary care was provided round the clock at the farms. All the animals were protected against contagious diseases through regular vaccination for Foot and Mouth Disease, Haemorrhagic Septicemia, Black Quarter, etc. Routine program of deworming and treatment of sick animals was followed. Sick animals were isolated for specialized care and prevention of communicable diseases.

3.1.6 Traits under study

The traits with its abbreviations included in the present study are mentioned as under:

S.N.	TRAIT	UNIT	ACRONYM USED
1	Standard Lactation Milk Yield	Litres	SLMY
2	Peak Yield	Litres	PY
3	Lactation Length	Days	LL
4	Dry Period	Days	DP
5	Days to attain Peak Yield	Days	DAPY
6	Milk Yield per Lactation Length	Litres	MY/LL
7	Persistency Index	-	PI
8	Gestation Period	Days	GP

9	Calving Interval	Days	CI
10	Service Period	Days	SP

3.1.7 Classification of Data

The data were classified according to farm, season, period and parity as follows:

Farm		Season			Period				Parity				
1	2	1	2	3	1	2	3	4	1	2	3	4	≥ 5
524	892	456	315	645	288	498	358	272	323	272	247	188	386

The total lactations were 1416 in the present study..To study the effect of farm on production and reproduction traits, the farm effect was divided into two farms *viz* farm 1 (FM1) at Bikaner and farm 2 (FM2) at Nohar.

To study the effect of season of birth on production and reproduction traits, each year was divided into three seasons according to the climatic conditions like average temperature and humidity per month over the years, considering the month wise averages of minimum and maximum temperature and humidity over the years the seasons were classified as follows summer S_1 (March to June), monsoon S_2 (July to October) and winter S_3 (November to February).

To evaluate the effect of period of calving on various production and reproduction traits, the whole data were grouped into four periods according to date of calving as P_1 (1977 - 1985), P_2 (1986 - 1994), P_3 (1995 - 2003) and P_4 (2004 - 2011).

To study the effect of parity on production and reproduction traits, parity was classified into five groups *viz.* Parity 1, Parity 2, Parity 3, Parity 4 and Parity 5 and above.

3.2 Statistical Analysis

a) Effect of non-genetic factors: - The following Least squars and maximum likelihood models as given by Harvey (1987) were used to explain the effect of non-genetic factors:

$$Y_{ijklm} = \mu + F_i + P_j + S_k + L_l + e_{ijklm}$$

Where,

Y_{ijklm} is the m^{th} observation in the l^{th} parity belonging to k^{th} season of j^{th} period and i^{th} farm effect

μ is the overall mean

F_i is the effect of i^{th} farm (level 2)

P_i is the fixed effect of i^{th} period (level 4)

S_k is the fixed effect of k^{th} season of birth (level 3)

L_l is the effect of l^{th} parity (level 5)

e_{ijk} is the residual random error under the standard assumption that makes the analysis valid, i.e., NID $(0,\sigma^2_e)$.

b) Phenotypic correlations

Phenotypic correlations between traits x and y were calculated by the formula mentioned as under –

$$r_{p\,(XY)} = \frac{Cov\,(XY)}{\sqrt{[\sigma^2_{(X)} * \sigma^2_{(Y)}]}}$$

Where,

σ^2_x and σ^2_y are the variance components for trait X and trait Y, respectively and Cov (XY) is the covariance among the two traits.

4. RESULTS AND DISCUSSION

The results of the present study are presented object-wise and discussed simultaneously under the following sub-headings:

4.1 Production Traits

4.2 Reproduction Traits

4.3 Relationship among the Production and Reproduction Traits

4.4 Managemental Practices

4.1 Production Traits:

4.1.1 Standard Lactation Milk Yield (SLMY)

The least-squares means with standard error for different farm, period of calving, season of calving and parity with overall means are given in Table 4.1. The overall yield was observed to be 1726.08 ± 112.621 litres. The estimated value of pooled lactation yield of Rathi cattle in literature ranged from 1062.7 (Chourasia *et al.,* 1983) to 1770.8 ± 57.30 (Joshi, 1989) litres. Lower estimates for SMLY (overall) was reported by Gahlot *et al.* (1991) as 1535.5 ± 18.2 litres and higher estimate for

the same trait was reported by Singh (2012) as 1660.63 ± 33.984 liters in Rathi cows. Trend of SLMY showed that the performance of both the herds at Bikaner and Nohar improved over the years.

4.1.1.1 Effect of Period

The effect of period of calving on lactation yield was found to be highly significant (P≤0.01). Fourth period is having highest SLMY (1851.97 ± 26.728 litres). It shows that both the farms improved in the fourth period with respect to standard lactation milk yield. Whereas theose born in second period were estimated lowest. It seems that selection and culling of cows was very effective in fourth period. Managemental practices were also very good in fourth period. The farm records shows that ample green fodder was available in most part of the year in the fourth period. Significant effect of period of calving on lactation yield was also reported by Gahlot (1972) in Rathi and its crosses.

However Nehra (2004) and Kumar (2012) in Rathi cattle, Singh *et al.* (1973) in Sahiwal cattle and Tikam Chand (2011) in Tharparkar cattle found non-significant effect of period of calving on standard lactation milk yield.

4.1.1.2 Effect of Season

The influence of season of calving on lactation yield was observed to be non-significant indicating poor contribution of season of calving to the total variability of lactation yield. Winter season calvers had the highest lactation yield, whereas those born in other seasons had the lower lactation yield, but differences are statistically non-significant. These results are in agreement with those reported by Beniwal (1993) in Red Sindhi cows and its crosses, Nehra (2004), Kumar (2012) in Rathi

and Tikam Chand (2011) in Tharparkar. Contrary to these findings Gahlot (1986) in Rathi cattle observed significant seasonal variation in lactation yield.

4.1.1.3 Effect of Parity:

In this investigation the results revealed that the standard lactation milk yield was highly significantly (P≤0.01) influenced by parity. These estimates of parity-wise standard lactation milk yield indicates that as the parity increases cows were giving more milk. It may be due selection and culling practices on the farms resulting in high producers were retained on the farms. Third parity cows were higher producer than fourth, fifth, second and first parity. Similar results were found by Vij *et al.* (1992b), Yadav *et al.* (1994a) and Tikam Chand (2011) in Tharparkar cattle. Whereas, non-significant effect was reported by Bhatnagar *et al.* (1982a) Parmar and Johar (1982a) in Tharparkar cattle. Significant effect is indicating better contribution of parity to the total variability of lactation yield.

4.1.1.4 Effect of Farm:

In this study effect of farm on milk yield was found to be non-significant. The higher milk yield was recorded at Bikaner farm as 1739.69 ± 19.202 litres while lower yield at Nohar farm as 1712.48 ± 16.087 litres. Nehra (2004) also reported non-significant effect of farm on SLMY. Similar trends were reported by Ram and Singh (1975) in Tharparkar cattle.

4.1.2 Peak Yield (PY):

Peak yield is an important economic trait which determines the lactation yield, can be used as early measure for selecting the stock as considerable time elapses before the records of complete lactation become available. The least-squares means with standard error for different farm, period of calving, season of calving and parity with overall means are given in Table 4.1. The overall least-squares mean of peak yield was estimated as 9.47 ± 0.066 litres which is in close agreement to the value reported by Joshi (1989) in Rathi cattle.

4.1.2.1 Effect of Period

The effect of period of calving was found to be statistically highly significant (P≤0.01). Peak milk yield was higher during the fourth period, indicating good managemental practices followed by second, third and first period. Hingane (1980) in Hariana cattle, Vij *et al.* (1992) and Tikam Chand (2011) in Tharparkar cattle observed significant effect of period of calving on peak yield. However, Nehra (2004) and Kumar (2012) in Rathi and Joshi (1989) also observed non-significant effect of period of calving on peak yield in Rathi cattle and its crosses.

4.1.2.2 Effect of Season

Season of calving showed non-significant effect on peak yield in the present study. The maximum peak milk yield was found to be 9.14 ± 0.093 litres in third (winter) season and minimum was 8.83 ± 0.127 litres in second (rainy) season. It can be inferred that peak yield was not influenced by seasonal variations.

Nehra (2004) and Kumar (2012) in Rathi cattle, Joshi (1989) in Rathi cattle and its crosses and Sharma *et al.* (1972) in Tharparkar cattle also reported that peak yield was not influenced significantly by season of calving. Rao and Dommerholt (1981), Vij *et al.* (1992b) and Tikam Chand (2011) in Tharparkar cattle and Hingane (1980) in Hariana cattle observed significant effect of season of calving on peak milk yield.

4.1.2.3 Effect of Parity:

The peak yield generally increased from first to third parity and remains more or less same in 4^{th} and 5^{th} parity Effect of parity was observed to be non-significant, whereas third parity got peak yield as 9.25 ± 0.143 litres, which was highest and lowest in first parity was 8.80± 0.128 litres, Non-significant effect of parity on peak yield was reported by Yadav *et al.* (1992) in Sahiwal cattle. Contrarily, significant effect of parity on peak yield was reported by Gill (1969), Chauhan *et al.* (1976b) Vij *et al.* (1992), Yadav *et al.* (1995) and Kumar (1997) in zebu breeds and Ram (1974) and Parmar *et al.* (1997) in crossbreds.

4.1.2.4 Effect of Farm:

Effect of farm was observed to be non-significant indicating similar managemental practices in both farms. Hingane (1980) in Hariana and Vij *et al.* (1992) showed same trends. Singh (2012) observed peak yield significantly higher in Rathi cattle at Bikaner farm than Nohar farm. Whereas, Naidu and Desai (1966) reported significant effect of farm in northern and southern zones of the country.

4.1.3 Lactation length:

The least-squares means of lactation length with standard error for different farms, periods of calving, seasons of calving and parities with overall means are given in Table 4.1.The overal mean for lactation length was estimated as 275.49 ± 4.655 days which is lower than The mean of lactation length estimated by Joshi (1989), Ohri and Singh (1970) and Chourasia *et al.* (1983) as 305.95 ± 6.64, 308.00 ± 4.60 and 311.10 ± 21.70 days, respectively in Rathi cows. Whereas Singh and Raut (1980) observed much higher value for this trait (431.0 ± 9.80 days) in the same breed. There may be some non-tangible factors for lower lactation length but by improving management this can be improved ideally to 300 days.

4.1.3.1 Effect of Period

The effect of period of calving was observed to be significant on lactation length. In the present study the lactation length in second and third period (285.06 ± 7.183 and 287.94 ± 8.339 days) were significantly higher than first and fourth period (260.23 ± 8.338 and 268.31 ± 11.1 days). This might be due to favorable climatic conditions and good managemental practices at the farm in those periods. The comparable results of significant effect of periods on lactation length have also been reported by Gahlot (1972) in Rathi cattle, Chawla and Mishra (1982) in Sahiwal cattle and Tikam Chand (2011) in Tharparkar cattle. Joshi (1989), Nehra (2004) and Kumar (2012) in Rathi cattle, Dahiya (2002) in Hariana cows and Pareek (1991) in Tharparkar cattle reported non-significant effect of period on lactation length.

4.1.3.2 Effect of Season

In the present study the effect of season of calving on lactation length was found to be highly significant (P≤ 0.01).The rainy season calvers had highest lactation length (283.35 ± 8.718 days) and winter calvers had the lowest (267.87 ± 6.658

days) showing that rainy season calvers gave milk for longer period may be due to the next favourable winter season. Winter calvers had to face severe summer in the mid of lactation so these cows dried earlier. This is in agreement with the findings of Joshi (1989) in Rathi and its crosses, Pannerselvon *et al.* (1990) in Tharparkar, Yadav and Rathi (1992b) in Hariana also observed significant effect of season while Gahlot (1972) did not observe significant effect of season in lactation length of Rathi cows.

4.1.3.3 Effect of Parity:

In the present study the effect of parity on lactation length was found to be highly significant (P≤ 0.01). This is in agreement with the findings of Nehra (2004) in Rathi cattle. Whereas, Gahlot (1972), Singh and Raut (1980) and Chourasia *et al.* (1983) found non-significant effect of parity on lactation length of Rathi cattle.

In respect of lactation length in the present study it was observed that parity first was found to be highest (301.57 ± 8.852 days) than other parities. Significant parity variation in lactation length between first and other parities reflects that in indigenous breeds, cows after first calving come very late in estrous and become pregnant so the first lactation length is higher than the subsequent lactations.

4.1.3.4 Effect of Farm

In the present study the effect of farm on lactation length was found to be non-significant. This is in agreement with the findings of Naidu and Desai (1966) who reported non-significant effect of farm in northern and southern zones of the country, whereas Nehra (2004) in Rathi cattle found significant effect of farm on lactation length.

In the present study it was observed that Nohar farm had higher lactation length (276.75 ± 6.937 days) than Bikaner farm (274.23 ± 5.848 days). Non-significant farm variation in lactation length reflects that managemental practices were same in both the farms with respect to lactation length.

4.1.4 Dry period:

Least-squares means with standard error of dry period are presented in Table 4.1 the effect of various non-genetic factors such as period of calving, season of calving on dry period were calculated and depicted in the same table. The dry period of Rathi cows was observed to be 154.46 ± 5.530 days in the present investigation. It is almost similar to the estimate reported by D' Souza *et al.* (1979) in Red Sindhi cows. Whereas Nehra, (2004) (180.1 ± 6.79 days), Gahlot, (1972) (192.1 ± 18.6 days) and Singh and Raut, (1980) (191.01 ± 24.1 days) reported higher estimates in the same breed. Improved managemental practices can still decrease the dry period specially by pregnancy diagnosis, treatment of infertility and timely heat detection of the cows.

4.1.4.1 Effect of Period

The result of present study revealed that the period of calving did not influence the dry period. The cows calving in first and second period exhibited longer dry period as compared to cows calving in later two periods. Shorter dry period was observed in the fourth period (144.68 ± 13.186 days). Similar trends were reported by Gahlot (1972) in Rathi cattle and Tikam Chand (2004) in the Tharparkar cattle. Contarary to this Basu *et al.* (1979) in Indian dairy breeds, Nehra (2004) in Rathi cows reported that year of calving had significant effect on dry period.

4.1.4.2 Effect of Season

The seasonal influences at calving time on dry period were observed to be non-significant indicating contribution of season is not important in the total variability of dry period. Winter season calvers had higher dry period as compared to cows calving in other seasons. These results were in agreement with the findings of Nehra (2004) in Rathi cattle, Singh and Dubey (2005) in Sahiwal cattle and its crosses and Tikam Chand (2011) in Tharparkar cows.

However, Pannerselvon *et al.* (1990) and Gahlot (1999) in Tharparkar cattle for first lactation observed significant effect of season of calving on dry period.

4.1.4.3 Effect of Parity:

There was non-significant difference in dry periods due to parity. Fourth parity dry period was highest (170.91 ± 13.841days) and in fifth parity it was lowest (136.88 ± 11.972 days). Similar findings were reported by Dalal *et al.* (1993), Tajane *et al.* (1994), Chopra (1998) and Thakur and Singh (2000b) and Nehra (2004). Contrary to these findings Deshpande *et al.* (1992) in Sahiwal cattle, Kumar (1997) in Tharparkar cattle and Mane (1998) in Khillar cattle estimated significant effect of parity on dry period.

4.1.4.4 Effect of Farm:

The result of present study revealed that the farm effect significantly influenced the dry period. Dry period was lower in the cows of Nohar farm than those of Bikaner farm. This might be due to favorable conditions at the Nohar farm. The comparable results of significant effect of farm on dry period have also been reported by Nehra (2004) in Rathi and Gahlot (1999) in Tharparkar cattle. However non-significant effect was reported by Singh (2012) in Rathi cattle and Tikkam Chand (2011) in Tharparkar cows.

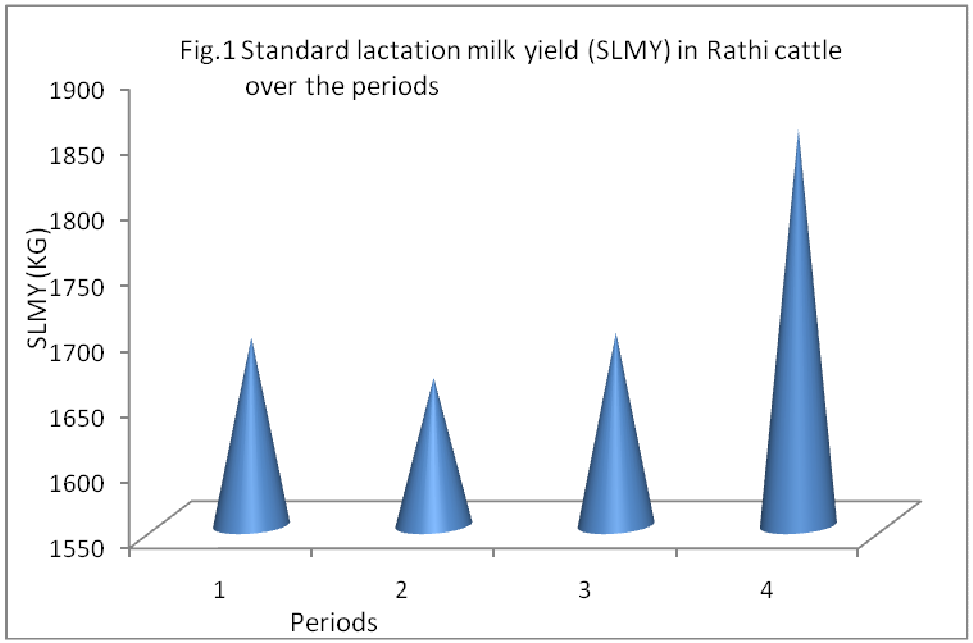
TABLE 4.1 Least-squares means with their standard error of production traits (Standard Lactation Milk Yield (SLMY), Peak Yield (PY), Lactation Length (LL) and Dry Period (DP) with numbers in parenthesis).

EFFECTS	SLMY(litres)	PY(litres)	LL(days)	DP(days)
OVERALL MEAN (μ)	1726.08±12.621 (1416)	9.02±0.066 (1416)	275.49± 4.655 (1416)	154.46 ± 5.530 (1416)
PERIOD	**	**	*	NS
1	1693.23± 25.584^{a} (288)	8.63±0.134^{a} (288)	260.63 ± 8.338^{a} (288)	171.25 ± 9.904 (288)
2	1662.39± 20.113^{a} (498)	9.08±0.105 ^{b} (498)	285.06 ± 7.813^{b} (498)	154.80 ± 9.281 (498)
3	1696.75 ± 23.757^{a} (358)	8.85±0.124^{ab} (358)	287.94 ± 8.339^{b} (358)	147.11 ± 9.906 (358)
4	1851.97 ± 26.728^{b} (272)	9.50±0.140 ^{c} (272)	268.31 ± 11.100^{a}	144.68 ± 13.186

			(272)	(272)
SEASON	NS	NS	**	NS
1	1718.66±20.775 (456)	9.08±0.108 (456)	275.25 ± 7.954[a] (456)	161.77 ± 9.448 (456)
2	1712.56±24.321 (315)	8.83±0.127 (315)	283.35 ± 8.718[b] (315)	145.14 ± 10.357 (315)
3	1747.03±17.800 (645)	9.14±0.093 (645)	267.87 ± 6.658[c] (645)	156.46 ± 7.908 (645)
PARITY	**	NS	**	NS
1	1623.45± 24.442[a] (323)	8.80±0.128 (323)	301.57 ± 8.852[c] (323)	156.91 ± 10.515 (323)
2	1705.15 ± 26.285[b] (272)	8.99±0.137 (272)	267.91 ± 8.630[b] (272)	155.85 ± 10.251 (272)
3	1788.16± 27.562[c] (247)	9.25±0.143 (247)	271.89 ± 10.130[b] (247)	151.75 ± 12.033 (247)
4	1752.58± 31.483[a] (188)	8.93±0.164 (188)	249.06 ± 11.652[a] (188)	170.91 ± 13.841 (188)
≥5	1752.58± 31.483[c] (386)	9.11±0.118 (386)	281.02 ± 10.079[b] (386)	136.88 ± 11.972 (386)
FARM	NS	NS	NS	*
1	1739.69± 19.202 (524)	8.95±0.100 (524)	274.23± 5.848 (524)	167.36 ± 6.947[b] (524)
2	1712.48± 16.087 (892)	9.08 ± 0.084 (892)	276.75± 6.937 (892)	141.55 ± 8.240[a] (892)

* (p≤0.05). * * (p≤0.01). NS = non-significant

Different superscripts indicate difference among means



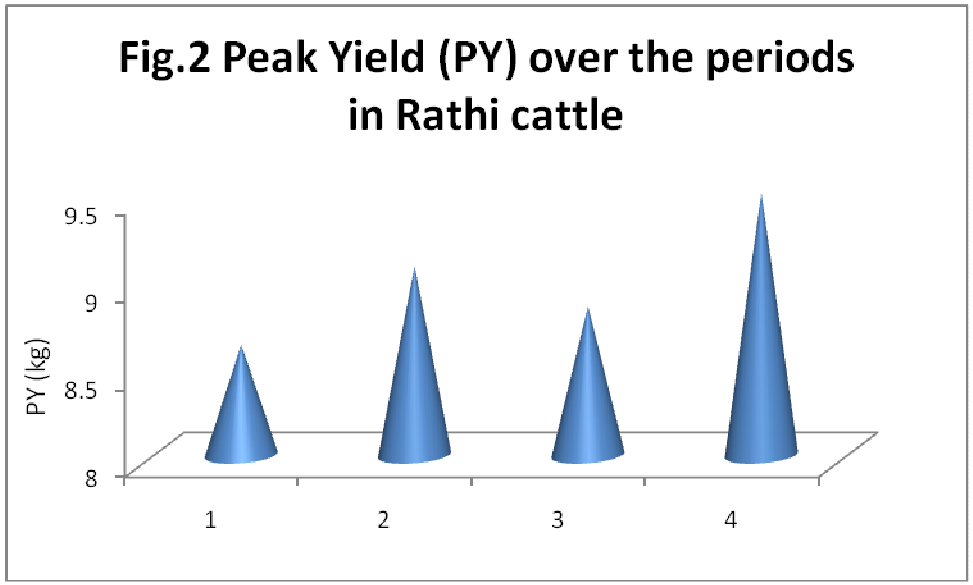


Fig.2 Peak Yield (PY) over the periods in Rathi cattle
PY (kg)
9.5
9
8.5
8
1
2
3
4

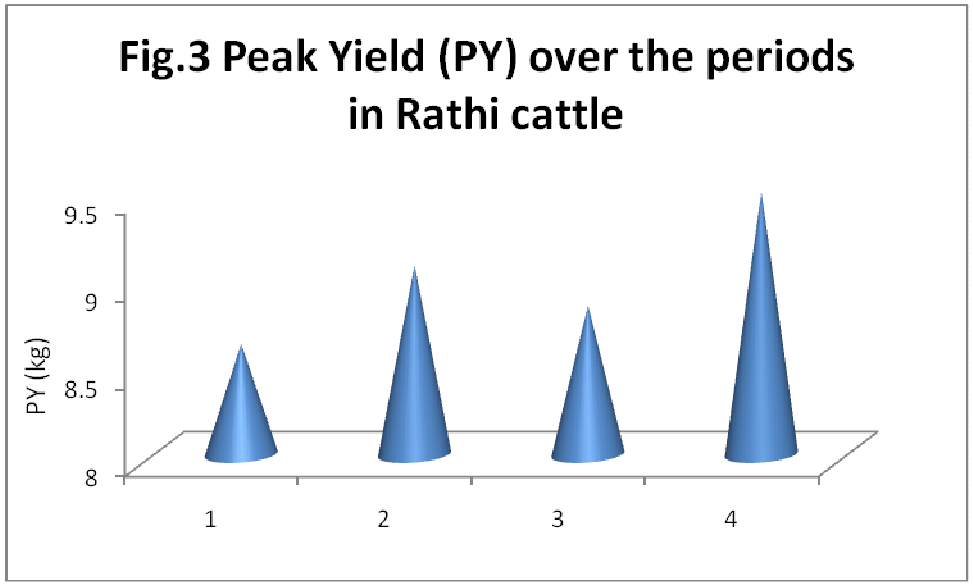


Fig.3 Peak Yield (PY) over the periods in Rathi cattle
PY (kg)
9.5
9
8.5
8
1
2
3
4

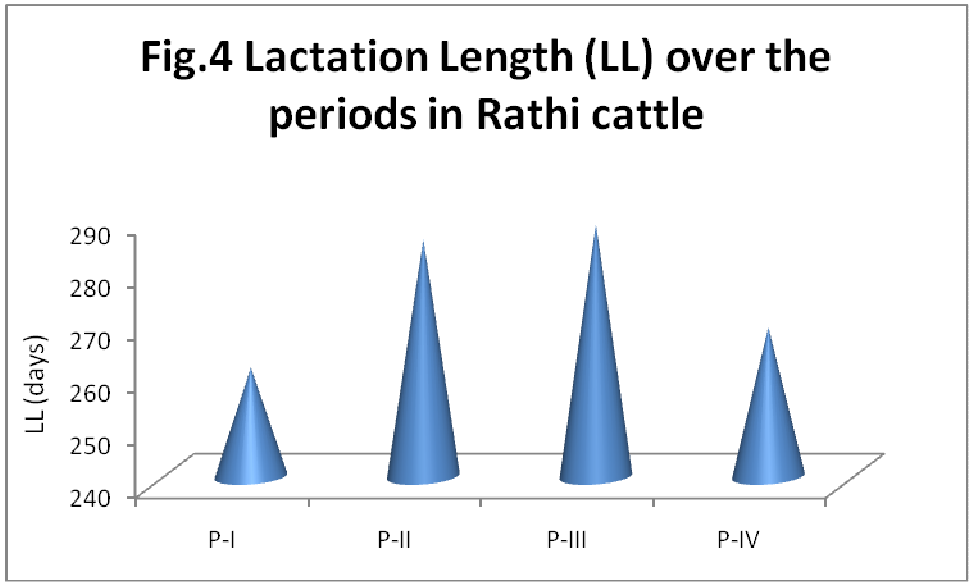


Fig.4 Lactation Length (LL) over the periods in Rathi cattle
LL (days)
290
280
270
260
250
240
P-I
P-II
P-III
P-IV

4.1.5. Days to attain Peak Yield (DAPY)

The least-squares means with standard error for different farms, periods of calving, seasons of calving and parities with overall means are presented in Table 4.2 Days to attain peak yield is an important economic trait which is determined as the number of days between the date of calving and date of achieving peak yield. The overall least-squares mean of days to attain peak yield was estimated as 30.95 ± 0.036 days. If peak yield is achieved earlier within reliable limits then it is expected that milk yield shall be more. Vij *et al.* (1992) reported 33.002 ± 39.15 days to attain peak yield in different breeds of cattle which is higher.

4.1.5.1 Effect of Period

The effect of period of calving on days to attain peak yield was found to be statistically highly-significant (P≤0.01). Comparison of the period-wise mean days to attend peak yield were found to be higher in fourth period than third, second and first periods. Results are in agreement with the reports of Chhikara (1974) in buffaloes and Yadav *et al.* (1995) and Kumar (1997) in indigenous cattle. Whereas, Yadav and Rathi (1992) in dairy cattle and Chowdhary and Chaudhary (1981), Gajbhiye and Tripathi (1988) and Neog *et al.* (1993) in buffaloes observed non-significant effect of period on days to attain peak yield.

4.1.5.2 Effect of Season

Season of calving showed significant (P≤0.05) effect on days to attain peak yield in the present study. The maximum days to attain peak yield was found to be 31.06 ± 0.060 days in season first (summer) and minimum was 30.85 ± 0.052 days in third season (winter). In the present study more number of days to attain peak yield

were during summer season which may also be attributed to the environmental conditions. Similar findings were reported by Yadav *et al.* (1995) and Kumar (1997) in dairy cattle. On the other hand Yadav and Rathi (1992) in dairy cattle and Chowdhary and Chaudhary (1981), Gajbhiye and Tripathi (1988) and Neog *et al.* (1993) in buffaloes observed non-significant effect on days to attain peak yield.

4.1.5.3 Effect of Parity:

The days to attain peak yield generally remained same from first to third parity and than increased up to 5^{th} parity. Effect of parity was observed to be highly significant (P≤0.01), Parity fifth found 31.23 ± 0.064 days to attain peak yield, which is higher than other parities. Significant effect of parity on days to attain peak yield was reported by Garcha and Tiwana (1980), Gajbhiye and Tripathi (1988) in indigenous cows, whereas Yadav and Rathi (1992), Yadav *et al.* (1995) and Kumar (1997) in dairy cattle reported non-significant effect of parity on days to attain peak yield.

4.1.5.4 Effect of Farm:

Effect of farm was observed to be significant (P≤0.05) which indicates that managemental practices in both farms were different. This traits Nehra (2004) and Singh (2012) showed same trend of higher days to attain peak yield in Rathi cattle at Nohar than Bikaner farm.

4.1.6. Milk yield per day of Lactation Length:

The least-squares means with standard error for different farms, periods of calving, seasons of calving and parities with overall means are given in Table 4.2. The overall milk yield per day of lactation length was estimated as 5.92 ± 0.038 litres. These results are in agreement with Joshi (1989), Vij *et al.* (1992) and Yadav *et al.* (1994b).

4.1.6.1 Effect of Period

The effect of period of calving on milk yield per day of lactation length was found to be highly significant. (P≤0.01) The fourth period showed highest average yield per day of lactation length than other periods which indicates that fourth period is having marked improvement in the performance in respect of milk yield per day of lactation length. Similar findings were reported by Hayatnagarkar *et al.* (1990) Thakur and Singh (2000b) and Juneja (1987) in exotic cattle and Yadav *et al.* (1992b), Murdia and Tripathi (1991), Yadav *et al.* (1995) and Kumar (1997) in zebu cattle. Contrarily Yadav *et al.* (1994b) in Tharparkar cattle, Neel Kant and Prasad (1997) and Thakur and Singh (2000a) in crossbred cattle found non-significant effect of period on milk yield per day of lactation length.

4.1.6.2 Effect of Season:

The estimates revealed that season-wise milk yield per day of lactation length were non-significant among themselves. This could be due to better feeding and managemental practices in the herd in aII seasons. Similar findings were reported by Yadav and Rathi (1992b), Yadav *et al.* (1995) in zebu cattle and Thakur and Singh (2000 a, b) in crossbred cattle. Contrary to these results, Hayatnagarkar *et al.* (1990), Yadav *et al.* (1994b) and Katkade *et al.* (1995) observed significant effect of season of calving on average yield per day of lactation length.

4.1.6.3 Effect of Parity:

Comparison of parity-wise means differed highly significantly (P≤0.01) from each other. The parity-wise means indicated that the milk yield per day of lactation length continued to increase with the advancement in parity except a slight decrease in third parity which could be due to smaller number of observations or selected cows were maintained in the herd in subsequent parities. Significant effect of parity on milk yield per day of lactation length was reported by Murdia and Tripathi (1991) Yadav *et al.* (1992, 1994, 1995), Katkade *et al.* (1995), Mathur and Chahal (1997) in dairy cattle and Nehra (2004) in Rathi cows.

4.1.6.4 Effect of Farm:

The effect of farm was highly significant (P≤0.01) on milk yield per day of lactation length. Farm second (Nohar) showed higher average than farm first (Bikaner). Similar findings were reported by Singh and Desai (1961) and Naidu and Desai (1966) in northern and southern zone of the country in zebu cattle.

4.1.7. Persistency Index:

Least-squares means with standard errors of persistency index were calculated to estimate (Table 4.2) the effect of various non-genetic factors such as period of calving, season of calving, parity and farm effect on persistency index. The persistency index of Rathi cows was observed to be 196.29 ± 1.296 in the present investigation. Similar findings was reported by Singh *et al.* (1999 a, b) in crossbred cattle

4.1.7.1 Effect of Period

The effect of period of calving on persistency index was found to be highly significant (P≤0.01). The first period showed highest persistency index than other periods which indicates that different periods were having varying managemental conditions. This difference in persistency index seems to be attributed to growth. The persistency declined with the advancement of age. Similar findings were reported by Dhaka *et al.* (1994) and Kumar (1997) Contrarily, Gupta and Johar (1982), Gupta and Johar (1986), Khan and Johar (1985) in Tharparkar crossbred cows found no effect of period.

4.1.7.2 Effect of Season

The effect of season of calving on persistency index was found to be non-significant. The second season showed highest persistency index than other seasons which indicates that persistency was better in cows calved during second season than those calved during other seasons. Similar findings were reported by Gill (1969), Koley et al (1979) and Gupta and Johar (1982) in Hariana, Tharparkar and Jersey x Hariana crossbred cattle, respectively.

4.1.7.3 Effect of Parity:

Variation in persistency of milk yield in different lactations has been studied in terms of parity and it was observed that the effect of parity on persistency was statistically significant ($p \leq 0.05$). The third parity showed highest persistency index than other parities. Significant effect of parity on persistency of milk were observed by Gill (1969), Singh and Shukla (1985), Garcha and Tiwana (1980), Bhat *et al.* (1982) and Rao and Sundaresan (1982). On the contrary with Narain *et al.* (1981), Yadav *et al.* (1992a) in Sahiwal cattle, Yadav and Rathi (1992b) in Hariana cattle, Yadav *et al.* (1994b) and Kumar (1997) in Tharparkar cattle found non-significant effect of parity.

4.1.7.4 Effect of Farm:

The estimates revealed that the effect of farm on persistency index was found to be significant. It indicates that persistency index was better in cows in Bikaner farm than Nohar farm. Present study indicates good environmental control, better feeding and reproductive management of the farm and regular culling pattern. Contrary to our result Narain *et al.* (1981) and Kumar (1997) found non-significant effect of farm on Sahiwal and Tharparkar cattle, respectively

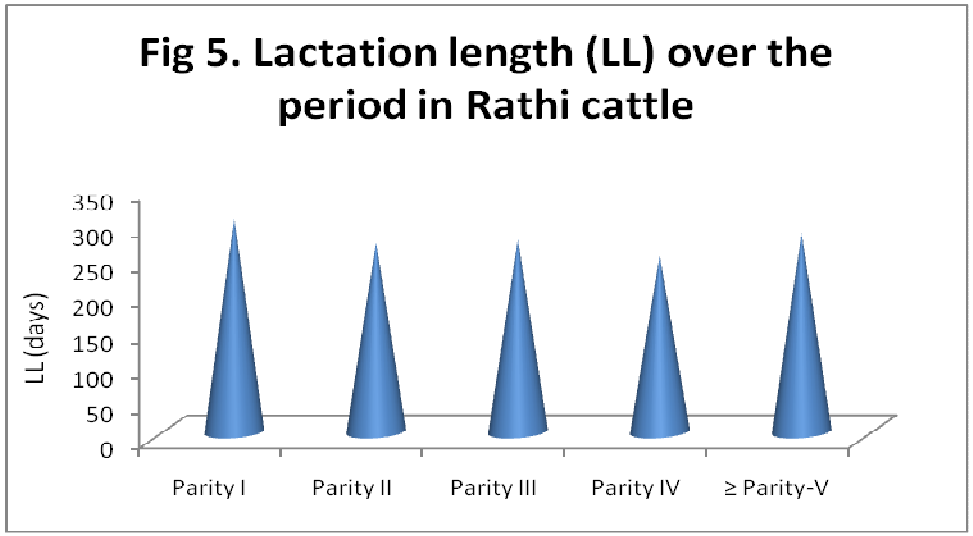


Fig 5. Lactation length (LL) over the period in Rathi cattle
LL (days)
350
300
250
200
150
100
50
0
Parity I
Parity II
Parity III
Parity IV
≥ Parity-V

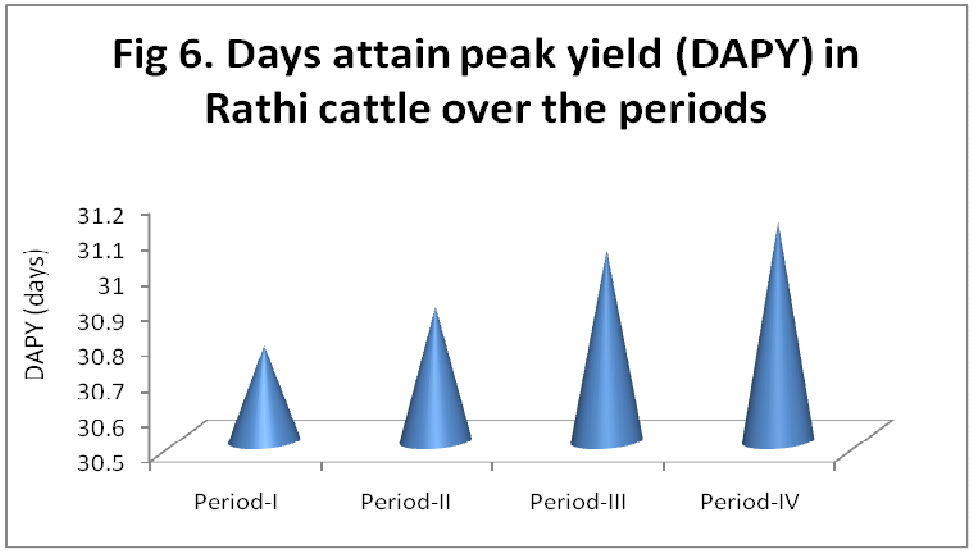


Fig 6. Days attain peak yield (DAPY) in Rathi cattle over the periods
DAPY (days)
31.2
31.1
31
30.9
30.8
30.7
30.6
30.5
Period-I
Period-II
Period-III
Period-IV

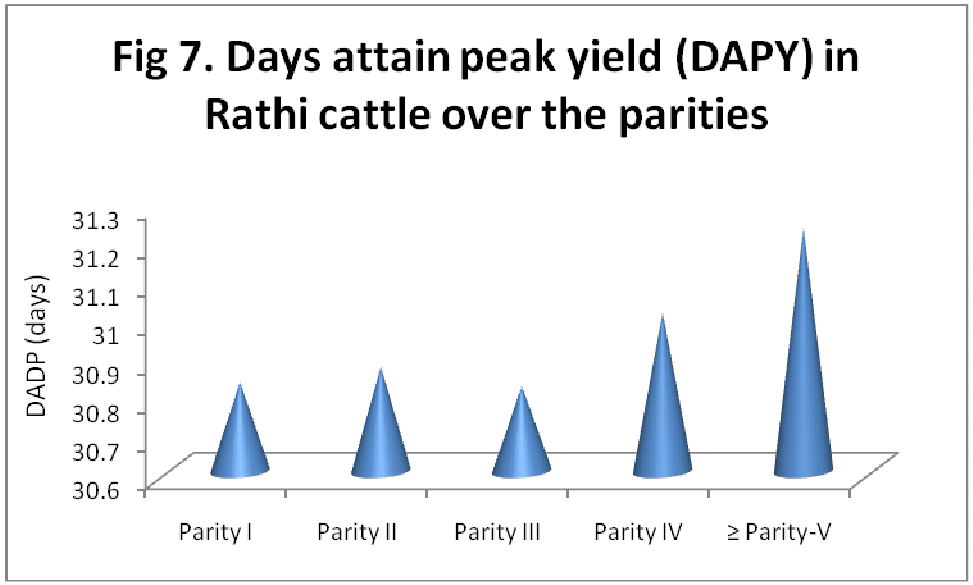


Fig 7. Days attain peak yield (DAPY) in Rathi cattle over the parities
DADP (days)
31.3
31.2
31.1
31
30.9
30.8
30.7
30.6
Parity I
Parity II
Parity III
Parity IV
≥ Parity-V

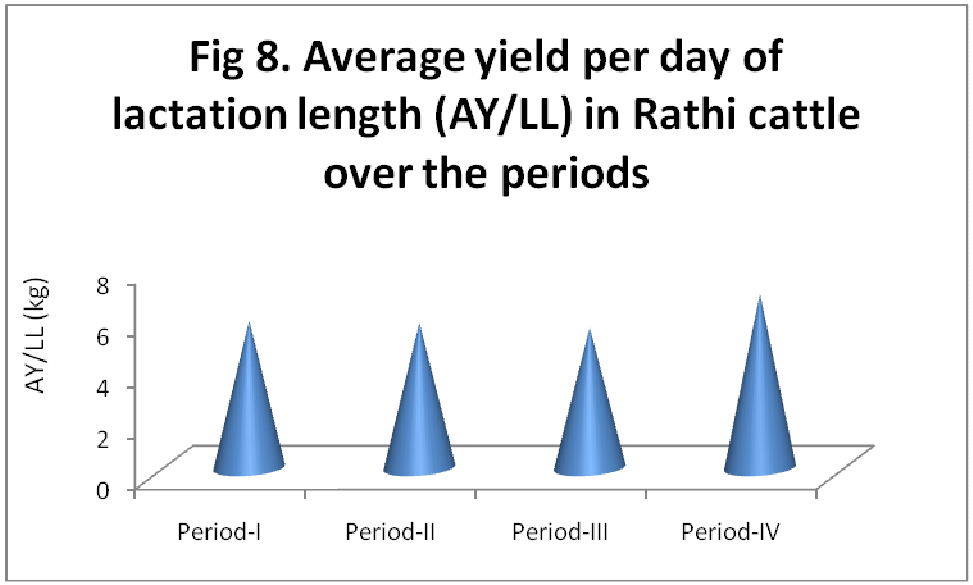


Fig 8. Average yield per day of lactation length (AY/LL) in Rathi cattle over the periods
AY/LL (kg)
8
6
4
2
0
Period-I
Period-II
Period-III
Period-IV

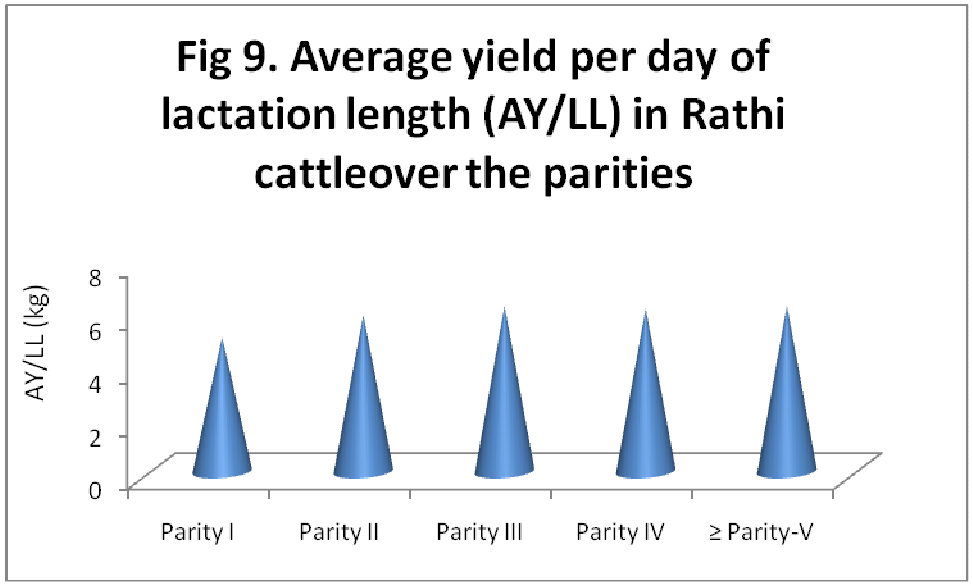


Fig 9. Average yield per day of lactation length (AY/LL) in Rathi cattleover the parities
AY/LL (kg)
8
6
4
2
0
Parity I
Parity II
Parity III
Parity IV
≥ Parity-V

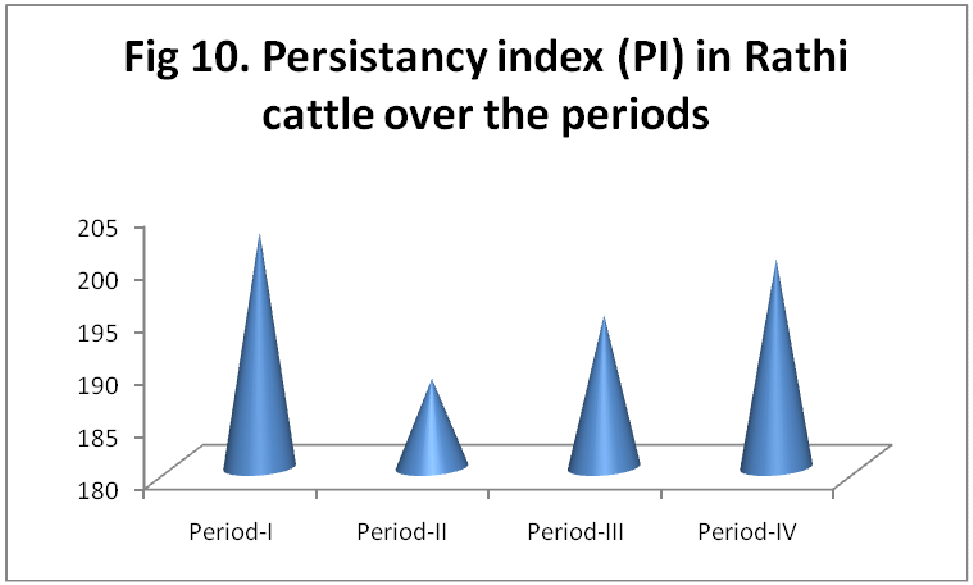


Fig 10. Persistancy index (PI) in Rathi cattle over the periods
205
200
195
190
185
180
Period-I
Period-II
Period-III
Period-IV

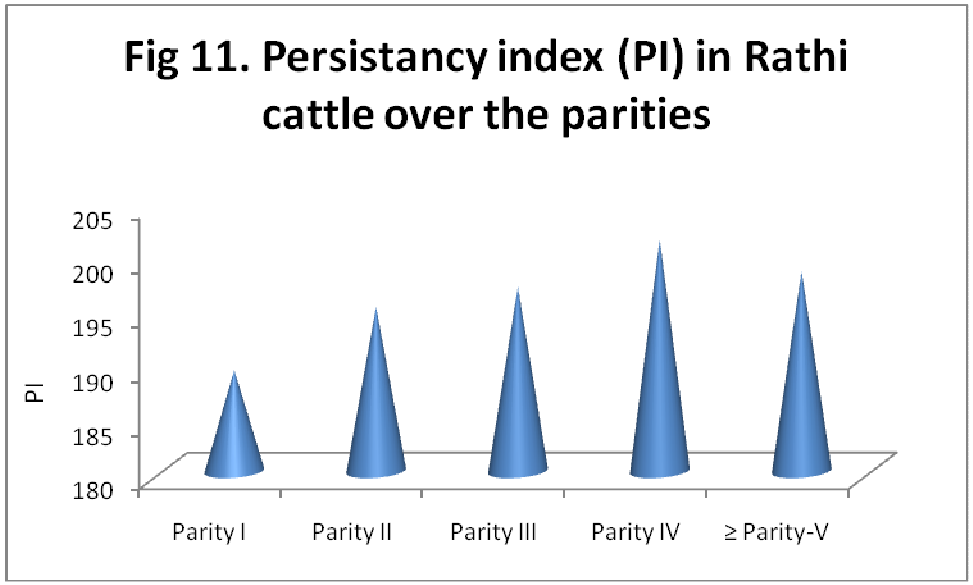


Fig 11. Persistancy index (PI) in Rathi cattle over the parities
205
200
195
190
185
180
PI
Parity I
Parity II
Parity III
Parity IV
≥ Parity-V

TABLE 4.2 Least-squares means with their standard error of production traits (Days to attain Peak Yield (DAPY), Milk Yield per day of Lactation Length (MY/LL) and Persistency Index (PI) with numbers in parenthesis).

EFFECTS	DAPY(days)	MY/LL(litres)	PI
OVERALL MEAN (μ)	30.95 ±0.036 (1416)	5.92±0.038 (1416)	196.29±1.296 (1416)
PERIOD	**	**	**
1	30.77 ± 0.073^{a} (288)	5.74±0.076^{b} (288)	202.40±2.626^{c} (288)
2	30.88 ± 0.059^{a} (498)	5.66±0.060^{b} (498)	188.43±2.065^{a} (498)
3	31.04 ± 0.069^{b} (358)	5.47±0.071^{a} (358)	194.50±2.439^{b} (358)
4	31.12 ± 0.075^{bc} (272)	6.79±0.080^{c} (272)	199.81±2.744^{c} (272)
SEASON	*	NS	NS
1	31.06 ± 0 .060^{b} (456)	5.87±0.062 (456)	194.18±2.133 (456)
2	30.96 ± 0.067^{a} (315)	5.90±0.073 (315)	199.23±2.497 (315)
3	30.85 ± 0.052^{a} (645)	5.98±0.053 (645)	195.45±1.827 (645)
PARITY	**	**	*

1	30.83 ± 0.071[a] (323)	5.06±0.073[a] (323)	189.33±2.509[a] (323)
2	30.87 ± 0.074[a] (272)	5.90±0.079[b] (272)	195.17±2.698[b] (272)
3	30.82 ± 0.081[a] (247)	6.24±0.083[cd] (247)	197.04±2.829[b] (247)
4	31.01 ± 0.090[b] (188)	6.14±0.094[c] (188)	201.41±3.232[c] (188)
≥5	31.23 ± 0.064[c] (386)	6.26±0.067[d] (386)	198.49±2.324[b] (386)
FARM	*	**	*
1	31.03 ± 0.055[b] (524)	5.73±0.058[a] (524)	198.98±1.971[b] (524)
2	30.87 ± 0.047[a] (892)	6.11 ± 0.048[b] (892)	193.60±1.651[a] (892)

* (p≤0.05). * * (p≤0.01). NS = non-significant

Different superscripts indicate difference among means

4.2 Reproduction Traits

4.2.1 Gestation Period

Gestation period is calculated as the period between date of conception and date of parturition. Optimum gestation period would be of economic importance in normal parturition and maintaining short calving interval. This trait is least variable. It provides a protected environment to the off- spring in early stage of their development inside the body of the mother supplying nutrients and favorable environment. The least-squares means with standard error for different farms, periods of calving, seasons of calving and parities with overall means are given in Table 4.3. The average gestation period was(280.38±0.781days) in present study. Similar finding was reported by Mishra and Mishra (1987) in Jersey x Hariana cattle and Vij *et al.* (1992) and Kachwaha *et al.* (1993) in Tharparkar cattle.

4.2.1.1 Effect of Period

The present study revealed that the effect of period of calving on gestation period was estimated to be non-significant. The result of present study indicates slightly higher gestation period in first and second periods as compared to third and fourth period of calving. The difference in gestation periods may be due to variation in birth weight of the calves, feeding regimes or managemental effect. Similar findings were reported by Sharma *et al.* (1979), and Das *et al.* (1990) in dairy cattle.

4.2.1.2 Effect of Season

The effect of season on gestation period was found to be non-significant in the present study. The least squares means for gestation period were higher as 281.31 ± 1.118 days in season third and lower as 279.84 ± 1.464 days and

280.00 ± 1.335 days in season second and first respectively. Similar findings were also reported by Das *et al.* (1990) and Kumar (1997) in zebu cattle found non-significant effect of season of calving on gestation period in Jersey cattle.

4.2.1.3 Effect of Parity: Effect of parity of calving was observed to be non-significant on gestation period of Rathi cows. The maximum gestation period was observed in fourth parity while the minimum was in third parity. The gestation period marginally increased with the advancement of lactation order. Non-significant effect of parity on gestation period was also observed by Vij *et al.* (1992) and Katiyar *et al.* (1997) in Tharparkar and Sahiwal cattle. However Das *et al.* (1990) and Kumar (1997) observed significant effect of parity on gestation period in Jersey and Tharparkar cattle, respectively.

4.2.1.4 Effect of Farm:

Effect on gestation period of farm was found to be significant. Nohar farm showed higher gestation length than the Bikaner farm. Significant effect of farm was also shown by Gaur and Raheja (1996) in dairy cattle. However, Sharma *et al.* (1979), Das *et al.* (1990) and Nehra (2004) in Rathi cattle estimated non-significant effect of farm on gestation period.

4.2.2 Caving Interval:

Interval between two successive calvings is the calving interval. Shorter calving interval reduces the cost of rearing of an animal and increases the lifetime productivity of milk. The least-squares means with standard error for different farms, periods of calving, seasons of calving and parities with overall means are given in Table 4.3.

It is the parameter used to assess bovine reproductive efficiency which effects the production. Farm manager likes to keep the calving interval and dry period as short as possible, so that the animal remains productive for longer period in its life- time. The average calving interval was 429.34 ± 3.488 days in Rathi cows. Kachwaha (1993), Tikam Chand (2011) and Kishore (2012) reported similar results in Tharparkar cattle. However higher results than the present study was reported by Nehra (2004) in Rathi cattle.

4.2.2.1 Effect of Period

The results revealed that the effect of period of calving on calving interval was estimated to be non-significant. The results of present study indicates good environmental control, better feeding and reproductive management of the farm and regular culling pattern on the basis of reproductive fitness that helps in reducing calving interval. The cows calved in second period has longer calving interval than those calved in later two periods. Gahlot (1972) and Nehra (2004) in Rathi cows also reported significant effect of period of calving on calving interval. However, Govindiah *et al.* (1984) in Red Sindhi cows and Sahiwal crosses, Dhaka et al (1999) in Hariana cows and Thakur and Singh (2000a, b) observed significant effect of period of calving on calving interval.

4.2.2.2 Effect of Season

The season-wise least squares means for calving interval were non-significant. The overall means for calving Interval were calculated higher as 436.17 ± 5.960 days in season first and lowest as 422.86 ± 4.989 days in season third. The cows calving in summer season had lower calving interval than those calved in winter and monsoon season. Similar findings were also reported by Tikam Chand (2011) and Nehra (2004) in Tharparkar and Rathi cows, respectively.

4.2.2.3 Effect of Parity

Effect of parity of calving was observed to be highly significant ($p \leq 0.01$) on calving interval of Rathi cows. The maximum calving interval was observed in first parity. It is observed that first calvers used to calve late in next parity and there is not a great difference in the calving intervals of successive parities. Significant effect of parity on calving interval was also observed by Chourasia et al. (1983) in Rathi cows and Vij et al. (1992b), Kachwaha (1993), Gahlot (1999) and Gahlot et al. (2002) in Tharparkar cows. However, Nehra (2004) reported non- significant effect of parity on calving interval in Rathi cows.

4.2.2.4 Effect of Farm

Farm effect on calving interval was found to be highly significant. Nohar farm showed higher calving interval than the Bikaner farm. Significant effect of farm was shown by Gaur and Raheja (1996) in Sahiwal cattle. However, Sharma *et al.* (1979), Das *et al.* (1990) and Nehra (2004) in Rathi cattle estimated non-significant effect of farm on calving interval.

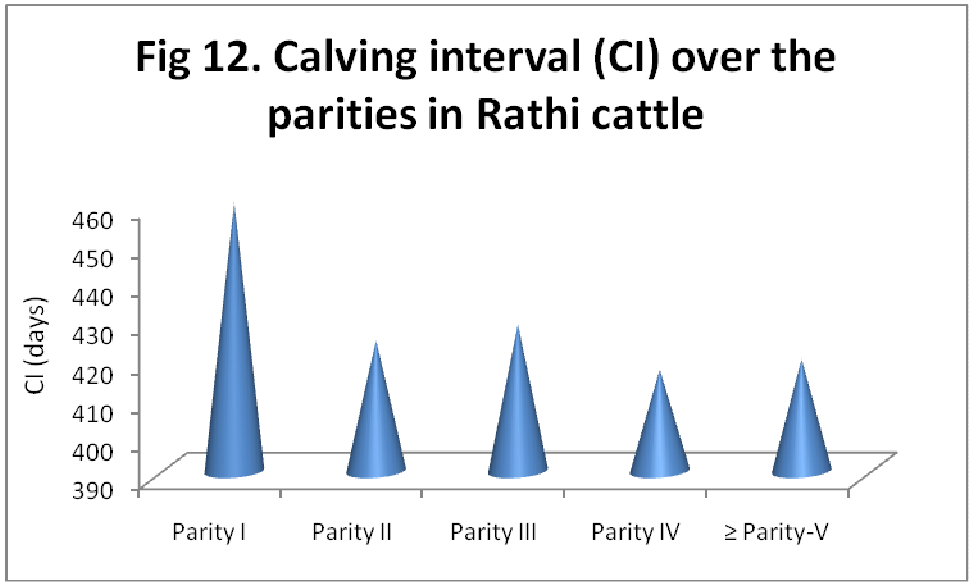


Fig 12. Calving interval (CI) over the parities in Rathi cattle
CI (days)
460
450
440
430
420
410
400
390
Parity I
Parity II
Parity III
Parity IV
≥ Parity-V

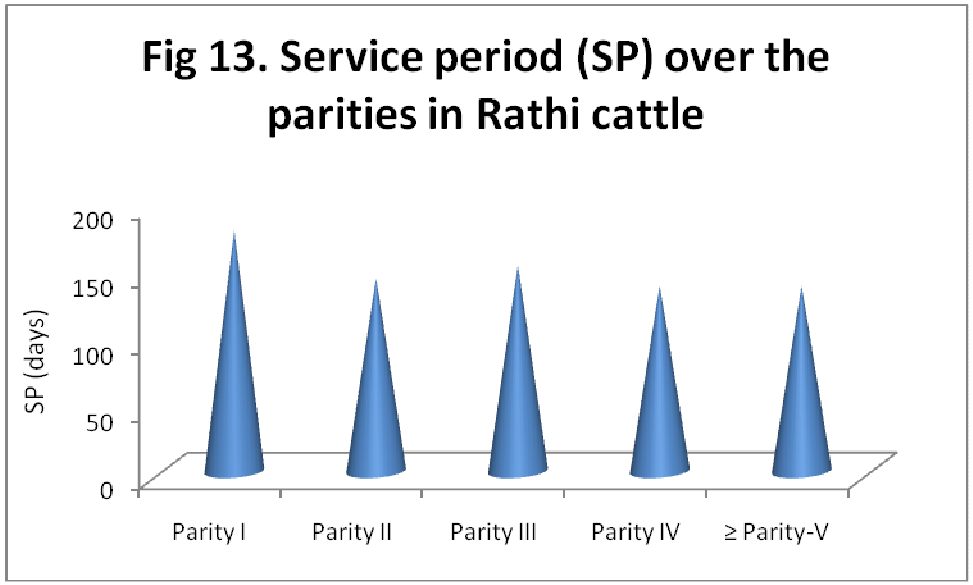


Fig 13. Service period (SP) over the parities in Rathi cattle
SP (days)
200
150
100
50
0
Parity I
Parity II
Parity III
Parity IV
≥ Parity-V

4.2.3 Service Period

. The least-squares means with standard error for different farms, periods of calving, seasons of calving and parities with overall means are given in Table 4.3 The overall average service period was estimated to be 149.56 ± 3.385 days and is in close agreement with the reports of Kachwaha (1993), Gahlot *et al.* (2002) and Tikam Chand (2011) in Tharparkar cattle. Ohri and Singh (1970), Nehra (2004) and Kumar (2012) reported higher estimates in Rathi cattle.

4.2.3.1 Effect of Period:

Period of calving was found to be non-significant on service period. The longest service period was 158.27 ± 5.681 days in the second period, whereas it was lowest during fourth season. Non-significant effect of period of calving on service period was observed by Basu *et al.* (1979a) in Red Sindhi, Sahiwal cattle and Tharparkar cattle and Dahiya (2002) in Hariana cows. However, significant effect of period on service period has been reported by Gaur and Raheja (1996), Nehra (2004) and Tikam Chand (2011) in Sahiwal, Rathi and Tharparkar cattle respectively.

4.2.3.2 Effect of Season

Season of calving was found to be non-significant on service period. The longer service period was in the first season, whereas it was smaller during second and third season.

Vij *et al.* (1992) and Tikam Chand (2011) in Tharparkar and Singh (1994) in Hariana cattle observed non-significant effect of season on service period However, Beniwal (1993) in Red Sindhi and its crosses, Kachwaha (1993) in Tharparkar, Nehra (2004) in Rathi cattle observed significant seasonal variation in service period.

The seasonal influences on first service period could be due to variation in environmental and managemental conditions. The service period of Rathi cows calving in the winter was smallest which might be a result of favorable environment in terms of temperature, rainfall and humidity. Further the green pastures hasten the onset of estrus probably due to high nutrient contents.

4.2.3.3 Effect of Parity

Analysis revealed that the service period differs highly significantly (P≤0.01) among the the parities. Longer service period was observed in first parity. This indicated that during early lactations the involution of uterus took longer time after parturition resulting in increased service period. The shortest service period was estimated at subsequent parities. The significant effect of parity on service period was observed by Das *et al.* (1990), Katiyar *et al.* (1993), Parmar *et al.* (1997) and Mane *et al.* (1998) in various breeds of cattle. However, Chhikara (1993) and Chopra (1998) reported non-significant effect of parity on service period.

4.2.3.4 Effect of Farm

Effect of farm showed significant variation in service period in the present study being the longer at Nohar and shorter at Bikaner.

Nehra (2004) in Rathi cows and Tikam Chand (2011) in Tharparkar cattle reported significant effect of period of calving on service period. Contrarily, Basu *et al.* (1979) in Red Sindhi, Sahiwal and Tharparkar and Dahiya (2002) in Hariana cows observed non-significant effect of period of calving on service period.

TABLE 4.3 Least-squares means with their standard error of reproduction traits (Gestation Period (GP), Calving Interval (CI) and Service Period (SP) with numbers in parenthesis)

EFFECTS	GP(days)	CI(days)	SP(days)
OVERALL MEAN (μ)	280.38 ± 0.781 (1416)	429.34 ± 3.488 (1416)	149.56 ± 3.385 (1416)
PERIOD	NS	NS	NS
1	282.49 ± 1.400 (288)	432.07 ± 6.247 (288)	149.39 ± 6.063 (288)
2	281.59 ± 1.312 (498)	438.84 ± 5.855 (498)	158.27 ± 5.681 (498)
3	279.23 ± 1.400 (358)	434.01 ± 6.249 (358)	155.82 ± 6.064 (358)
4	278.23 ± 1.864 (272)	412.44 ± 8.318 (272)	134.76 ± 8.072 (272)
SEASON	NS	NS	NS
1	280.00 ± 1.335 (456)	436.17 ± 5.960 (456)	157.02 ± 5.784 (456)

2	279.84 ± 1.464 (315)	428.97 ± 6.533 (315)	148.65 ± 6.340 (315)
3	281.31 ± 1.118 (645)	422.86 ± 4.989 (645)	143.02 ± 4.841 (645)
PARITY	NS	**	**
1	280.34 ± 1.486 (323)	459.57 ± 6.633^{c} (323)	178.14 ± 6.437^{c} (323)
2	280.88 ± 1.449 (272)	423.85 ± 6.467^{b} (272)	142.88 ± 6.275^{a} (272)
3	277.36 ± 1.701 (247)	427.99 ± 7.591^{b} (247)	152.28 ± 7.366^{b} (247)
4	282.75 ± 1.956 (188)	416.27 ± 8.731^{a} (188)	137.22 ± 8.473^{a} (188)
5	280.61 ± 1.692 (386)	419.01 ± 7.552^{a} (386)	137.29 ± 7.329^{a} (386)
FARM	*	**	**
1	278.91 ± 0.982^{a} (524)	441.29 ± 4.382^{b} (524)	162.68 ± 4.253^{b} (524)
2	281.86 ± 1.164^{b} (892)	417.39 ± 5.198^{a} (892)	136.44 ± 5.044^{a} (892)

* ($p \leq 0.05$). * * ($p \leq 0.01$). NS = non-significant
Different superscripts indicate difference among means

4.3. Correlations of Production and Reproduction Traits

Correlations of production and reproduction traits are presented in Table 4.4

4.3.1. Correlations among Production Traits

Standard lactation milk yield was having highly significant and positive correlation with lactation length (0.372). Similar correlation between milk yield and lactation length were found by Sandhu *et al.* (1976), Sharma and Singh (1981) and Bhatnagar *et al.* (1983) as 0.33, 0.35 and 0.40, in Sahiwal cows. The standard lactation milk yield was also having highly significant and positive correlations with peak yield, persistency index and milk yield per day of lactation length as 0.618, 0.328 and 0.598, respectively. Joshi (1989), Beniwal (1993), Gahlot (1997) and Hingane (1980) reported estimates of phenotypic correlations between lactation yield and milk yield per day of lactation length as 0.66, 0.36, 0.82 and 0.90 in Rathi, Red Sindhi, Tharparkar and Hariana cattle, respectively. It was having a non-significant but negative correlation with dry period. It can be inferred that an increase in one production trait results in increase in another production trait except dry period having negative correlation which is desirable.

Correlations of lactation length with peak yield, days to attain peak yield were 0.338 (highly significant) and 0.034 respectively. There were negative correlations of lactation length with persistency index, milk yield per day of lactation length and dry period as – 0.004, – 0.454 (highly significant) and – 0.108 (significant). Beniwal (1993) in Red Sindhi cows estimated negative correlation between lactation length and milk yield per day of lactation length as -0.39. It can be inferred that lactation length increases with increase in peak yield, which was desirable and decreases with the milk yield per day of lactation length and dry period.

Correlation of peak yield with milk yield per day of lactation length was 0.264 which is positive and highly significant. It showed that peak yield and milk yield per day of lactation length changes simultaneously in the same direction. Correlations of peak yield with persistency index, dry period and days to attain peak yield were negative and the values are

– 0.480 (highly significant), – 0.131 (significant) and – 0.027, respectively, indicating the increase in the peak yield amounts the decrease in persistency index and dry period.

Correlation of milk yield per day of lactation length with dry period and days to attain peak yield were positive but non-significant as 0.011 and 0.003. There was no correlation of dry period with days to attain peak yield.

4.3.2. Correlations among Reproduction Traits

Among reproduction traits the correlation between calving interval and service period is highly significant and positive and the estimated value was 0.947. This shows that as there was an increase or decrease in the service period, simultaneous increase or decrease was found in calving interval. This phenomenon is natural as there is the least variability in gestation period.

4.3.3 Correlations of Production with Reproduction Traits

The correlations of production with reproduction traits are not very important but some important trends are observed as the correlation of service period and calving interval with production traits are generally highly significant and in both the directions. The correlation of calving interval and dry period was found to be positive and highly significant and the estimated value was 0.296. Higher values than the present study were obtained by Gahlot (1997) and Dahiya (2002) as 0.49 and 0.81, respectively.

Table 4.4 Estimates of phenotypic correlations for production and reproduction traits

	SLMY	LL	PY	PI	MY/LL	GP	SP	DP	CI	DAPY
SLMY	1.000									
LL	0.372**	1.000								
PY	0.618**	0.338**	1.000							
PI	0.328**	-0.004	-0.480**	1.000						
MY/LL	0.598**	-0.454**	0.264**	0.361**	1.000					
GP	-0.071	-0.055	-0.010	-0.036	-0.036	1.000				
SP	0.134**	0.511**	0.170**	-0.075	-0.293**	-0.063	1.000			
DP	-0.084	-0.108*	-0.131*	0.088	0.011	-0.006	0.343**	1.000		
CI	0.113*	0.512**	0.143**	-0.069	-0.320**	0.000	0.947**	0.296**	1.000	

DAPY	**0.045**	**0.034**	**-0.027**	**-0.005**	**0.003**	**0.016**	**-0.040**	**0.000**	**0.040**	**1.000**

4.4 To Suggest Various Managemental Practices to Improve Production and Reproduction Traits of Rathi cattle.

1 The overall performance of both the herds in terms of production reproduction traits were generally significantly improved in the fourth period as compared to other periods. From going through the records and management of the farms it was established that there was good supply of the green round the year regular culling was practiced.

2 Increase in parity-wise standard lactation milk yield indicates that as the parity increases cows are giving more milk. So it may be suggested that selection of high producers and culling of low producers on the farms should be done regularly. The monitoring of animal performances and selection of outstanding individuals is an important part of good management to get good production.

3 The results showed that peak milk yield was higher during the fourth parity, followed by second, third and first parity so it may be suggested that the cattle should be maintained in herd up to 5^{th} parity.

4 In the present study the lactation lengths in second and third periods were significantly higher than first and fourth periods. This might be due to favorable climatic conditions and good managemental practices so it may be suggested that management practices like supply of green fodder, provision of balanced feed, good housing conditions adoption of disease preventive programs should be adopted throughout the year for better production.

5 The farm effect significantly influenced the dry period. Dry period was lower in the cows of Nohar farm than those of Bikaner farm. This might be due to favorable conditions like availability of green fodder at the Nohar farm suggesting that the regular supply of green fodder to cows may reduce the dry period in Rathi cows.

6 In the present study more number of days to attain peak yield were during summer season so it may be suggested that if efforts are made to reduce the temperature in the animal houses like plantation of trees in and around animal houses, provision of fan and humidifier in the animal house may reduce the number of days to attain peak yield during summer season.

7 The first period showed highest persistency index than other periods which indicates those different periods were having varying managemental conditions so good farm management practices are necessary.

8 Managemental practices like prevention of naval ill and calf scour should be adopted. There should be scientific disposal of carcass.

9 From the present study in nutshell it may be concluded that good environmental control, nutritive, green and quality fodder, balance feeding good reproductive management like pregnancy diagnosis and regular treatment of infertility and regular culling improves the production of the farm animals. On the basis of reproductive fitness helps in reducing the

calving interval, dry period, service period of the cows. Managemental practices are recommended as breeding strategies supply of mineral mixture, three times milking of high yielders, udder should be washed with mild antiseptic, full hand milking or machine milking and weaning. Improved quality of fodder and provide balanced feed. Provide more A.I. centers in villages or pure bred proven sires in interior villages, castrate stray male calves and conservation of Rathi cattle by giving subsidy on good cows and bulls. It is imperative to start A.I. or progeny tested proven bulls may be used. Once progeny tested bulls are available, then seman can be supplied to the A.I. centres of Rathi cattle breeding tract for improvement of the breed. Open nuclear breeding system may be adopted so new germ-plasm may be inducted regularly at the farm. Presently same bulls were used for long periods.

5. SUMMARY AND CONCLUSION

Rathi cattle is a distinct, relatively unknown breed that possesses good potential with high degree of variability for milk production and has not yet been fully explored for its production potential. There is need to exploit the genetic potential of this breed that is well known for its hardiness to withstand the harsh agro-climatic conditions especially in the drought prone area *viz* arid and semi arid zone. Rathi animals can produce to their full potential even when maintained on dry fodder available in arid regions. Genetic improvement of Rathi cattle through selective breeding is of paramount importance for conservation, propagation and improvement of this valuable germplasm as a part of national heritage. Reproductive efficiency of a cow is measured through gestation period, calving interval, service period while the productive efficiency is measured through standard lactation milk yeild, dry period, peak yield, lactation length, days to attain peak yield, persistency index and milk yield per day of lactaion..

The information on these aspects is vital for planning and monitoring breeding program for increased profitability from Rathi cows. It is, therefore, important to determine the variability in these economically important traits and their components to explore profitability through genetic improvement.

Keeping in view, the poor status of knowledge in Rathi breed of cattle, the present study was undertaken to abridge this yawning research gap with the following objectives:-

1. To evaluate milk production, its persistency and reproduction traits of Rathi cattle
2. To study effect of environmental and managemental factors affecting production and reproduction traits.

3. To study relationship among production and reproduction traits.
4. To suggest various managemental practices to improve production and reproduction traits of Rathi cattle.

The performance records of Rathi cattle maintained at Livestock Research Station, Department of Animal Breeding and Genetics, College of Veterinary and Animal Science, Bikaner and Livestock Research Station, Nohar, District Hanumangarh were used for present investigation. at both the farms, the animals were stall fed except for short period during rainy season during which the animals were sent for grazing. The standard feeding schedule based on age, production level, stage of pregnancy and other physiological conditions were followed. Roughage fed to all animals was chaffed. Common dry grasses are available at farm like Sewan, Anjan grass, Bhurat, Karad and chaffed Wheat straw. Seasonal green fodder in the form of Jowar, Bajra, Berseem, Rijka, Jai, etc. was fed to animals due to availability of water of Indira Gandhi Canal (Rajasthan canal) in this tract.

The concentrate ration containing 15% DCP and 70% TDN was fed to milking animals at the rate of 0.5 kg per litre of milk produced over and above maintenance ration. All the animals at these farms were maintained under uniform managemental conditions. Animals were housed in free barn housing system with adequate sheds for shelter against high temperature rain and extreme winter. For efficient management and care, animals were reared separately in different barns according to their age group. Young calves were kept in pucca calf pans till weaning.

The information from both the farms was recorded from history-cum-pedigree sheets on date of service, date of calving, date of dry, number of the cow, parity and 300 days SLMYmilk year 1974 to and calved 2008 The data were recorded calculated for the following traits: (A) Production traits e.g. persistency index, standard lactation milk yield, peak

yield, days to attain peak yield, milk yield per day of lactation length, lactation length and dry period, (B)Reproduction traits,e.g. service period, gestation period, calving interval.

The overall standard lactation milk yield (SLMY) was observed to be 1726.08 ± 12.621 litres. The effect of period of calving on lactation yield was found to be highly significant (P≤0.01). Fourth period is having highest SLMY (1851.97±26.728 litres). The influence of season of calving onSLMY was observed to be non-significant indicating poor contribution of season of calving to the total variability of lactation yield. The standard lactation milk yield was highly significantly (P≤0.01) influenced by parity. The effect of farm on milk yield was found to be non-significant. The higher milk yield was recorded at Bikaner farm as 1739.69 ± 19.202 litres while lower yield at Nohar farm as 1712.48 ± 16.087 litres.

The overall least-squares mean of peak yield was estimated as 9.02 ± 0.066 litres. The effect of period of calving was found to be statistically highly significant (P≤0.01). Peak milk yield was higher during the fourth period, followed by second, third and first period. Season of calving showed non-significant effect on peak yield in the present study. The maximum peak milk yield was found to be 9.14 ± 0.093 litres in third (winter) season and minimum was 8.83 ± 0.127 litres in second (rainy) season.

Effect of parity was observed to be non-significant whereas parity third got peak yield as 9.25 ± 0.143 litres which was highest and lowest in parity first was 8.80 ± 0.128 litres. Effect of farm on parity was observed to be non-significant indicating similar managemental practices in both farms.

The mean of lactation length was estimated to be 275.49 ± 4.655 days. The effect of period of calving was observed to be significant on lactation length. In the present study the lactation lengths in second and third periods were significantly higher than first and fourth periods. In the present study the effect of season of calving on lactation length was found to be highly significant (P≤ 0.01). The effect of parity on lactation length was found to be highly significant (P≤ 0.01). In respect of lactation length in the present study it was observed that parity first was found to be highest (301.57 ± 8.852 days) than other parities. The effect of farm on lactation length was found to be non-significant.

The dry period of Rathi cows was observed to be 154.46 ± 5.530 days in the present investigation. The cows calving in first and second periods exhibited longer dry period as compared to cows calving in preceding two periods which differ with each other. Shorter dry period was observed in the fourth period (144.68 ± 13.186 days). The seasonal influences at calving time on dry period were observed to be non-significant indicating contribution of season is not important in the total variability of dry period.

There was non-significant difference in dry periods due to parity. Fourth parity dry period was highest (170.91 ± 13.841days) and in fifth parity it was lowest (136.88 ± 11.972 days). The farm effect significantly influenced the dry period. Dry period was lower in the cows of Nohar farm than those of Bikaner farm.

The overall least-squares mean of days to attain peak yield was estimated as 30.95± 0.036 days. The effect of period of calving on days to attain peak yield was found to be statistically highly-significant (P≤0.01). Comparison of the period-wise mean days to attend peak yield were found to be higher in fourth period than third, second and first periods. Season of calving showed significant (P≤0.05) effect on days to attain peak yield in the present study. The maximum days to attain

peak yield was found to be 31.06 ± 0.060 days in season first (summer) and minimum was 30.85 ± 0.052 days in third season (winter). Effect of parity was observed to be highly significant (P≤0.01), parity fifth found 31.23 ± 0.064 days to attain peak yield, which is higher than other parities. Effect of farm was observed to be significant (P≤0.05) on days to attain peak yied.

The overall milk yield per day of lactation length was estimated as 5.92±0.038 litres. The effect of period of calving on milk yield per day of lactation length was found to be highly significant. (P≤0.01). Season-wise milk yields per day of lactation length were non-significant among themselves.. Comparison of parity wise means differed highly significantly (P≤0.01) from each other. The effect of farm was highly significant on wet average. . Farm second (Nohar) showed higher than farm first (Bikaner).

The persistency index of Rathi cows was observed to be 196.29 ± 1.296 in the present investigation. The effect of period of calving on persistency index was found to be highly significant (P≤0.01). The first period showed highest persistency index than other periods. The effect of season of calving on persistency index was found to be non-significant. The Second season showed highest persistency index than other seasons. The effect of parity on persistency index was statistically significant (p≤0.05). The third parity showed highest persistency index than other parities. The effect of farm on persistency index was found to be significant.

The average gestation period was 280.38 ± 0.781 days in present study. The effect of period of calving on gestation period was estimated to be non-significant. The season- wise least- squares means and standard errors for gestation period were non-significant. Effect of parity of calving was observed to be non-significant on gestation period of Rathi cows. The

maximum gestation period was observed in fourth parity while the minimum was in third parity. Effect on gestation period of farm was found to be significant Nohar farm showed higher gestation length than the Bikaner farm.

The average calving interval was 429.34 ± 3.488 days in Rathi cows. The effect of period of calving on calving interval was estimated as non-significant. The season-wise effect least-squares means for calving interval were non-significant. The overall means for calving Interval were calculated higher as 436.17 ± 5.960 days in season first and lowest as 422.86 ± 4.989 days in season third. Effect of parity of calving was observed to be highly significant ($p \leq 0.01$) on calving interval of Rathi cows. The maximum calving interval was observed in first parity. It is observed that first calvers used to calve late in next parity and there is not a great difference in the calving intervals of successive parities. Farms effect on calving interval was found to be highly significant. Nohar farm showing high then the Bikaner farm.

The overall average service period was estimated to be 149.56 ± 3.385 days. Period of calving was found to be non-significant on service period. The longest service period was 158.27 ± 5.681 days in the second period, whereas it was lowest during fourth season. Season of calving was found to be non-significant on service period. The longer service period was in the first season, whereas it was smaller during second and third season. Analysis revealed that the service period differs highly significantly by the parity. Longer service period was observed in first parity. Effect of farm showed significant variation in service period in the present study being the longer at Nohar and shorter at Bikaner.

Standard lactation milk yield was having highly significant and positive correlation with lactation length. It can be inferred that an increase in one production trait results in increase in another production trait except dry period having negative correlation which is desirable. Correlations of lactation length with peak yield and days to attain peak yield were

positive and significant. There were negative correlations of lactation length with persistency index, milk yield per day of lactation length and dry period. Correlation of peak yield with milk yield per day of lactation length was positive and highly significant. Correlations of peak yield with persistency index, dry period and days to attain peak yield were negative indicating the increase in the peak yield amounts the decrease in persistency index and dry period. Correlation of milk yield per day of lactation length with dry period and days to attain peak yield were positive but non-significant. There was no correlation of dry period with days to attain peak yield. Among reproduction traits the correlation between calving interval and service period is highly significant and positive. The correlation of service period and calving interval with production traits are generally highly significant.

It may be concluded from the results obtained that there is the significant effect of farm managemental practices on milk yield suggest that supply of green fodder and good concentrate mixture to animals, culling of unproductive animals from the herd managerial administration resulted into significant improvement in milk yield (the good managemental practices also enhance significant difference)

Good management practices like hygienic environment etc. causes highly significant difference over calving interval and service period which can be minimize by effective management

The following inferences have been drawn:

1. Rathi breed of cattle is very suitable in its home tract and selective breeding should be done and there shall not be encouragement of crossbreeding.

2. Early expressed traits like peak yield are a good indicative of total lactation.

3. Persistency index is a good indication of selection in the next lactation.

4. The performance of both the herds is improving in terms of production and reproduction traits over the periods.

5. Managemental practices are recommended breeding strategies, improved nutritive quality of fodder and provide suitable balanced feed.

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PERFORMANCE OF RATHI CATTLE UNDER ORGANIZED FARM

MANAGEMENT CONDITIONS

Ph.D.Thesis

Department of Livestock Production and Management
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Submitted by: **Chhote Singh Dhaka**
Under Guidance of **Dr. R. N. Kachwaha**

ABSTRACT

The present investigation was conducted on the performance records of 524 lactations of Rathi cows maintained at Livestock Research Station, Department of Animal Breeding and Genetics, College of Veterinary and Animal Science, Bikaner and 892 lactations of Rathi cows maintained at Livestock Research Station, Nohar, District Hanumangarh. To take account for genrtic as wel as environmental trends.The whole data were grouped into four periods according to date of calving as P1(1977-1985), P2 1986-1994), P3 (1995-2003) and P4 (2004-2011).To study the effect of season of calving on other production and reproduction traits, each year was divided into three seasons according to the climatic conditions The three seasons were summer S_1 (March to June), monsoon S_2 (July to October) and winter S_3 (November to February).

The overall standard lactation milk yield (SLMY) was observed to be 1726.08 S±112.621 litres. The effect of period of calving on lactation yield was found to be highly significant (P≤0.01). Fourth period is having highest SLMY (1851.97 ± 26.728 litres). The SLMY was highly significantly (P≤0.01) influenced by parity. The effect of farm on SLMY was found to be non-significant. The highest SLMY was recorded at Bikaner farm as 1739.69 ± 19.202 litres while lowest yield at Nohar farm was 1712.48 ± 16.087 litres. The overall least-squares mean of peak yield was estimated as 9.02 ± 0.066 litres. The effect of period of calving was found to be statistically highly significant (P≤0.01). The mean of lactation length was estimated to be 275.49 ± 4.655 days. The effect of period of calving was observed to be significant on lactation length. The effect of season of calving on lactation length was found to be highly significant (P≤ 0.01). The effect of parity on lactation length was found to be highly significant (P≤ 0.01).

The dry period of Rathi cows was observed to be 154.46 ± 5.530 days in the present investigation. There was non-significant difference in dry periods due to parity. The overall least-squares mean of days to attain peak yield was estimated as 30.95 ± 0.036 days. The effect of period of calving on days to attain peak yield was found to be statistically highly-significant (P≤0.01). Effect of parity was observed to be highly significant (P≤0.01), The overall milk yield per day of lactation

length was estimated as 5.92 ± 0.038 litres. The persistency index of Rathi cows was observed to be 196.29 ± 1.296 in the present investigation. The effect of period of calving on persistency index was found to be highly significant (P≤0.01). The average gestation period was 280.38 ± 0.781days in present study. The average calving interval was 429.34 ± 3.488 days in Rathi cows The overall average service period was estimated to be 149.56 ± 3.385 days The longest service period was 158.27 ± 5.681 days in the second period, whereas it was lowest during fourth season. Effect of farm showed significant variation in service period in the present study being the longer at Nohar and shorter at Bikaner. Positive and significant correlations of dry period with service period and calving interval were observed.

The standard lactation milk yield was correlated phenotypically with other traits. All these values were statistically significant (P≤ 0.05) to highly significant (P≤0.01). All the phenotypic correlations of SLMY with lactation length and milk yield per day of lactation length were ranging from high, positive and highly significant (P≤ 0.01). Service period had high, positive and significant phenotypic correlation with calving interval. A positive and significant phenotypic correlation was observed between service period and SLMY.

O;ofLFkr QkeZ izca/ku ifjfLFkfr;ksa esa jkBh xk;ks dk izn'kZu

विद्या–वाचस्पति शोध ग्रन्थ
पशुधन उत्पादन एवं प्रबंधन विभाग
पशु चिकित्सा एवं पशु विज्ञान महाविद्यालय
राजस्थान पशु चिकित्सा एवं पशु विश्वविद्यालय, बीकानेर–334 001

vx"kd&
e[; min"Vk&

NkV fl g <kdk
Mk- vkj-,u- dPNkok

vu ki!k

वर्तमान अनुसंधान पशु अनुसंधान केन्द्र बीकानेर (524 राठी गायों के रिकार्ड) एवं पशु अनुसंधान केन्द्र, नोहर (892, राठी गायो के रिकार्ड) हनुमानगढ पर निष्पादित अभिलेखों पर किया गया। समस्त अभिलेखों को चार समयकाल पी–1 (1974–1983), पी–2 (1984–1988), पी–3 (1989–1993) और पी–4 (1994–2002) में विभक्त किया गया। इन अभिलेखों के आधार पर प्रथम ब्यात की उम्र पर ब्यांत के समय पर और अन्य उत्पादक एवं प्रजनन गुणो का अध्ययन किया गया। प्रत्येक वर्ष को तापमान, आर्द्रता एवं वर्षा के आधार पर तीन अवधियों में बांटा गया। समस्त मानक दुग्ध उत्पादन 1726.08±112.62 लीटर पाया गया। ब्यांत के समय का दुग्ध–उत्पादन पर अत्यधिक प्रभाव पाया गया। चौथी ब्यांत के बाद अधिक दुग्ध उत्पादन 1851.97±26.728 लीटर था। ब्यांत का मानक दुग्ध–उत्पादन पर सर्वाधिक प्रभाव पाया गया। परंतु फार्म प्रभाव का दुग्ध उत्पादन पर प्रभावी नहीं पाया गया। सर्वाधिक दुग्ध उत्पादन 1739.69±19.202 लीटर बीकानेर फार्म पर तथा नोहर फार्म पर न्यूनतम 1712.48±16.087 लीटर रिकार्ड किया गया। ब्यांत के समय का दुग्ध उत्पादन पर सर्वाधिक प्रभाव पाया गया। औसत दुग्धकाल 275.49±4.655 दिन पाया गया। ब्यांत के समय का दुग्धकाल पर सर्वाधिक प्रभाव रहा। इसी प्रकार ब्यांत संख्या का भी दुग्ध काल पर सर्वाधिक प्रभाव रहा।

प्रस्तुत अध्ययन में राठी गायों में सूक्ष्मकाल 154.46±5.530 दिन रहा। ब्यांत की संख्या का शुष्ककाल पर प्रभाव नगण्य था। औसतन, उच्चतम दुग्ध उत्पादन 30.95±0.036 दिन पर पाया गया। ब्यांत की संख्या का प्रभाव उच्चतम दुग्ध उत्पादन के समय पर सर्वाधिक रहा। औसत दुग्ध–उत्पादन, संपूर्ण दुग्ध काल में 5.92±0.038 लीटर रहा। प्रस्तुत अध्ययन में राठी गायों का परसिसटेन्सी, सूचकांक 196.29±1.296 रहा और इस पर ब्यांत के समय का सर्वधिक प्रभाव रहा परन्तु अध्ययन में औसतन गर्भकाल 280.38±0.781 पाया गया जबकि औसतन गर्भ अंतराल 429.34±3.466 दिन रहा। सबसे लंबा सर्विस काल 158.27±5.661 दिन दुसरे सर्विस काल पर

पाया गया जबकि चौथे सर्विस काल पर यह न्यूनतम था। फार्म का प्रभाव सर्विस काल पर प्रभावित रहा जो कि नोहर फार्म पर अधिकतम व बीकानेर फार्म पर न्यूनतम पाया गया।

मानक दुग्ध उत्पादन का सीधा संबंध अन्य सभी गुणों पर भी निर्भर रहा। सभी विशेषताएं सांख्यिकीय रूप से कुछ गुणों पर प्रभावित व कुछ गुणों पर अत्यधिक प्रभावित रही। सभी आनुंवाशिक व ऊपरी (फीनोटोपिक) गुण जैसे दुग्धकाल, दुग्ध उत्पादन, सर्वाधिक दुग्ध उत्पादन, जीवनकालिन दुग्ध–उत्पादन अर्थपूर्ण व अच्छे व बेहतर रहे।

सर्विस काल पर प्रजनन का सहसंबंध 0.84±0.12 और बाहरी (फीनोटोपिक) सहसंबंध 0.66±0.024 रहा। सर्विस काल व दुग्ध उत्पादन का सकारात्मक और अर्थपूर्ण प्रभाव रहा।

फार्म पर अच्छे प्रबंधन का प्रभाव समस्त मूल्यांकनो पर न्यूनतम से मध्यम व सर्वाधिक पाया गया।

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Rajasthan University of Veterinary and Animal Sciences,
Bikaner-334001

ैनइउपजजमक इलरू बीवजमैपदही कीं

Under Guidance of **Dr. R. N. Kachwaha**

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O;ofLFkr QkeZ izca/ku ifjfLFkfr;ksa esa jkBh xk;ks dk izn'kZu

विद्या–वाचस्पति शोध ग्रन्थ

पशुधन उत्पाद एवं प्रबंधन विभाग
पशु चिकित्सा एवं पशु विज्ञान महाविद्यालय
राजस्थान पशु चिकित्सा एवं पशु विश्वविद्यालय, बीकानेर–334 001

vx:"kd& NkVs fl:g <kdk
e:[; min"Vk& Mk- vkj-,u- dPNkok

vu:ki!k

वर्तमान अनुसंधान पशु अनुसंधान केन्द्र बीकानेर (524 राठी गायों के रिकार्ड) एवं पशु अनुसंधान केन्द्र, नोहर (892, राठी गायो के रिकार्ड) हनुमानगढ पर निष्पादित अभिलेखों पर किया गया। समस्त अभिलेखों को चार समयकाल पी–1 (1974–1983), पी–2 (1984–1988), पी–3 (1989–1993) और पी–4 (1994–2002) में विभक्त किया गया। इन अभिलेखों के आधार पर प्रथम ब्यात की उम्र पर ब्यांत के समय पर और अन्य उत्पादक एवं प्रजनन गुणो का अध्ययन किया गया। प्रत्येक वर्ष को तापमान, आर्द्रता एवं वर्षा के आधार पर तीन अवधियों में बांटा गया। समस्त मानक दुग्ध उत्पादन 1726.08±112.62 लीटर पाया गया। ब्यांत के समय का दुग्ध–उत्पादन पर अत्यधिक प्रभाव पाया गया। चौथी ब्यांत के बाद अधिक दुग्ध उत्पादन 1851.97±26.728 लीटर था। ब्यांत का मानक दुग्ध–उत्पादन पर सर्वाधिक प्रभाव पाया गया। परंतु फार्म प्रभाव का दुग्ध उत्पादन पर प्रभावी नहीं पाया गया। सर्वाधिक दुग्ध

उत्पादन 1739.69±19.202 लीटर बीकानेर फार्म पर तथा नोहर फार्म पर न्यूनतम 1712.48±16.087 लीटर रिकार्ड किया गया। ब्यांत के समय का दुग्ध उत्पादन पर सर्वाधिक प्रभाव पाया गया। औसत दुग्धकाल 275.49±4.655 दिन पाया गया। ब्यांत के समय का दुग्धकाल पर सर्वाधिक प्रभाव रहा। इसी प्रकार ब्यांत संख्या का भी दुग्ध काल पर सर्वाधिक प्रभाव रहा।

प्रस्तुत अध्ययन में राठी गायों में सूक्ष्मकाल 154.46±5.530 दिन रहा। ब्यांत की संख्या का शुष्ककाल पर प्रभाव नगण्य था। औसतन, उच्चतम दुग्ध उत्पादन 30.95±0.036 दिन पर पाया गया। ब्यांत की संख्या का प्रभाव उच्चतम दुग्ध उत्पादन के समय पर सर्वाधिक रहा। औसत दुग्ध–उत्पादन, संपूर्ण दुग्ध काल में 5.92±0.038 लीटर रहा। प्रस्तुत अध्ययन में राठी गायों का परसिसटेन्सी, सूचकांक 196.29±1.296 रहा और इस पर ब्यांत के समय का सर्वधिक प्रभाव रहा परन्तु अध्ययन में औसतन गर्भकाल 280.38±0.781 पाया गया जबकि औसतन गर्भ अंतराल 429.34±3.466 दिन रहा। सबसे लंबा सर्विस काल 158.27±5.661 दिन दुसरे सर्विस काल पर पाया गया जबकि चौथे सर्विस काल पर यह न्यूनतम था। फार्म का प्रभाव सर्विस काल पर प्रभावित रहा जो कि नोहर फार्म पर अधिकतम व बीकानेर फार्म पर न्यूनतम पाया गया।

मानक दुग्ध उत्पादन का सीधा संबंध अन्य सभी गुणों पर भी निर्भर रहा। सभी विशेषताएं सांख्यिकीय रूप से कुछ गुणों पर प्रभावित व कुछ गुणों पर अत्यधिक प्रभावित रही। सभी आनुंवाशिक व ऊपरी (फीनोटोपिक) गुण जैसे दुग्धकाल, दुग्ध उत्पादन, सर्वाधिक दुग्ध उत्पादन, जीवनकालिन दुग्ध–उत्पादन अर्थपूर्ण व अच्छे व बेहतर रहे।

सर्विस काल पर प्रजनन का सहसंबंध 0.84±0.12 और बाहरी (फीनोटोपिक) सहसंबंध 0.66±0.024 रहा। सर्विस काल व दुग्ध उत्पादन का सकारात्मक और अर्थपूर्ण प्रभाव रहा।

फार्म पर अच्छे प्रबंधन का प्रभाव समस्त मूल्यांकनो पर न्यूनतम से मध्यम व सर्वाधिक पाया गया।

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(C.S. Dhaka)

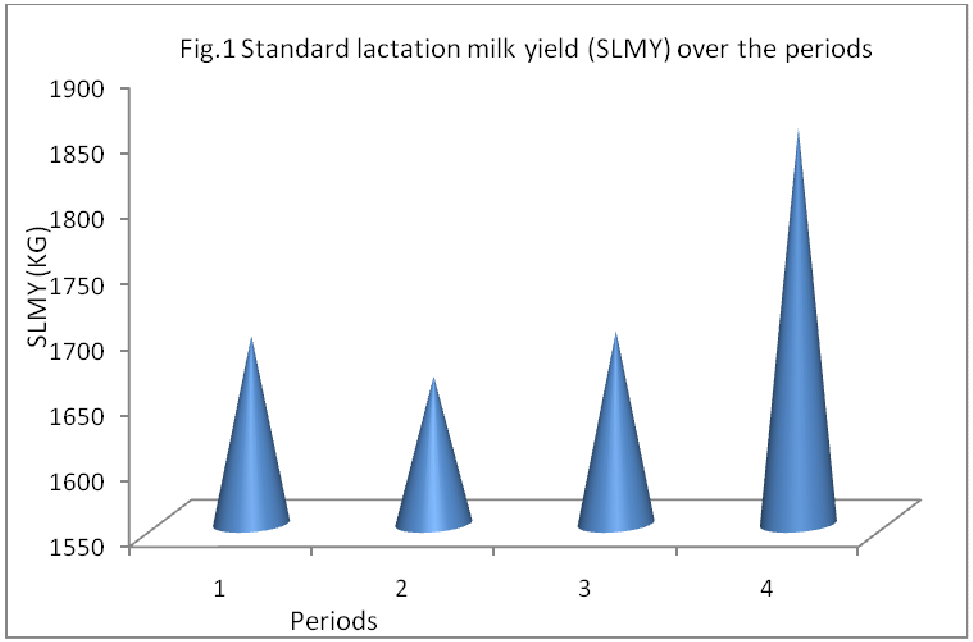


Fig.1 Standard lactation milk yield (SLMY) over the periods
1900
1850
1800
1750
1700
1650
1600
1550
SLMY (KG)
1
2
3
4
Periods

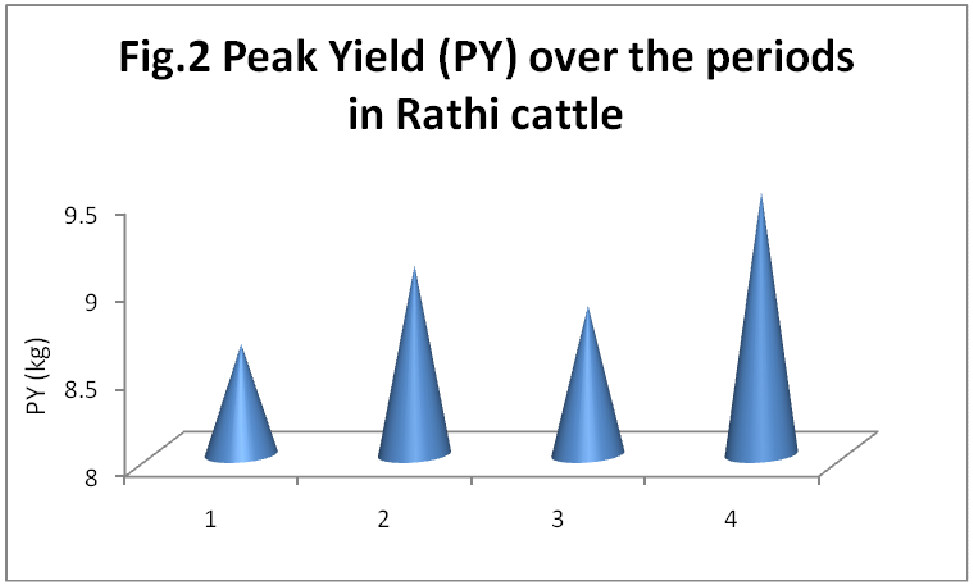


Fig.2 Peak Yield (PY) over the periods in Rathi cattle
PY (kg)
9.5
9
8.5
8
1
2
3
4

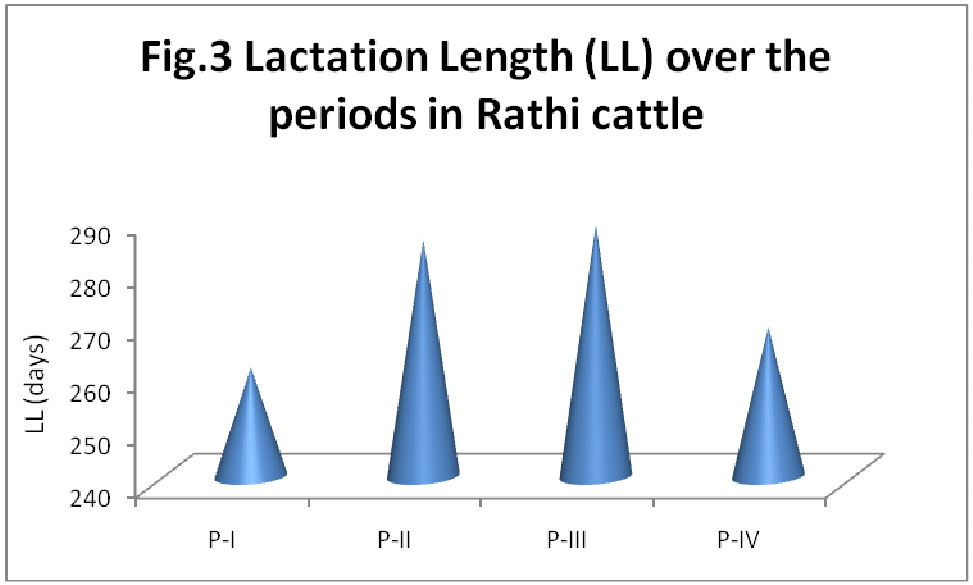


Fig.3 Lactation Length (LL) over the periods in Rathi cattle
LL (days)
290
280
270
260
250
240
P-I
P-II
P-III
P-IV

Fig 3. STandard lactation milk yield (SLMY) in Rathi cattle

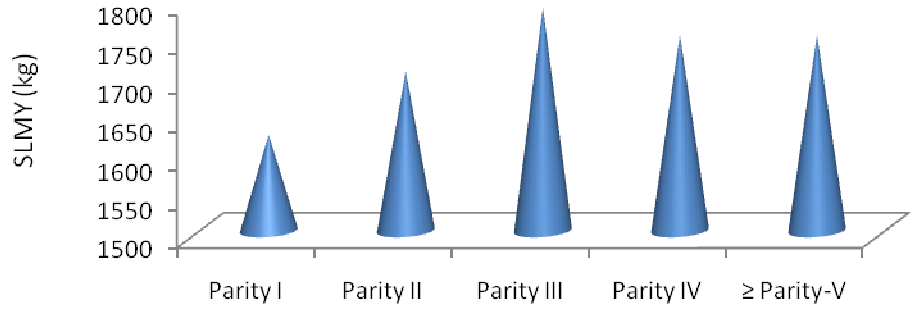
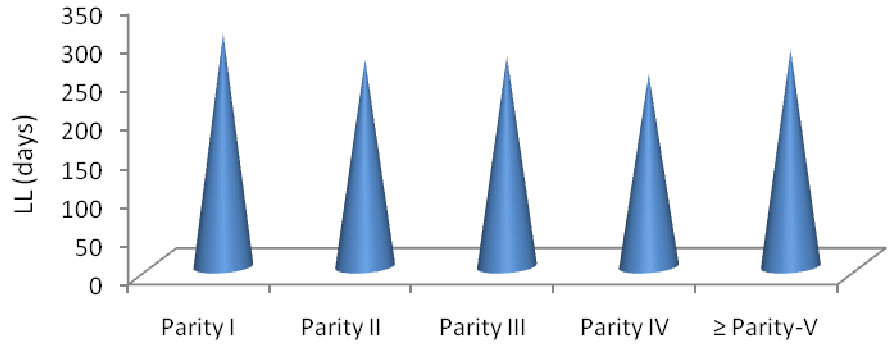


Fig . Lactation length (LL) over the period in Rathi cattle



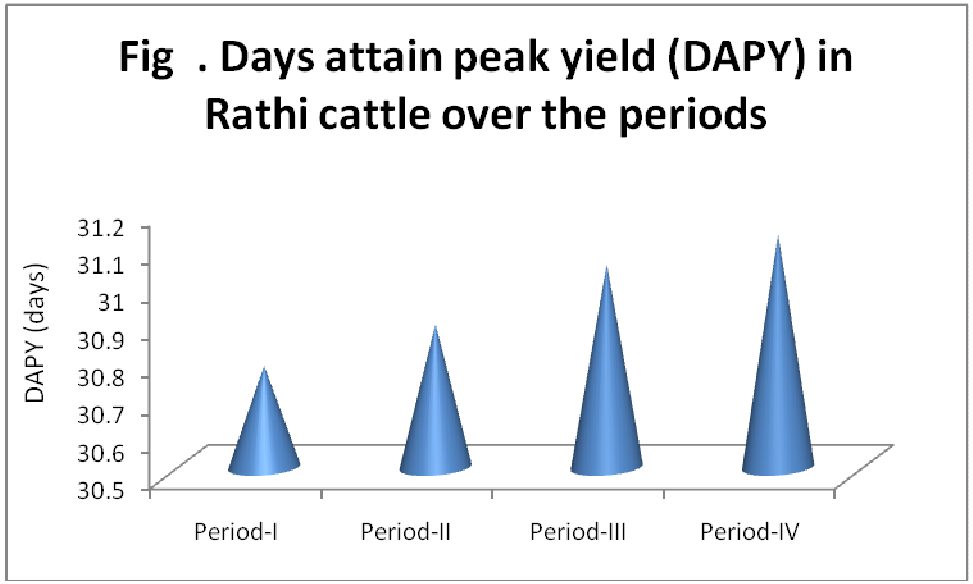


Fig . Days attain peak yield (DAPY) in Rathi cattle over the periods
DAPY (days)
31.2
31.1
31
30.9
30.8
30.7
30.6
30.5
Period-I
Period-II
Period-III
Period-IV

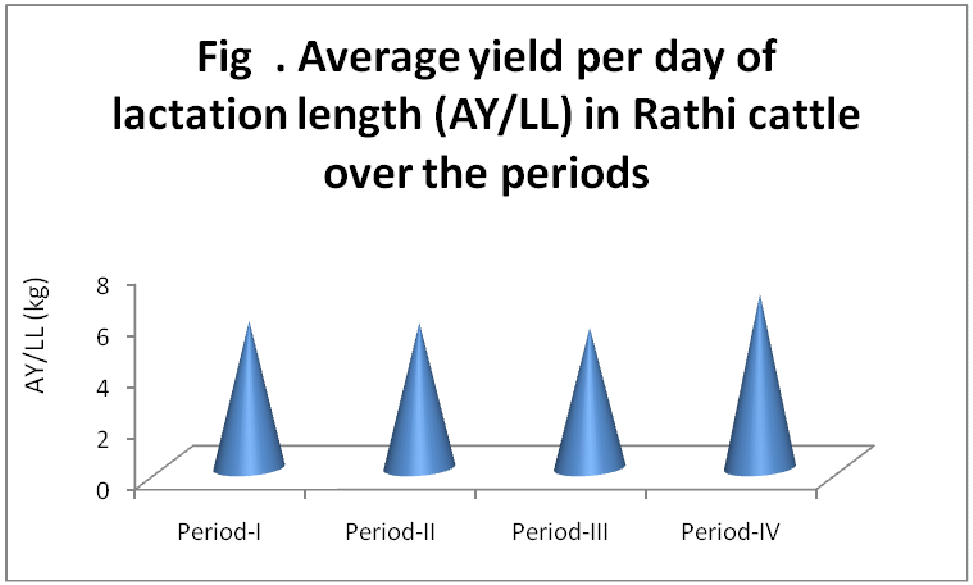


Fig . Average yield per day of lactation length (AY/LL) in Rathi cattle over the periods
AY/LL (kg)
8
6
4
2
0
Period-I
Period-II
Period-III
Period-IV

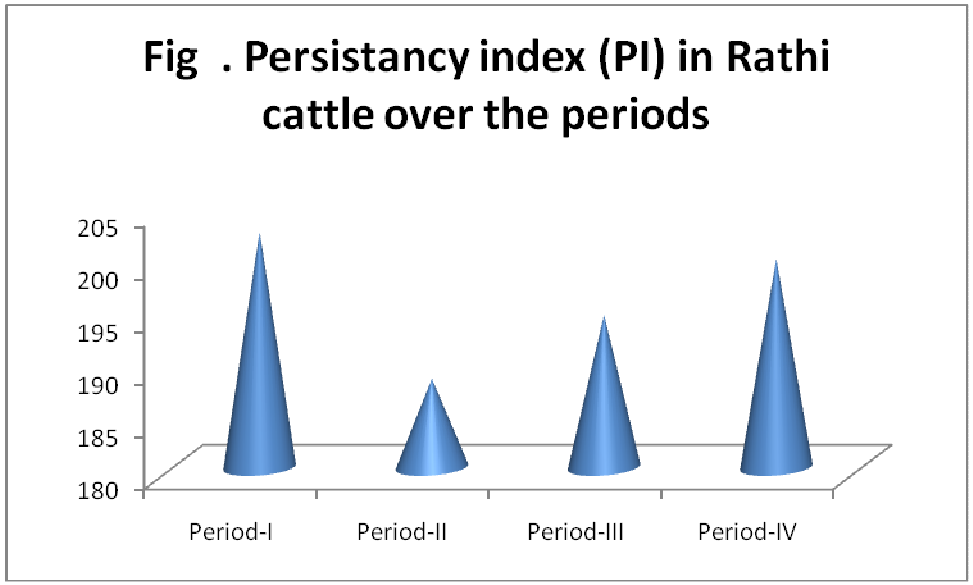


Fig . Persistancy index (PI) in Rathi cattle over the periods
205
200
195
190
185
180
Period-I
Period-II
Period-III
Period-IV

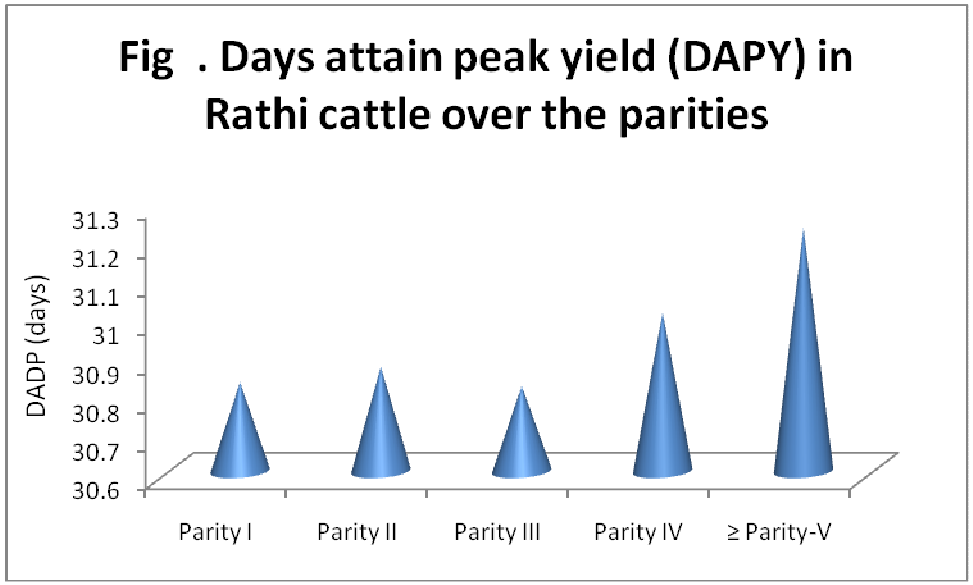


Fig . Days attain peak yield (DAPY) in Rathi cattle over the parities
DADP (days)
31.3
31.2
31.1
31
30.9
30.8
30.7
30.6
Parity I
Parity II
Parity III
Parity IV
≥ Parity-V

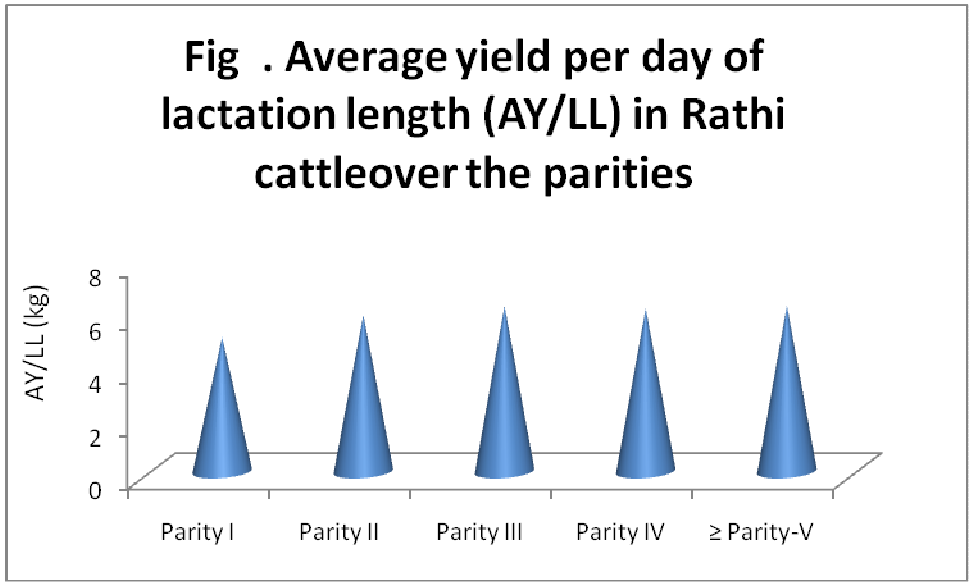


Fig . Average yield per day of lactation length (AY/LL) in Rathi cattleover the parities
AY/LL (kg)
8
6
4
2
0
Parity I
Parity II
Parity III
Parity IV
≥ Parity-V

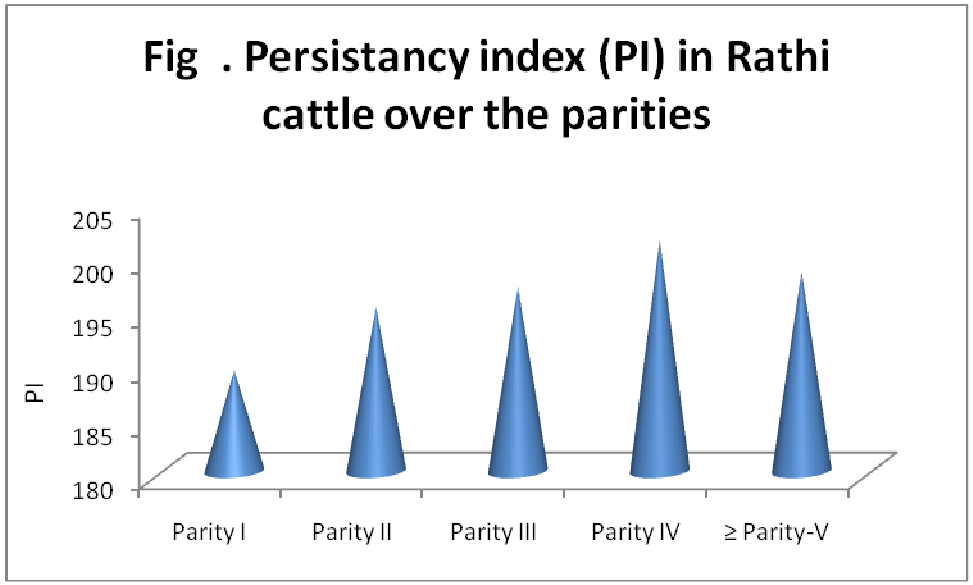


Fig . Persistancy index (PI) in Rathi cattle over the parities
205
200
195
190
185
180
PI
Parity I
Parity II
Parity III
Parity IV
≥ Parity-V

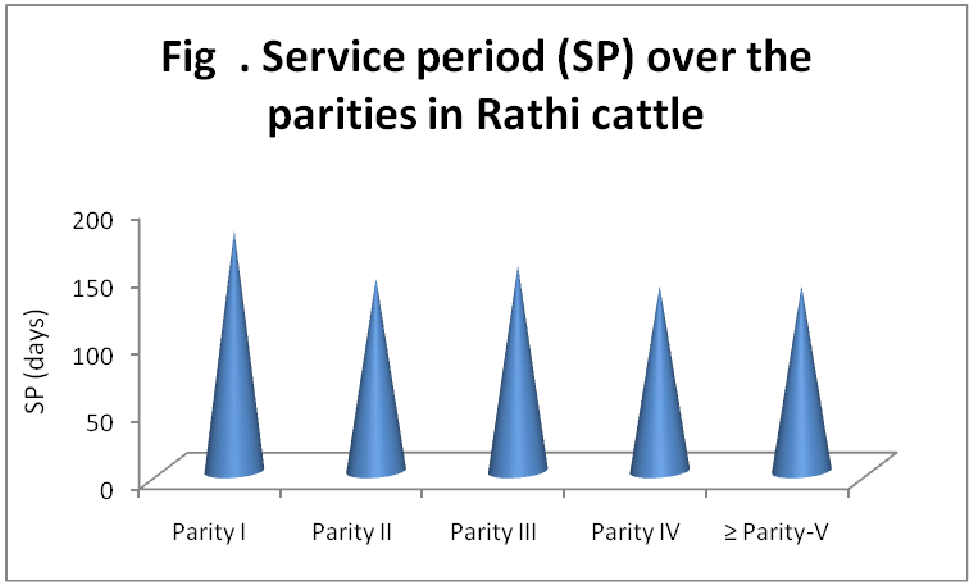


Fig . Service period (SP) over the parities in Rathi cattle
SP (days)
200
150
100
50
0
Parity I
Parity II
Parity III
Parity IV
≥ Parity-V

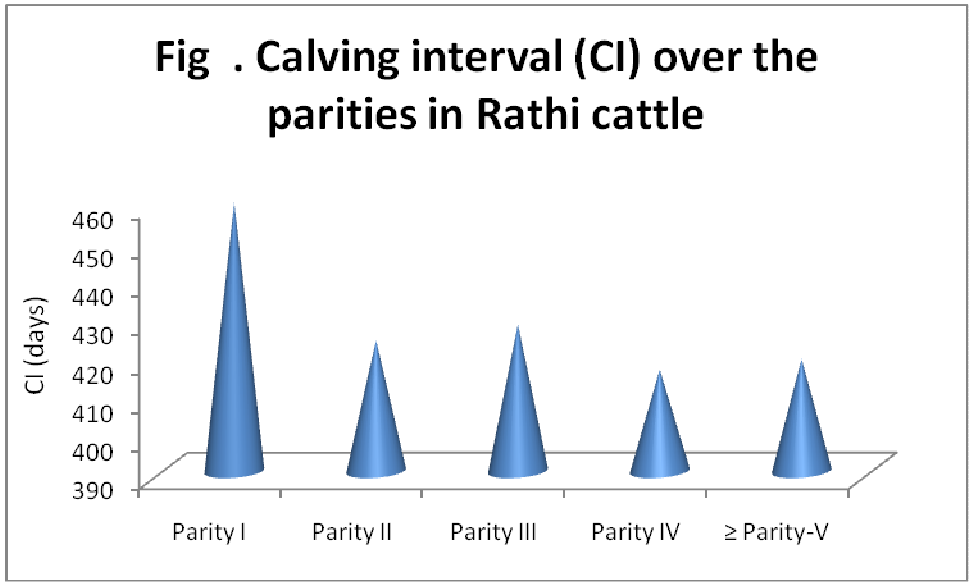


Fig . Calving interval (CI) over the parities in Rathi cattle
CI (days)
460
450
440
430
420
410
400
390
Parity I
Parity II
Parity III
Parity IV
≥ Parity-V

INTRODUCTION

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