# GENETIC STUDIES ON REPRODUCTIVE TRAITS OF THARPARKAR COWS

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( S. C. MAJUMDAR )

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# CHAPTER - I

# INTRODUCTION

# INTRODUCTION

According to 1961 census the cattle population of India is 226.8 million. So the cattle population at the rate of 2% increase per year can be taken at about 260 million in 1969. This population is about one fifth of the total population of the world. Yet the milk production is alarmingly low in India. An Indian, on an average, consumes 5 oz. of milk and milk products which is less than half the minimum amount (12 oz.) recommended by F.A.O. In order to step up milk production, the productive potential of each cow has to be raised. In addition the cows must be regular breeder with a calving interval of one year so that a higher percentage of cows may be in milk at any time of the year. Therefore, reproductive efficiency is an essential item for raising the productivity of cows.

Variation in "reproductive efficiency" according to Iush is due to heredity plus environment and their interaction. Within a breed the genetic variation of reproductive efficiency is small but genes are surely responsible for variation among breeds and in different herds.

Indian cattle are reported to be of late sexual maturity and of having long calving intervals. Early maturity has been found to be economical since increase in the age of sexual maturity of a cow by one day increases expenditure of Re 1/- (Desai & Kumar, 1963). It would also reduce the unproductive period of our cattle and hence increases their life-time production.

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The reduction in age at sexual maturity would result in the reduction of generation interval which would in turn increase the rate of genetic gain under any selection programme per unit of time.

Thus, improvement in reproductive efficiency has direct relationship with the productivity of the cow. The present investigation was undertaken to study the various factors related with reproduction.

Therefore, the study included the following factors:-

(a) Age at first calving.

(b) Open period i.e. interval from calving upto the first insemination.

(c) Insemination period i.e. interval from first service upto conception.

(d) Calving interval i.e. interval between two successive calvings.

(e) Number of services per conception.

(f) Number of heats missed in an insemination period, i.e. number of oestrus in which insemination could not be done.

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# CHAPTER - II

# REVIEW OF LITERATURE

# REVIEW OF LITERATURE

Works done on the reproductive efficiency of Indian breeds of cows are not so extensive as in case of cows of temperate zone.

As fertility is influenced by heredity, according to Wegscheider (1939), the disorders of reproduction can be controlled by breeding. Wilcox et al.(1956) measured fertility as the number of viable calves produced in the life-time by Holstein-Friesian cows. Heritability of this fertility was 0.3.

Koort (1948) observed that fertility in Swedish Red and White cattle was affected by age of cow, even when the herd management was Quite good. Lindley et al.(1958) reported that reproductive efficiency was affected by age. Koort (1948) also reported that the fertility of the cow was affected by the quality of the food and by the occurrence of diseases, but not by her production. Gerdemann (1966) found that there was a close association between fertility and lactation curve. In his investigation he found that 67.2 % of cows showed fertility disorders and 8.6 % was completely infertile out of 174 cows with irregular lactation curves. Out of 147 cows with steep lactation curves 44.2 % showed fertility disorders and 6.8 % showed completely infertile.

According to Mahadevan & Hutchison (1964) within breeds, heredity played only a minor part in reproductive activity.

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## I. AGE AT FIRST CALVING

The age at first calving is a character of much economic importance. It affects the life-time production of animals, as early age at first calving would reduce the unproductive period of cows, hence increase their life-time production giving immediate benefit to owner. From genetic point of view it would reduce generation interval, thus making progeny testing a practicable proposition in late maturing tropical cattle and also increasing genetic gain per year.

Prasad (1962) obtained relative economic value of age at first calving with one month as its unit in Tharparkar herd of Patna and this was Rs.32.39 per unit. According to Ahmad (1961) the relative economic value was 472.67 with year as its unit in Hariana herd.

According to Dickerson & Chapman (1940), Hanson (1941) and Ragab et al. (1953 and 1954) age at first calving has got much influence over the first lactation yield.

Mahadevan (1958) reported that age at first calving is a matter of management practice in temperate zone, where as in Indian cattle, it is a result of age at first heat period which in turn is a physiological and probably hereditary trait.

Stonaker (1953) reported that this trait is highly hereditary in the pure bred Red Sindhi herd at Allahabad Agricultural Institute. But Singh (1957) found that heritability

of this trait was zero in the Tharparkar herd at Government Cattle Farm, Patna.

Tandon (1951) reported that age at first calving has a threshold of expression and that genes for early maturity are dominant over those for late sexual maturity. Lecky (1951) inferred that breed characteristics were responsible for late maturity in tropical breeds like Fulani. Sayer (1936) held the opinion that by good feeding and management it would be possible to lower age at first calving in Indian cattle.

The averages of age at first calving for Tharparkar cattle reported by different workers have been presented in table I.

TABLE-I

Age at first calving of Tharparkar cattle

| Breed | Average age at first calving (Months) | Reference |
|---|---|---|
| Tharparkar | 43.0 | Kartha (1934) |
| | 48.7 ± 0.4 | Singh (1957) |
| | 49.4 ± 0.4 | Amble, Krishnan & Soni (1958) |
| | 43.5 | Singh, Sinha (1960) |
| | 43.5 | Singh & Chowdhury (1961) |

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The average of age at first calving of other Indian breeds are as follows:-

TABLE-II

Age at first calving of other Indian breeds

| Breed | Average age at first calving (Months) | Reference |
|---|---|---|
| Sahiwal | 36.5 | Kartha (1934) |
| Hariana | 46.0 | Kartha (1934) |
| Red Sindhi | 36.9 | Rigor (1949) |
| Sindhi | 1331.3 (days) | Rajagopalan (1951-52) |
| Kangayam | 1447.5 ( " ) | " " |
| Kankrej | 48.47 months | Joshi & Phillip (1953) |
| Red Sindhi | 42.0 " | Sundaresan et al. (1954) |
| " " | 47.0 " | Mahadevan (1955) |
| " " | 42.9 " | Venkayya & Krishnan (1956) |
| Gir | 47.3 " | Venkayya & Krishnan (1956) |
| Hariana | 58.83 " | Kohli & Suri (1957) |
| Hariana at Madhurikund | 1546 (days) | Johari & Talapatra (1957) |
| Hariana at Bharari | 1683 (days ) | " " " |
| Hariana at Babugarh | 1262 (days) | " " " |
| Hariana at Hastinapur | 1498 ( " ) | " " " |
| Hariana at Nilgaon | 1693 ( " ) | " " " |
| Hariana at Mathura | 1544 ( " ) | " " " |

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TABLE - XI (Contd.)

| Breed | Average age at first calving (months) | Reference |
|---|---|---|
| Sindhi at Hosur : | | |
| Ist generation | 40.3 | Amble, Krishnan & Srivastav (1958) |
| 2nd " | 40.3 | " " " |
| 3rd " | 42.6 | " " " |
| Sindhi at Bangalore: | | |
| Ist generation | 39.4 | " " " |
| 2nd " | 42.1 | " " " |
| 3rd " | 44.1 | " " " |
| Red Sindhi at Hosur: | 41.7 | Amble, Krishnan & Soni (1958) |
| " " at Bangalore | 41.7 | " " " |
| Kangayan | 44.1 | " " " |
| Gir | 47.0 | " " " |
| Kankrej | 47.4 | " " " |
| Hariana at Mathura | 38.92 | Singh & Desai (1961) |
| " at Madhurikund | 50.09 | " " " |
| " at Bharari | 50.87 | " " " |
| " at Babugarh | 44.09 | " " " |
| Sahiwal | 41.1 | Singh & Chowdhury (1961) |
| Hariana | 59.3 | Kohli et al.(1961) |
| Sahiwal at M.F. Lucknow | 1196.8 (days) | Batra (1961) |
| " at M.F. Ambala | 1144.7 ( " ) | " " |
| " at Meerut | 1154.1 ( " ) | " " |

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The average age at first calving of some crossbreds:-

TABLE - III

| Cross breed. | Average age at first calving (months) | Reference |
|---|---|---|
| Ayreshire, Red Sindhi crossbreds | 35.1 | Venkayya & Ananta Krishnan (1956) |
| ½ Jersey x ½ R.S. | 29.0 | Sundaresan et al.(1954) |
| ¾ J. x ¼ R.S. | 36.0 | " " |
| ½ Brownswiss x ½ R.S. | 42.0 | " " |
| ¾ B.S. x ¼ R.S. | 33.0 | " " |
| ½ Holstein x ½ R.S. | 38.0 | " " |
| ½ Ayreshire x ½ R.S. | 38.8 | Rigor (1949) |
| ¾ A. x ¼ R.S. | 43.4 | " " |
| ⅞ A. x ⅛ R.S. | 48.7 | " " |

The average age at first calving of some African and European breeds:-

TABLE - IV

| Breed | Average age at first calving (months) | Reference |
|---|---|---|
| African | | |
| Native Egyptian | 44.3 | Asker et al.(1958) |
| Kenana | 38.4 | Alim (1960) |
| Butana | 44.0 | Alim (1962) |
| African Dairy cows | 42.9 | Danasoury & Bayomi(1962) |



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## TABLE - IV (Contd.)

| Breed | Average age at first calving (months) | Reference |
|---|---|---|
| Small east African Zebu | 42.7 | Galukande et al. (1962) |
| Nganda | 42.0 | Mahadevan & Marples (1961) |
| Boran & Jiddu | 39.9 | Mahadevan & Hutchison (1962) |
| **European:** | | |
| Friesian | 33.5-34.0 | Bonmi (1957) and Dassat (1953) |
| Jersey | 26.5 | Copeland (1939) |
| Friesian | 25.0 | Giuliani (1952) |
| Jersey | 30.0 | Sundaresan et al. (1954) |
| Brown Alpine | 27.0 | Giuliani (1953) |
| " " | 33.0 - 33.5 | Bonmi (1957) & Dassat (1953) |
| Sweedish lowland | 32.5 | Ralsson (1952) |
| Aosta | 32.4 | Dassat (1953) |
| Pied Mount | 32.4 | " " |
| Red Pied Aosta | 2 yrs. 7½ months | Aghina (1952-'53) |
| Black Pied lowland | 2½ yrs.-3 yrs. | Hartman (1953) |
| Yellow Franconian | 31 months. | Hofman & Kleiber (1955) |
| Brown Alpine | 35 " | Maoli & Mazziotti Dicelso (1964) |
| Dutch Friesian | 36 " | " " " |
| Brown Alpine and Dutch Friesian | 35 " | " " " |
| Bulgarian Red | 34 " | Conev, Iocov & Angelov (1965) |



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From the averages given in table 1, II, III & IV, it is found that the age at first calving of Indian breeds is about seventeen months latter than European breeds. The range of average age at first calving of Indian breeds is 36.5 to 59.3 and the same for European breeds is between 24.6 months to 34 months. African cattle are intermediate between the two and their range is between 34.3 to 44.3 months. Crossbreds are maturing earlier than Indian breeds and their range is between 29.0 to 48.7 months. Little wood (1936) found that the age of sexual maturity of Nellore cows was after 4 - 5 years in India, while for the same breed Veiga, Chieffi & Raiva (1946) reported that the age at first calving was 41 months and 24 days in Brazil.

Amble, Krishnan & Soni (1958) found that village cattle calved at an older age (47 to over 50 months) than dairy cows (42 to 49 months) belonging to farms and Research institute.

Heritability

Many workers have studied the heritability of the trait in temperate, Tropical and subtropical countries. The results are presented in table V.

TABLE - V

| Author | Year | Breed | Heritability | d.f. | Method of analysis |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Stonaker | 1953 | Red Sindhi | 0.39 | 90 | Intrasire regression. |
| Singh | 1957 | Tharparkar | -0.361 ±0.099 | 139 | -do- |
| " | " | " | -0.305 ±0.083 | 139 | Intrasire correlation. |



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TABLE - V (contd.)

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Singh | 1957 | Tharparkar | 0.046 ± 0.086 | 139 | Paternal half sibs correlation |
| Amble et al. | 1958 | Red Sindhi at Hosur | -0.09 ± 0.17 | 192 | Intrasire regression |
| " " | " | R.S. at Bangalore | 0.16 ± 0.29 | 134 | " |
| Amble, Krishnan & Soni | 1958 | Kangayam | -0.08 ± 0.16 | 281 | " |
| " " | " | Gir | -1.24 ± 0.58 | 29 | " |
| " " | " | Kankrej | 0.66 ± 0.24 | 41 | " |
| " " | " | Tharparkar | 0.48 ± 0.16 | 215 | " |
| Singh | 1959 | Hariana | 0.3403 | - | " |
| " | " | " | 0.5916 | - | Half sib correlation |
| Singh & Desai | 1961 | " | 0.34 ± 0.12 | 243 | Intrasire regression |
| " " | " | " | 0.34 ± 0.19 | 243 | Half sib correlation |
| " " | " | " | 0.40 ± 0.18 | 322 | " |
| Batra | 1961 | Sahiwal | 0.50 ± 0.19 | 159 | " |
| Ahmad | 1961 | Hariana | 0.37 * | 146 | Regression |
| Prasad | 1962 | Tharparkar | 0.08 | - | By dividing additive genetic variance by Phenotypic variance. |
| Singh | 1964 | Hariana | 0.35 ± 0.269 | 149 | Paternal half sib |
| | | | -0.095 ± 0.234 | 49 | Regression |
| | | | -0.121 ± 0.272 | 49 | Correlation |
| Bhasin & Desai, | 1967 | Hariana | 0.17 ± 0.13 | 20 | Regression. |



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Effect of age at first calving on Reproduction

Dickerson (1940) studied two large Holstein herds varying in age at first calving from 24 - 36 months. His analysis indicated that breeding of heifers as early as 26 months is not detrimental to reproduction.

Rognoni & Pasti (1955) found that age at first calving and first calving interval was insignificantly positively correlated ( r = 0.04 ) in Friesian cows in Piacanza district.

In Franconian cattle, Hofmann & Kleiber (1955) found that when age at first calving increased from 27 months to 38-42 months there was a decrease in average number of calves produced per cow from 9.00 to 8.03.

In Brown Alpine cattle in Piacentino, Rognoni (1956) found a negative correlation ( r = -0.48) between age at first calving and first calving interval.

Venkayya & Anantakrishnan (1956) obtained correlation coefficient of 0.56, 0.20 and 0.28 for Red Sindhi, Gir and crossbred respectively while studying relationship between age at first calving and first calving interval.

Singh (1957) obtained correlation coefficient of 0.025 between age at first calving and calving interval in Tharparkar cattle.

Kohli & Suri (1961) obtained non-significant correlation between age at first calving and first calving interval.



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Singh & Chowdhury (1961) obtained correlations of 0.12 and 0.04 between age at first calving and calving interval for Sahiwal and Tharparkar herd respectively.

Danasoury & Bayomi (1962) found non-significant correlation between age at first calving and first calving interval in indigenous dairy cattle of Khartoum farm.

Prasad (1962) obtained - 0.2 as genetic correlation between age at first calving and first calving interval.

Singh (1964) on analysis of records of Hariana herd obtained 0.1669 and 0.3211 as phenotypic and genetic correlation respectively between age at first calving and first calving interval.

Gautam, Tomar and Agrawal (1966) reported that breeding efficiency was affected significantly by age at first calving. They estimated breeding efficiency as 365 (n-1) x 100/D, where n=number of calving and D = number of days from first to last calving. It was found maximum (91.0 %) when the age at first calving was between 36 to 39 months.

Singh & Sundaresan (1966) obtained 0.091 and 0.701 as phenotypic and genetic correlation respectively between age at first calving and first calving interval in Tharparkar cattle.

<u>Effect of age at first calving on milk production</u>

Chapman & Dickerson (1936) found correlation of age at first calving with cumulative milk yield of first two, three, four and five lactations as 0.22, 0.24, 0.22, 0.17 and 0.13



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respectively, showing a decline in relationship with each additional lactation.

Robertson (1951) found that the effect of age at first calving on milk yield of first lactation in Fulani cattle was very small and regression was also non-significant.

On analysis of D.H.I.A. record Larson et al.(1951) obtained 0.06 as correlation coefficient between age at first calving and first 305 days milk production in first lactation.

Rajagopalan (1951-'52) analysed correlation between age at first calving and first lactation yield. The data were obtained for 81 Sindhi cows of the Hosur cattle farm, Madras and the correlation coefficient was found to be 0.1217 which is not significant. Correlation coefficient was estimated also for 31 Kangayam cows of the same farm between the two characters. It was found to be 0.60694 which was highly significant.

Hartman (1953) investigated relationship between age at first calving and milk production of Blackpied lowland cattle in Altmark breeding area. His findings can be summarised in the following way :-

(1) Cows calving at an early age showed maximum life-time production.

(2) Annual yield was maximum in cows which calved at $2\frac{1}{2}$ - 3 years of age.

(3) First lactation yield was maximum in cows which calved over 3 years of age and subsequent lactation yield

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was maximum in cows which calved earlier than 3 years of age.

(4) Earlier calvers consume less food per kg. of milk production.

Sundaresan, Elbridge and Atkeson (1954) reported significant negative correlations between age at first calving and first 5 years milk production after calving. It was indicated that milk production in these cattle was positively correlated with early maturity. The result of this finding is given below in table VI.

TABLE - VI

| Group | Breeding | Number of pairs of observation | r. |
|---|---|---|---|
| A | Red Sindhi | 82 | 0.064 |
| B | ½ Jersey x ½ R.S. | 30 | 0.300 |
| C | ½ Brown Swiss x ½ R.S. | 16 | 0.074 |
| D | ¼ J. x ¾ R.S. | 69 | 0.071 |
| E | ¼ B.S. x ¾ R.S. | 28 | 0.120 |
| F | ½ Holstein x ½ R.S. | 11 | - 0.330 |
| G | Kansas State College Jersey | 91 | 0.186 |

Ragab et al. (1954) obtained 0.03 as phenotypic correlation between age at first calving and first lactation yield in Egyptian cows.

Mahadevan (1955) found very small effect of age at first calving on first lactation yield in Red Sindhi cattle. The



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regression was negative and non-significant.

Hofmann & Kleiber (1955) on analysis of data of 494 yellow Franconian cattle found that there was no effect of age at first calving on (1) First lactation yield (2) a 5 year average (3) the total average yield.

Venkayya & Anantakrishnan (1956) estimated correlation between age at first calving and first lactation yield in three breeds. The results are given as follows:-

| Breed | Number of animals | Coefficient of correlation |
|---|---|---|
| Red Sindhi | 216 | 0.44** |
| Gir | 80 | 0.34** |
| Ayreshire x R.S. | 241 | 0.19** |

(** denotes significant at 1% level)

In Brown Alpine cows in Piacentino, Rognoni (1956) found an insignificant positive correlation between age at first calving and total life-time production ( r = 0.002).

Venkayya & Anantkrishnan (1957) obtained correlation and regression between age at first calving and milk yield during first lactation as 0.39 and 0.613 respectively in Murrah buffaloes. They also found in the same year a high significant correlation between age at first calving and first lactation yield in Red Sindhi ( r = 0.78) and Ayreshire x Red Sindhi ( r = 0.41).

Patel (1957) obtained 0.164 as correlation coefficient

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between age at first calving and first lactation yield in Kankrej.

Using data of more than 300 cows having 900 lactations Asker et al. (1958) worked on environmental factors affecting milk production in Egyptian cows and found that age at first calving had no significant effect on first lactation yield.

Singh (1959) obtained -0.1 and 0.654 as phenotypica and genetic correlation respectively between age at first calving and first milk yield in Hariana cattle. The same author also obtained in the same year 0.07 and 0.982 as phenotypic and genetic correlation between age at first calving and first lactation period in Hariana.

Holl (1959) found in Czechoslovak Redspotted heifers that 8½ years production of the heifers did not vary significantly when bred at 27, 24, 21 and 18 months. So without any deliterious effect heifers could be bred as early as 18 - 19 months.

Singh & Sinha (1960) reported that age at first calving had significant effect on first 180 days yield but had no significant effect on 30 days, 90 days and 300 days yield in Tharparkar herd maintained at Government Cattle Farm, Patna.

Lahousse (1960) found in 138 Friesian at Droogmanns Farm that when age at first calving increased from 21 to 31 months, first lactation yield also increased significantly. When age at first calving increased from 32 to 40 months the correlation was not significant. A significant negative relationship between age at first calving and average monthly yields upto 4th calving



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was also found.

Amble & Krishnan (1960), Kohli et al. (1961), Alim (1962) and Puri & Sharma (1965) found a significant linear increase in first lactational milk yield, when the age at first calving also increased in Kangayam, Hariana, Butana, Tharparkar and Sahiwal cattle respectively.

Singh & Desai (1961), on analysis of Hariana herds, found intra herd correlation and regression between age at first calving and first lactation yield as 0.078 and 0.308 respectively.

Singh & Chowdhury (1961) studied on correlation between age at first calving and first lactation yield in Sahiwal and Tharparkar cows maintained at Ranchi Agriculture College Farm, Kanke. The correlation between these two traits in Sahiwal and Tharparkar herd were 0.09 and 0.047 respectively and they were not significant.

Ahmad (1961) obtained 0.185 as phenotypic correlation between age at first calving and milk yield in Hariana.

Danasoury & Bayonmi (1962) obtained correlation and regression of 0.402 and 2.27 between age at first calving and first lactation yield. It was highly significant.

Prasad (1962) obtained 0.105 as phenotypic correlation between age at first calving and milk yield in Tharparkar cow.

Batra & Desai (1964) estimated genetic correlation between age at first calving and first lactation milk yield in

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Sahiwal herd as 0.81.

Singh et al.(1964) obtained 0.32 as phenotypic correlation between age at first calving and milk production upto age at culling in Hariana.

Fiorentino (1965) observed in Red Pied Aosta herd that production increased from 847 kg. to 1144 kg. as the age at first calving increased from 26 to 38 months and after that production declined.

Horn et al.(1965) obtained 0.222 at P < 0.1 % as correlation coefficient between age at first calving and first lactation yield in crossbred Hungarian Brown x Jersey cows. The range of correlation coefficient was from 0.082 to 0.361 as it varied from Farm to Farm.

Son, Ja (1965) reported that if the heifers were first bred at 15 to 17 months and 24 months, the increase of second lactation yield over corresponding first lactation yield were 33.9 and 12.8 % respectively in Black Pied heifers. The same increase for Simmental heifers were 28.9 and 28.0 percent. It was reported further that optimum age for both the breeds was 18-20 months.

In Hungarian spotted heifer Gube (1966) observed that when the heifers were first bred at 18 months, the milk production was higher in each of their 4 lactations than of the cows that were first bred over 18 months of age.



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Bhasin & Desai (1967) studied the relationship between age at first calving and milk yield in Hariana and obtained the following result :-

| Correlation traits | Amount of data | Phenotypic correlation |
|---|---|---|
| Age at first calving and first lactation milk yield | 117 | - 0.03 |
| Age at first calving and milk production upto 6 yrs. of age. | 68 | - 0.62** |
| Age at first calving and milk production upto 8 yrs. of age. | 41 | - 0.57** |

(** - significant at 1 % level).

Vankov & Alekseiv (1967) studied the effect of age at first calving on the productivity of Red Sindhi cows and their ♀ crosses. Data obtained from various farms on 203 Red Danish .. and 316 of their first generation crosses with various breeds were arranged according to 7 ages at first calving from < 27 - > 37 mths. In both groups i.e. pure bred as well as crossbreds the 300 day milk yield increased with age at first calving upto 30 months and then decreased. Milk yield per 100 kg. body weight was greatest for Red Danish ♀♀ calving at 27-28 months and for their ♀ crosses at 29 to 30 months.



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II. OPEN PERIOD

Some workers also called it as service interval or post partum interval to first service.

Its importance lies in the fact that by knowing the magnitude of variation in the interval between calving and subsequent heat, there would be less chance for the breeder to miss the oestrus for natural or artificial service and this would constitute the earliest possible measure for reducing calving interval. Furthermore, the study of season and age which are likely to be the factors influencing this interval would be of much importance in curtailing the unduely long intervals.

Effect of season on open period

Herman & Edmondson (1950) found that the average interval between 968 normal calvings and first oestrus in 347 cows was 57 days. This interval was not related to season of year. But Garman (1955) reported that cows calving in March to May had shorter open period than that of the cows that calved in other months.

Kohli & Suri (1957) studied the effect of month of calving on the open period and found that the period was higher for the months of April and May and lesser for September. This effect of month and season was significant.

Grekke (1967) obtained 55.7 days as an average open period for cows calving in winter, which was less than 30 days for cows calving in April to July.



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Other factors

Herman & Edmondson (1950) reported that age of the cow and lactation number were found to be the factors influencing the open period.

Hafez (1952) observed that older animals seemed to manifest early post partum oestrus than young cows.

Kohli & Suri (1957) found a significant effect of age on the open period and also found a significant difference in calving sequence with respect to this character. The first calf heifer had a high interval and afterwards with the increase in number of lactations there was definite trend towards a shorter interval upto fifth lactation and then an increase was obtained in succeeding lactations.

Biswal & Rao (1960) obtained 110 days as average in Red Sindhi cows in Orissa whose calves were weaned and it was 157 days for the cows which suckled their calves.

Singh (1964) obtained first open period to be longest than the rest of the periods.

Open period and fertility

It was reported by number of workers that there is a relationship between open period and fertility and the conception rate of each service. Fertility is measured by the number of services required per conception.

Edward (1950), Swensson (1952), Shannon et al.(1952), Old & Seath (1954), Sognen & Filseth (1958), Steklenev (1966), and Segling (1967) all found that conception rate increased by an increase in period upto a certain limit thereafter it declined. Vandemark & Salisbury (195), Lindley et al.(1958) reported that cows bred at shorter open period took more services per conception than those bred after long intervals.

Kohli & Suri (1960) obtained 230 days as the average of first open period from 575 normal calvings over a nine period in a Hariana herd. The conception rate was satisfactory when the minimum open period was one hundred days.

Foote et al.(1960) found that there was significant relationship between age at first calving and length of the open period. The coefficient of linear correlation between them was 0.04 at $P < 0.05$.

El-Sheikh & El-Fouly (1963) obtained average open period as 88.6 in 963 pregnancies of 435 Friesian cows. The various open periods were arranged in three groups and the corresponding service period was as follows:-

| Open period | Service period |
|---|---|
| $\leq$ 60 days | 122 days |
| 61-90 days | 138 days |
| > 90 days | 235 days |

Khan (1955) and Logvinov (1966) found that there was no significant relationship between length of open period and



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conception rate.

Grekke (1967) found in Moscow in 1965 that the percentage of 120,000 cows conceiving to first insemination increased from 15.3 to 89.9 as the open period increased from $\angle$ 30 to 61-90 days; the percentage remaining infertile to subsequent inseminations decreased as this interval increased.

Relationship with milk production

Herman & Edmondson (1950), Carman (1955) found that open period was not related to daily milk yield during the interval, while Lewis & Norwood (1950), Olds & Seath (1953), Pavuna (1960) observed that open period was related to current production.

Lunka et al.(1962) found that milk production in corresponding lactation was affected by ealier conception.

Heritability and Repeatability estimates

Heritability and Repeatability estimates of open periods are presented in table VII.

TABLE-VII

| Author | Year | Breed | $h^2 \pm$ S.E. | R $\pm$ S.E. |
|---|---|---|---|---|
| Olds & Seath | 1953 | Dairy cattle | 0.27 | 0.293 |
| Carman | 1955 | " | 0 | 0.15 (one herd) |
| | | " | 0 | 0.27 (second herd) |
| Bognoni & Betta | 1960 | " | 0.06 | 0.47 |



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## III. INSEMINATION PERIOD

Lewis & Horwood (1950) and Carman (1955) reported that the insemination period was affected by high production in the current lactation. They observed that insemination period was significantly positively correlated ( r = 0.15) with current daily average lactation yield. This character was not affected by age, parity and year.

Pou et al.(1953) obtained 0.07 and 0.11 as heritability and repeatability estimates respectively of insemination period.

Carman (1955) on analysis of 1646 lactations of 763 Holstein Friesian cows found that the average insemination periods were 28 days in one herd and 42 days in another herd. Heritability and repeatability estimates of these two herds were -0.03 ± 0.18 and 0.08 ± 0.09 and 0.27 and 0.06 respectively.

Lindley et al.(1958) found that insemination period was affected by season and observed that this period was 13.2 days less in summer than in autumn-bred cows. They also found that heritability and repeatability estimates of this character was low.

Touchberry et al.(1959) obtained a significant relationship between open period and insemination period. It was also found that insemination period decreased as open period increased from 0 to 127, afterwards there was a slight decrease.



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## Service period

The period between date of calving and fertile service is termed as service period. So service period is equal to open period plus insemination period.

Service period practically shows the same relationship with current lactation yield as is shown by calving interval, because most of the variation in calving interval is introduced through variation in service period only, as the variation for other component of calving interval i.e. gestation period is very small, the intercalving period is mostly dependant upon the length of service period.

TABLE - VIII

Average service period

| Author | Year | Amount of data | Breed | Average (days) |
|---|---|---|---|---|
| Sikka | 1931 | 1944 | Sahiwal | 123.8 ± 1.7 |
| Dave & Singh | 1934 | - | Red Sindhi | 118 |
| Schmidt | 1948 | - | German Red | 95.1 |
| Lambardt | 1951 | 18693 | West Phalian cattle | 85.5 |
| Sharma *et al.* | 1951 | 230 | Hariana | 233 |
| Ragab *et al.* | 1956 | - | Egyptian cattle | 119 |
| Prasad | 1958 | 1338 | Tharparkar | 131 |
| Venkayya & Anantkrishnan | 1958 | - | R. S. | 156 |
| Kohli & Suri | 1960a | - | Hariana | 263 |



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## TABLE-VIII(Contd.)

| Author | Year | Amount of data | Breed | Average (days) |
|---|---|---|---|---|
| Kohli & Acharya | 1961 | - | Hariana | 289 |
| Kohli et al. | 1961 | - | " | 314 |
| Kohli & Suri | 1960b | - | " | after first calf 283<br>after 2nd calf 239 |
| Singh & Dutt | 1963 | - | Sahiwal | 126 ± 6.3 |
| Danasoury & Bayonmi | 1963 | - | Cows of university of Khartoum | 129 |
| Dutt & Desai | 1965 | 50 | Gangatiri | 118 ± 1.3 |
| Cjurlis | 1965 | - | Dutch | 116.3 |
| | | | Lithuanion | 120.9 |
| | | | $F_1$ | 107.8 |
| Florscheitz | 1967 | - | Simmental | 84.9 |
| | | | Red Pied Lowland | 129.5 |

### Heritability

The estimates of heritability of service period are given in table IX.

## TABLE - IX

| Author | Year | Breed | Heritability |
|---|---|---|---|
| Olds & Sheath | 1953 | | 0.27 |
| Carman | 1955 | | 0.06 |
| | | | 0.15 |
| Prasad | 1958 | Tharparkar | - 0.016 , -0.12 |
| Kohli et al. | 1961 | Hariana | 0.10 ± 0.17 |
| Batra | 1961 | Sahiwal | - 0.1764 |

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Repeatability

TABLE - X

| Author | Year | Breed | Repeatability |
|---|---|---|---|
| Berge | 1942 | Red Polled Oesterland | 0.013 |
| Olds & Sheath | 1953 | - | 0.29 |
| Ragab *et al.* | 1956 | Egyptian cattle | 0.051 |
| Batra | 1961 | Sahiwal | 0.2406 |

Effect of season on service period

Schmidt (1948), Lambardt (1951) and Ramba (1961) observed that the service period was affected by season. Kohli & Suri (1960a) found that service period was shortest in September to March. This relationship was significant.

On the other hand Plocek (1959), Odegard (1965) and Prasad (1958) did not find any significant relationship between season and service period.

Effect of sequence of calving on service period

Prasad (1958) found that there was a significant relationship between sequence of calving and service period. He also observed that it contributed 4 % of the total variance.

Plocek (1959) found that after the first calving the service period was highest.

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## IV. NUMBER OF SERVICES PER CONCEPTION

There are so many factors which are responsible for the failure of the cow to conceive on the first insemination. So some times it needed more than one service for the successful conception A lesser number of services per conception would surely mean a better reproductive efficiency. Services per conception is one of the direct factors controlling service period and indirectly determines the length of calving interval. So a knowledge of this trait with regard to its nature of inheritance and factors controlling it would be much valuable for keeping the service period, dry period and calving interval at optimum levels, so that a maximum possible life-time production can be received.

The average number of services per conception reported by different workers on different breeds are given in table XI.

TABLE - XI

| Author | Year | Breed | Sequence of conception. | Average | No.of observation |
|---|---|---|---|---|---|
| Trimberger & Davis | 1945 | - | - | 1.70 | - |
| Korkman | 1947 | Ayreshire | - | 1.57 | - |
| Boyd *et al.* | 1954 | Jersey | - | 1.59 | 225 |
| | | Holstein | - | 1.76 | 208 |
| | | Guernsey | - | 1.71 | 86 |
| Legates | 1954 | Ayreshire | herd no.1 | 1.91 | 11 |
| | | Guernsey | " | 2.02 | 171 |



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TABLE-XI (Contd.)

| Author | Year | Breed | Sequence of conception. | Average | No.of obs. |
|---|---|---|---|---|---|
| Legates | 1954 | Holstein | herd no.1 | 1.93 | 158 |
| | | Jersey | " | 1.70 | 309 |
| | | Holstein | herd no.2 | 1.67 | 24 |
| | | " | " 3 | 1.69 | 191 |
| | | " | " 4 | 1.66 | 32 |
| | | " | " 5 | 1.58 | 125 |
| | | " | " 6 | 2.02 | 63 |
| | | " | " 7 | 1.37 | 27 |
| | | " | " 8 | 1.60 | 20 |
| | | " | " 9 | 1.97 | 107 |
| | | Guernsey | herd no.10 | 2.31 | 36 |
| | | Jersey | " | 1.88 | 357 |
| | | Ayreshire | " 11 | 1.74 | 470 |
| | | Jersey | " | 1.79 | 342 |
| Tandon | 1959 | ½ Jersey x ½ R.S. | - | 1.3 | 412 |
| | | R. S. | - | 2.0 | - |
| Singh | 1961 | Tharparkar | Ist | 1.73±0.07 | 207 |
| | | | 2nd | 1.73 ± 0.11 | 163 |
| | | | 3rd | 1.89 ± 0.12 | 114 |
| | | | 4th | 1.74 ± 0.10 | 80 |
| | | | 5th | 1.78 ± 0.19 | 60 |
| | | | 6th | 1.68 ± 0.21 | 31 |
| | | | 7th & after | 1.80 ± 0.18 | 42 |

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Heritability and Repeatability estimates

Heritability and repeatability estimates of this character have been calculated by various workers. Most of them reported this trait to be non-heritable or slightly heritable and variation in it were mostly due to managemental practices.

Berge (1942) reported repeatability of 0.22 ± 0.08 for conception rate in the reproduction records of a Norwegian herd for a period of 50 years.

Trimberger & Davis (1945) reported that the heritability and repeatability of this character is zero. Similar findings were reported by Tanabe & Casida (1949) and Olds et al.(1949).

On analysis of records of 1015 Holstein Friesian cows from different herds located throughout New York state, Dunbar & Handerson (1953) obtained repeatability estimates as 0.027 from a population of half-sisters and 0.05 from cows by different sires within the same herd. Using the component of variance due to different among sires, heritability estimate was 0.004. Thus it was concluded that selection for fertility on the basis of number of services per conception can not be very effective. Pou et al. (1953) also obtained a very low heritability and repeatability (0.07 and 0.12 respectively) and drew the same conclusion.

Legates (1954) studying genetic variation in services per conception and calving interval in dairy cattle, calculated the heritability of services per conception as 0.026. He obtained

intra-cow repeatability of zero for services per conception.

Carman (1955) obtained 0 & 0.06 as Heritability and Repeatability respectively of the number of services per conception in Holstein Friesian cows. The repeatability of the number of services per conception was found to be 0.009 for Egyptian cattle by Ragab et al.(1956).

Rottensten & Touchberry (1957) estimated heritability of conception rate on first and second service as zero in heifers of three breeds at Danish progeny testing station.

Ahmed & Tantawy (1959) obtained 0.01 as intra-cow repeatability of number of services per conception in Egyptian cattle.

Schinder & Angel (1960) observed that correlation was more or less zero between conception rates of successive pregnancies in most of the herd excepting few herds showed moderately high correlation.

Rognoni & Betta (1960) obtained heritability and repeatability as 0.04 and 0.06 respectively of number of services per conception.

Singh (1961) in Tharparkar cattle obtained the heritability of services per conception as (-)0.048 and 0.147 for first pregnancy and for three pregnancies respectively by paternal half-sib correlation method. He also calculated repeatability of 0.099 for services per conception.



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LeRoy & Kohn (1963) obtained 0.1 as heritability of conception rate of first insemination.

On analysing the records of 534 dairy cows sired by 9 bulls, Rognoni et al.(1968) obtained the heritability of number of services per conception as 0.24.

Effect of sire on number of services per conception

Kab (1937) obtained a considerable variation in fertility in some of the families by 22 yellow Franconian bulls.

On analysing the records of 20 cow families Trimberger & Davis (1945) observed that one family showed an average of 2.92 services per conception and two with significantly low values (1.22 and 1.00). Daughters of one sire were served with 2.25 services per conception which was significantly different from other groups. Korkman (1947) found that out of total variation of this character only 4.72 % was due to hereditary causes and 14 % of this variation was due to differences amongst sires.

On analysing the records of 28 bull families Henle(1949) found that 8 bulls had an unfavourable and 5 bulls a favourable influence on the fertility of their daughters.

Mare et al.(1961) found that conception rate of heifers was affected significantly by the season of birth and by intraction of sire-line with system of mating, whereas that of cows was affected significantly by the sire-line ( $P < 0.01$) and by the interaction of sire line with the system of mating ($P < 0.05$).

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Swensson (1963) observed that all the 5 daughter groups sired by the same bull had sub-normal fertility.

Dam's influence

Erle et al. (1940) on analysis of some of the important cow families found that some families had higher breeding efficiency than others.

Trimberger & Davis (1945) analysed cow families of three different breeds of cattle and reported significant difference for the number of services per conception among cow families.

Korkman (1947) observed that 4.72 % of the variance was due to heredity and 43 % was due to differences among paternal half-sisters in number of services per conception.

Considerable but non-significant differences among cow families in number of services per conception was reported by Tabler et al. (1951).

Using number of services per conception as an index of breeding performance Olds et al. (1949) found statistically insignificant correlation between the breeding performance of eleven foundation cows and of their daughters.

Age of the bull

Various workers have reported that the age of the bull affected the number of services per conception and conception rate.

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Morgan & Davis (1938), Erb et al.(1940), Bowling et al. (1940), Hilder et al.(1944), Tanabe & Salisbury (1946), Detkens & Malik (1954) and Ahmed & Tantawy (1959) all reported that yearling bulls in general take minimum services per conception and showed highest conception rate. With the increase of age, there is a fall of breeding efficiency of the bulls gradually.

Tanabe & Salisbury (1946) obtained the highest conception rate when the cows were 4-6 years and that of the bulls were 1-3 years. But Carman (1955) and Morrison & Erb (1957) observed a negligible effect of the age of bull on number of services per conception.

Kohli et al.(1965) divided the bulls under study in three different age groups and obtained the corresponding number of services per conception as follows:-

| Age of bull | Services per conception |
|---|---|
| 2 - 5 years | 1.72 |
| 6 - 8 " | 1.76 |
| 9 -13 " | 2.02 |

The range of conception rate was between 40.0 and 63.8%.

Age of the Dam

With the increase in the age of the females from 1 year to 16 years, there was a progressive increase in the number of services per conception (Gowen & Dove,1931).

Hilder et al.(1944) and Detkens & Malik (1954) reported



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that heifers take more services than older or multiparous cows. But Morgan & Davis (1938) and Foot & Ridler (1949) reported the opposite result.

Tanabe & Salisbury (1946) observed that conception rate increased with the age of the cow and was maximal in 5 year old cows and then decreased upto 10 years old.

Pou et al. (1953) found that age of the cow had little effect on the character. According to Boyd & Reed (1961) conception rate for heifers was 60.5 %, then it increased upto 66.8 % at the third gestation and again decreased progressively to 51.1% in cows with more than 8 gestations.

Effect of season

Morgan & Davis (1938) found the effect of season of insemination on number of services per conception. He got the average number of services per conception as 2.28 from May to October and 2.14 from November to April.

Fro et al. (1940) reported highest conception rate in May and lowest in August. Seath & Staples (1941) reported that conception rate was affected by season and was highest in winter and lowest in summer.

Wilson (1946) and Lewis (1948) found seasonal variation in conception rate. Kumaran (1949) found seasonal variation in the rate of conception of Tharparkar, Sahiwal and Amrit Mahal cows on the basis of services required per conception.



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Trimberger & Davis (1945), Hilder et al.(1944), Lindley et al.(1958), Ahmad & Tantawy (1959), Paufer (1962), Stott & Williams (1962), Rognoni & Vismara (1962), Cicardi & Magnani(1963) and Ghiandoni et al.(1966) all reported seasonal variation in conception rate and number of services per conception.

Schindler (1954) observed highest conception rate during the period March to May and lowest in the month of September. Ehlers et al.(1958) reported highest conception rate in March to September.

Fryer et al.(1958) observed highest conception rate in fall. Kab (1963) observed the services per conception requirement in Sahiwal cattle was usually lowest for the month of January, February, March and April (1.8, 1.8, 1.6 and 1.9 respectively). Singh et al.(1964) reported a highly significant seasonal variation in conception rate in Hariana cattle. Sinha (1964) found highest conception rate in winter and lowest in summer. Pou et al. (1953), Kellgren et al.(1963) reported that seasonal variation is negligible in the female's fertility.

Anderson (1966) found that conception rate at first service was more in autumn than in spring.

However, number of workers could not confirm the above mentioned findings, such as Salisbury (1944), Prabhu & Bhattacharya (1953), Burgess (1953), Johnston et al.(1953), Kohli & Suri (1960), Kellgren et al.(1963) and Singh et al.(1964).



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Other factors

Johanson (1953) found a relationship of conception rate with the length of interval between calving and service in the following way:-

| Interval between calving and service (in days). | Conception rate (%) |
|---|---|
| 0 - 30 | 35.4 |
| 30 - 60 | 56.5 |
| 60 - 90 | 62.2 |

He found that this increase in conception rate was upto the interval of 210 days and then decreased.

Boyd et al.(1954) and Currie (1956) did not find any relationship between current production and number of services per conception.

On the contrary, Carman (1955) reported a positive significant correlation between current production and number of services per conception.

Number of services per conception were not affected by open period according to Touchberry et al.(1959). Mataserino & Nagarcenkar (1962) reported that the mean number of inseminations per conception varied curvilinearly as a function of open period.

It was found that regression was highly significant for natural services but not significant for artificial services.

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El-Sheikh & El-Fouly (1963) observed that with the increase in length of open period, there were increase in number of services per conception and conception rate. Their findings were as follows:-

| Open period (days) | Number of services per conception. | Percentage of cows conceived to first service. |
|---|---|---|
| < 60 | 2.89 | 48 |
| 61-90 | 2.55 | 70 |
| >90 | 2.62 | 76 |

Belling (1963), Segling (1967) and Grekke (1967) all found an increase in the conception rate when the open period increased.

Studying records of Friesians, Normandy & Swis Brown dairy herds, Brochart (1966) found that there was a highly significant correlation ( r = 0.72) between the mean number of inseminations per conception and the maximum monthly decrease in milk production over the first five months of a lactation.

V. CALVING INTERVAL

The period between two successive calvings is termed as calving interval and is composed of service period and gestation period. Total milk yield in an lactation is dependent on maximum yield reached during lactation, duration of maintenance of peak yield and length of the declining part of the lactation. This third component of yield is governed by the period between



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calving and effective service, as this period has direct relationship with milk yield, there obviously results a relationship between calving interval and milk yield. According to Mateon(1929), "The optimum calving interval varies directly with the milking capacity and inversely with age upto maturity".

Average

Many workers have calculated the average of calving interval to judge breeding efficiency with different breeds of cattle. The work already done is shown in table XII.

TABLE - XII

| Author | Year | Breed | Sequence of calving interval. | Average (days) | No. of observation. |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Dave & Singh | 1934 | Sindhi | - | 401 | - |
| Kartha | " | Sahiwal | - | 408 | - |
| | | Tharparkar | - | 399 | - |
| | | Hariana | - | 408 | - |
| Ostergaard | 1942 | Red Sindhi | Ist | 407 | 970 |
| | | | 2nd | 392 | 970 |
| Korkman | 1947 | Ayreshire | - | 382 | - |
| Rigor | 1949 | Red Sindhi (imported) | - | 446.09 | 162 |
| | | Red Sindhi (Alabang born) | - | 447.58 | 75 |
| Lewis & Horwood | 1950 | Guernsey | - | 12.1 mths | - |

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TABLE - XII (contd.)

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Lewis & Horwood | 1950 | Ayreshire | - | 12.6 mths. | - |
| | | Jersey | - | 12.6 " | - |
| | | Brown Swiss | - | 13.0 " | - |
| | | Holstein Friesian | - | 13.2 " | - |
| | | Overall | - | 12.7 " | 365 |
| Sharma et al. | 1951 | Hariana | - | 530 days | - |
| Rennie | 1952 | Holstein-Friesian | - | 413 ±78 | 1663 |
| Herman et al. | 1953 | Jersey | - | 15.48 mths. | - |
| | | Holstein | - | 14.45 " | - |
| | | Guernsey | - | 14.11 " | - |
| Joshi & Phillips | 1953 | Kankrej | - | 498 days | - |
| | | Bhagnari | - | 397 " | - |
| | | Nagori | - | 460 " | - |
| | | Ongole | - | 16 months | - |
| | | Amrit Mahal | - | about 600 days | - |
| Mahadevan | 1953 | Black Sinhala | - | 355 days | 600 |
| Stonaker et al. | 1953 | Red Sindhi | Ist | 16 months | 69 |
| | | | 2nd | 15 " | 59 |
| | | | 3rd | 14 " | 53 |
| | | | 4th | 13 " | 37 |
| | | | 5th | 14 " | 28 |
| | | ½ Jersey | Ist | 13 " | 27 |
| | | | 2nd | 13 " | 26 |



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TABLE - XII (contd.)

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Stonaker *et al.* | 1953 | ½ Jersey | 3rd | 14 months | 21 |
| | | | 4th | 14 " | 12 |
| | | | 5th | 15 " | 17 |
| Detkens & Iwanicka | 1954 | Black & white lowland of lower Silesia. | - | 378 days | - |
| Legates | 1954 | Cattle of North Carolina State herd. | - | 406 " | - |
| Arnold & Becker | 1956 | Cattle of Florida station. | - | 437 " | - |
| Sunderasan *et al.* | 1954 | Red Sindhi | - | 16 months | 70 |
| | | ½ J. x ½ R.S. | - | 14 " | 29 |
| Mahadevan | 1955 | R.S. | - | 433 days | - |
| Venkayya & Anantakrishnan | 1956 | R.S. | - | 416 " | 216 |
| | | Gir | - | 465 " | 80 |
| | | Ayreshire x Sindhi | - | 397 " | 241 |
| Patel | 1956 | Gir at Bangalore | - | 473 " | - |
| | | " " Kandivali | - | 446 " | - |
| | | " " Morvi | - | 520 " | - |
| Kohli & Suri | 1957 | Hariana | - | 530 " | - |
| Morrison & Erb | 1957 | Holstein-Friesian | - | 424 " | 9994 |
| Bonomi | 1957 | Brown Alpine | - | 12.3 mths. | 689 |
| | | Friesian | - | 12.5 " | 246 |
| Singh | 1957 | Tharparkar | Ist | 433 days | 1149 |
| Pattabhiraman | 1957 | Gir | - | 431.9 " | - |

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TABLE - XII (contd.)

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Amble et al. | 1958a | Kangayam | - | 16.7 months | 317 |
| | | Gir | - | 15.7 " | 69 |
| | | Kankrej | - | 16.2 " | 73 |
| | | Tharparkar | - | 14.8 " | 376 |
| Amble et al. | 1958b | Red Sindhi at Hosur | - | 546 ±10 days | - |
| | | R.S. at Bangalore | - | 447 ± 8 " | - |
| Prasad | 1958 | Tharparkar | - | * 131 days | 1338 |
| Dave | 1958 | Gir | - | 515 " | 431 |
| Singh | 1959 | Hariana | Ist | 458 " | - |
| Rigor & Nelmida | 1959 | R. S. | - | 510.4 ± 20.1 | - |
| | | Jersey x R.S. | - | 511.7 ± 10.6 | - |
| Alim | 1960 | Kenana | - | 395 | - |
| Ahmad | 1961 | Hariana | Ist | 432 | - |
| Singh & Chowdhury | 1961 | Sahiwal | - | 484.4 | 118 |
| | | Tharparkar | - | 480.6 | 90 |
| Kohli et al. | 1961 | Hariana | - | 630.8 | 277 |
| Batra | 1961 | Sahiwal at N.F. Lucknow | Ist | 428.8 | 66 |
| | | | 2nd | 412.7 | 53 |
| | | | 3rd | 433.6 | 57 |
| | | | Overall | 424.5 | 156 |
| | | Sahiwal at C.G.F. Lucknow | Ist | 421.8 | 52 |
| | | | 2nd | 400.6 | 52 |
| | | | 3rd | 406.5 | 35 |
| | | | Overall | 410.0 | 139 |

* Mean length of Post partum interval to conception.



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TABLE-XII (contd.)

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Batra | 1961 | Sahiwal at Ambala. | Ist | 394.4 | 58 |
| | | | 2nd | 397.6 | 43 |
| | | | 3rd | 384.5 | 28 |
| | | | overall | 393.3 | 129 |
| | | Sahiwal at Meerut. | Ist | 392.5 | 47 |
| | | | 2nd | 420.3 | 36 |
| | | | 3rd | 411.4 | 36 |
| | | | overall | 409.7 | 119 |
| El-Sheikh & El-Fouly | 1962 | Friesian | Ist | 474.2±6.2 | 359 |
| | | | 2nd | 399.3±5.6 | 359 |
| | | | 3rd | 392.8±8.0 | 359 |
| | | | 4th | 344.5±8.8 | 359 |
| Singh & Desai | 1962 | Hariana | - | 467.9 | 586 |
| Belling | 1963 | Dairy breeds | - | 363 | - |
| Danascury & Bayonmi | 1963 | Dairy breeds | - | 416 | - |
| Joshi | 1963 | Deoni at Udgir | - | 502.8 ± 12.9 | 125 |
| | | " at Hingoli | - | 441.008±12.4 | 120 |
| | | " at Rajendra-Nager | - | 491.9 ± 11.8 | 125 |
| Mahadevan & Hutchison | 1964 | Boran & Jiddu | - | 382 | - |
| Maoli & Mazziotti | " | Brown Alpine | - | 394 | - |
| | | Dutch Friesian | - | 398 | - |
| | | Crosses of the two- | | 386 | - |
| Anderson | 1966 | Red Danish | - | 394.0 | - |
| | | Black Pied Danish | - | 380.5 | - |



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## Heritability estimates of calving interval

Various workers have estimated heritability for calving interval. From their estimates it is found that variation in calving interval is due to non-genetic causes. Some of these estimates are given in the table XIII.

### T A B L E - XIII

| Author | Year | Breed | d.f. | $h^2 \pm$ S.E. |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| Dunbar & Handerson | 1950 | - | - | 0.01 |
| Rennie | 1952 | Holstein-Friesian | - | low |
| Dunbar & Handerson | 1953 | " " | - | 0.004 |
| Asker *et al.* | 1953 | Egyptian cattle | 34 | 0.13 |
| Stonaker | 1953 | Red Sindhi | 40 | 0.88 |
| Brown *et al.* | 1954 | Angus beef cattle | - | 0 |
| Legates | 1954 | - | - | 0 |
| Alim & Ahmad | 1954 | Holstein-Friesian | - | 0 |
| El-Itriby & Asker | 1956 | Egyptian buffaloes | - | 0 |
| Patel | 1957 | Kankrej | - | 0.242 |
| | | Sahiwal | - | - 0.066 |
| Annual Report of I.V.R.I. | 1957-'58 | Hariana | 59 | 0.1983 ±0.1195 |
| Singh | 1958 | Tharparkar | 58 | -0.18 ±0.145 (intrasire regression). |
| | | | 58 | -0.164 ±0.132 (intrasire correlation). |

TABLE-XIII(contd.)

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Amble et al. | 1958 | Red Sindhi (Hosur) | 155 | - 0.08 ± 0.20 |
| | | R. S. (Bangalore) | 125 | 0.13 ± 0.19 |
| | | Kangayam (Hosur) | 223 | 0.11 ± 0.19 |
| | | Gir (Bangalore) | 23 | -0.37 ± 0.48 |
| | | Kankrej (Anand) | 25 | -0.31 ± 0.40 |
| | | Tharparkar (Patna) | 204 | -0.01 ± 0.16 |
| Dedlani et al. | 1959 | Hariana | - | 0.02 |
| Wheat et al. | 1959 | " | - | 0.50 |
| I.V.R.I.Report | 1959-'60 | " | - | 0.014 ± 0.448 |
| Ahmad | 1961 | " | 165 | 0.22 |
| Batra | 1961 | Sahiwal | 226 | -0.2073 |
| Kohli et al. | 1961 | Hariana | 103 | 0.3 ± 0.18 |
| Singh & Desai | 1962 | " | 164 | 0.022 ± 0.058 (intrasire regression) |
| | | | 164 | -0.337 (Paternal half-sib correlation) |
| Singh | 1964 | " | - | 1.0316 (Paternal half-sib correlation) |
| | | | | -0.855 (intrasire regression) |
| | | | | -0.142 (Dam-daughter correlation). |
| Mishra | 1965 | Duel purpose | - | -0.04 |
| Odegard | 1965 | Norwegian Red | - | 0 |
| Anderson | 1966 | Red Danish & Black pied Danish | - | 0.012 ± 0.056 |
| Acharya | 1966 | Hariana | - | High |



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Repeatability estimates

TABLE - XIV

| Author | Year | Breed | d.f. | R ± S.E. |
|---|---|---|---|---|
| Ostergaard | 1942 | Red Danish | - | 0.13 |
| Johansson & Hansson | 1940 | Sweedish cattle | - | 0.04 |
| Johansson | 1949 | " " | - | 0.08 ; 0.03 |
| Rennie | 1952 | Holstein-Friesian | - | 0.175 to 0.184 |
| Asdell | 1952 | " " | - | 0.07 |
| Brown *et al.* | 1954 | Angus beef cattle | - | 0 |
| Legates | 1954 | - | - | 0.133 |
| Alim & Ahmad | 1954 | Holstein-Friesian | - | 0.05 |
| El-Itriby & Asker | 1956 | Native cattle | 475 | 0.08 |
| | | Crossbred cattle | 395 | 0.089 |
| Thompson, Carnek & Ralston | 1957 | Red Danish | - | 0.086 |
| Patel | 1957 | Kankrej | - | 0.22 |
| | | Sahiwal | - | 0.33 |
| I.V.R.I. Report | 1957-'58 | Hariana | - | 0.7489 ±0.221 |
| Singh | 1958 | Tharparkar | 582 | 0.226 |
| Amble *et al.* | 1958 | Red Sindhi (Hosur) | 517 | 0.21 |
| | | R. S. (Bangalore) | 609 | 0.08 |
| | | Kankrej (Hosur) | 681 | 0.08 |
| | | Gir (Bangalore) | 86 | 0.17 |
| | | Kankrej (Anand) | 66 | 0.17 |
| | | Tharparkar (Patna) | 1174 | 0.19 |

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TABLE-XIV (contd.)

| Author | Year | Breed | d.f. | R ± S.E. |
|---|---|---|---|---|
| Kohli et al. | 1958 | Hariana (Hissar) | 578 | 0.72 |
| Ahmad | 1961 | " | - | 0.224 |
| Batra | 1961 | Sahiwal | - | 0.1929 |
| Singh & Desai | 1962 | Hariana | 336 | 0.101 |
| Singh | 1964 | " | - | 0.245 |
| Anderson | 1966 | Red Danish & Black Pied Danish | - | 0.089 to 0.103 |

Effect of age of the cow on calving interval

Matson (1929) suggested that the optimum calving interval in Indian cattle varied directly with milking capacity and inversely with age upto maturity. Schmidt (1933) observed that period between two successive calvings increased with age of the cow. The interval was less than 12.9 months upto 7 years of age and 13.9 months in 12 years of age.

Lewis & Horwood (1950) could not find any effect of age on calving intervals of Ayreshire, Brownswiss, Guernsey, Jersey and Holstein-Friesian cows. There was no significant difference between first calving interval and others upto 9th calving, after which it increased to 14.4 months on an average. According to Rennie (1952) on y 10.3 % of the total variation in calving interval was due to age of the cow.

The effect of age on calving interval was not found upto



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the fifth lactation in an investigation in Department of Agriculture, Jamaica (1954) in Bodles herd.

Schmidt & Koriath (1956) observed the effect of age on calving interval in German cattle. They further found that except second each successive interval increased by two days.

Morrison & Erb (1957) reported a significant linear negative relationship between age of the cow and calving interval from 3 to 14 years.

Plocek (1959) did not find any effect of age on calving interval, while Belling (1963) observed a significant effect.

Bhatnagar & Chowdhury (1960-61) found in Malvi cows that calving interval tended to decrease with increasing age of the animal. Joshi (1963) reported that calving interval declined as the age advanced.

Effect of season

Singh (1958) did not find any significant effect of season of calving on calving interval in Tharparkar cows. On the other hand Singh et al.(1958) observed a statistically significant effect of season of calving on calving interval in Hariana females. The animals that calved between the months of May and June had the longest calving interval of 514 ± 10.67 days. Those calved between July and November had the shortest calving interval of 464 ± 6.67 days and the animals who calved between December to April had the intermediate calving interval (488 ± 6.97).



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According to report of livestock Bureau of Scotland (1959) the pedigreed Ayreshire cows that calved for the first time in summer (July) or autumn (October) had longer calving intervals than those which first calved in spring (April) and winter (January).

Odegard (1965) reported that the heifers which calved from December to March had significantly shorter calving intervals than the heifers which calved between August and November in Norwegian Red & White breed.

Anderson (1966) did not find any significant variation in calving intervals of Red Danish and Black Pied Danish cows which first calved in May, July and September.

Other factors

Rennie (1952) observed that out of total variationin calving interval 11.7 % was due to intra-herd intra-year variability and 4.8 % was due to yearly environmental differences.

Brown et al.(1954) found that year and sequence of calving accounted 17.5 and 6.7 % of total variance respectively in Angus beef cattle.

Singh (1958) reported significant effect of both year and sequence of calving on calving interval in Tharparkar herd.

Guba & Illes (1959) observed that calving interval was affected more by management and nutrition than by high production.



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El-Sheikh & El-Fouly (1962) and Danasoury & Bayonmi (1963) observed a significant correlation (r = 0.756 and 0.964 respectively) between calving interval and service period.

Belling (1963) found that the cows which nursed heifer calves had shorter calving intervals than the cows those nursed male calves.

Odegard (1965) found the correlation between service period and first and second calving interval.

Khan (1965) observed that when service periods were long viz. 196, 186, 134 days, the calving intervals were also excessively long in Dajjat cattle at Qudirabad.

VI. NUMBER OF HEATS MISSED

Tandon (1958) observed the average of the expected number of heats missed in the first insemination period in Red Sindhi and Jersey crossbred cows. He also observed that as the Jersey blood increases upto 50 % the average number of heats missed decreased.

As breeding efficiency has wider implication than individual measures of reproductive efficiency, various workers have evolved many expression of it.

Lowe (1938) reported an index for fertility known as "value index" which is equal to the ratio of Position Index and the calving index where ,

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Position index = Age of the cow in month at first successive service, and

Calving index = Total number of births (Multiple births are treated as one).

Pou et al.(1953) evolved one mathematical model of breeding efficiency which is as follows:-

$$Y_{ij} = \mu + a_i + c_j + e_{ij}$$

Where $Y_{ij}$ is the breeding efficiency of the jth cow in the ith year-season; $\mu$ is the mean of all breeding efficiency records; ai is the effect of the ith year-season ; cj is the effect of the jth cow and eij is the error associated with the breeding efficiency of the jth cow in the ith year-season; ai, cj and eij were assumed to be independent random variables with variance $\sigma a^2$, $\sigma c^2$ and $\sigma e^2$ respectively.

For measuring breeding efficiency of Bos taurus cattle , Wilcox et al.(1957) evolved one formula on the basis of calving intervals which is as follows:-

$$\text{Breeding efficiency} = \frac{(n-1)\ 365 \times 100}{D}$$

Where, n = Total number of calving

D = Number of days from first to last calving.

Assuming that 365 day interval is an ideal, this formula compares the observed calving interval with the ideal one.

Dohy (1960) evolved one index for fertility which is

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given below:-

$$T = 100 - (K_1 + 2i)$$

Where, T = Fertility index

$K_1$ = Age of the cow at first calving (in months)

i = Average calving interval in months.

This index takes into account of age of first calving and calving index. According to this formula, fertility is good when the index is 48, average when it is between 41 - 47 and when it is 40 or less, fertility is poor.

According to Johnson *et al.* (1964) current reproductive states of a herd can be measured by the following formula:-

Herd reproductive status ( H.R.S.)

$$= 100 - \left[ \left( \frac{Co}{Tc} + \frac{Do}{Tc \times 0.11 \times 305} \right) / 2 \right] \times 100$$

Where, Co = Number of cows not pregnant for > 100 days

Do = Total number of days of non-pregnancy for cows not pregnant for >100 days in the herd.

Tc = Number of cows in the herd.

If H.R.S. is 100, it indicates that all the cows in the herd are pregnant or not pregnant for less than 100 days. The relationship between H.R.S. and the average number of days of non-pregnancy per cow in a herd was significantly negative.

Tomar (1965) evolved one formula for breeding efficiency

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in Zebu cattle which is given below:-

$$\frac{[n(365) + 1020] \times 100}{Ac + Ci}$$

Where, n = Number of calving interval

Ac= Age at first calving in days.

Ci = Days between first and last calving

1020 = Optimum age at first calving in days.

Kubkowski (1965) reported that Morzow's formula permits determination of the proportion of non-pregnancies in a herd of any size in any period of time. According to this formula the proportion of non-pregnancies equals $\frac{P}{2.85 \times A}$, where P represents the total number of days of barrenness in the herd and A the herd size.

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# CHAPTER - III

# MATERIALS AND METHODS

# MATERIALS AND METHODS

## Source of data

Data used in the study were obtained from Government Cattle Farm, Patna. The records of 14 years from 1950 to 1963 were utilized for this study which included breeding and calving records of 1644 lactations from 454 cows. The records that were considered abnormal due to clerical mistakes, abortions, systemic disorders were not considered.

This farm was established in 1926 with 52 Tharparkar and 10 Sahabadi cows at Patna. Later from 1936, only Tharparkar breed was maintained.

Animals were fed according to the following schedule:-

Daily ration for cows included 5.50 kg. dry fodder and 13.6 kg. green fodder per cow. For heifer 2.75 kg. dry fodder and 7.20 kg. green was given. The green mostly available at the Farm composed of Joar, Goar, Berseem, Oat, Para, Napier, Elephant grass etc. according to the season.

One kg. of concentrate mixture was given as maintenance allowance per adult animal per day. Production allowance was given at the rate of one kg. of concentrate for every 3 kg. of milk. Pregnant animals were given daily 1½ kg. of additional concentrate after 6 months of pregnancy.

The concentrate mixture consists of wheat bran, G.N.cake,

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Goar seed or Meal or Gram or Oat. In addition to this each animal was given 1 oz. of salf and 2 oz. of mineral mixture daily.

Cows are housed in pucca byres. They are milked twice a day at 4 A.M. and 4 P.M. Selective breeding policy is practised in this herd on the basis of performance. Natural mating was practised till the year 1962 and since then artificial insemination is in use at the farm.

Daily teasing of the cows by the bulls is being carried on both morning and evening to detect heat. Heifers have been mated or inseminated at their first heat. Those cows which come in heat within 40 days after giving birth are not inseminated in their first heat.

No heifers/cows are culled until they complete the first lactation except in unavoidable circumstances like infectious diseases as Johne's disease, T.B. etc.

The present study includes the following parameters:-

(1) Age at first calving (in days)

(2) Open period (in days) : It is the interval between calving and subsequent first insemination. The day of calving was not included.

(3) Insemination period (in days) : It was calculated by substracting the open period from the interval between calving to fertile service. It ranged between zero to maximum value.

(4) Number of services per conception.

(5) Calving interval (in days). It is the period between



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two consecutive calvings. Only one date of calving was included in the interval.

(6) Number of heats missed by each cow in one insemination period were calculated according to the method used by Tandon(1958) which is as follows:-

[(Insemination period/21) + 1] - Number of services given to the cow in the insemination period.

## STATISTICAL METHODOLOGY

### I. Heritability

Heritability may be defined in two ways viz.,(i) heritability in broad sense (ii) heritability in narrow sense. Former is the portion of total phenotypic variance which is due to genetic effect while the latter is the portion of total phenotypic variance which is due to additive gene effect. Heritability in narrow sense is more accurate because only this portion of phenotypic variance is transmissible from generation to generation.

So, $P = G + E$ or $P = A + D + I + Ep + Et$

i.e. $\sigma p^2 = \sigma G^2 + \sigma E^2$ or $\sigma p^2 = \sigma A^2 + \sigma D^2 + \sigma I^2 + \sigma EP^2 + \sigma ET^2$

because covariance term will be equal to zero.

Now according to the above definition $h^2 = \frac{\sigma G^2}{\sigma P^2}$ (Broad sense)

$$h^2 = \frac{\sigma A^2}{\sigma P^2} \quad \text{(Narrow sense)}$$

Heritability tells the scope of selection. It applies to a particular population, a particular characteristic and a particular time. Since it is a ratio, its value will change with



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changes either in denominator or the numerator. The range of heritability is 0 to 1. The high heritability indicates greater genetic variation and less environmental variation and vice versa. Estimates of $h^2$ is essential in determining the efficiency and choice of different breeding systems. If heritability is high, the best method would be mass selection, with little use of pedigree selection. If $h^2$ is low a better plan would be to make considerable use of pedigree selection and some use of progeny testing and family selection. Its estimate is also essential to arrive at optimum weight to be given to severa traits in an index.

Various methods of estimating heritability were discussed by Lush (1948). Some of the important methods are as follows:-

(1) Heritability based on isogenic lines

(2) Regression of offspring on parents.

(3) Regression of offspring on mid-parent.

(4) Based on half-sib analysis.

(5) Based on full-sib analysis.

In the present study heritability of different traits was calculated by regression of offspring on parents. Intra-sire regression of offspring on dam procedure were used. The dams records were repeated in cases where more than one daughters were available from each dam. The estimate of heritability is obtained by doubling the coefficient of regression of phenotype of the offspring on phenotype for the same trait in the dam. In case of



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parent-offspring covariance estimate, bias is introduced if there is contribution to the estimate that is not due to the effects of the individual's genes on its own phenotype. The regression estimate gives a more reliable estimate from this point of view. Dickerson (1959) pointed out that the regression of offspring on dam estimate will be biased upward on account of maternal effect, interaction involving additive effects and the correlation of environmental effects of the dam with direct maternal influences on her offsprings.

It may be pointed out here that in the data used in this study the phenotypic variance of dam might have been reduced by selection practised in the choice of dams.

However, Fulconer (1960) had pointed out that the expectation of regression of offspring on parent is not changed by such selection. This is because expectation of parent offspring covariance is reduced in the same proportion as phenotypic variance of the parents. Therefore, the regression of offspring on one parent is a valid measure of half of heritability. However, the parent offspring covariance may not be a valid measure of one half of the additive genetic covariance.

The variance of regression coefficient for offspring on parent regression was computed from within sire components as follows:-

Let 'U' and 'V' represent records of offspring and dam respectively. Then the regression coefficient, 'bUV' is found as follows:-



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$$bUV = \frac{cov - UV}{s^2v}$$

Where, cov and $s^2$ are estimated covariance and variance respectively.

cov UV estimates $\frac{1}{2}\sigma^2 G$ and $s^2v$ estimates $\sigma^2 P$

so that $bUV = \frac{\frac{1}{2}\sigma^2 G}{\sigma^2 P}$

and $h^2 = 2bUV$

II. Repeatability

(i) As described by Prasad (1951), repeatability (R) is defined as regression of future performance or phenotype on past performance as measured by one expression of the trait and it may logically be estimated by the regression of the second record on the first as was demonstrated by Stewart (1945).

Let (1) and (2) denote the first and second records respectively by the same individual, then the regression coefficient is

$$b_{21} = \frac{cov\ 12}{s_1^2}$$

cov 12 estimates $\sigma^2 y + \sigma^2 e$ and $s_1^2$ estimates $\sigma^2 p$

such that $b_{21} = R$.

The correlation coefficient of the first and second record is ,

$$r_{21} = \frac{cov\ 21}{\sqrt{s_2^2 . s_1^2}}$$

Provided there has been no selection, the expectation of $s_2^2$ and $s_1^2$ are identical, and thus :

$$r_{21} = \frac{\sigma^2_y + \sigma^2_e}{\sigma^2_p}$$

which is equivalent to the regression procedure.

(ii) Intra-class correlation

Lush & Mollin (1942) demonstrated methods of intra-class correlation (Snedecor, 1945), which permits the estimation of repeatability on all the records by each individual. This method was illustrated in the following analysis of variance where the mean squares are broken up into their expected components of variance (Winsor & Clarke, 1940).

TABLE - XV

Analysis of variance for Estimating Repeatability

| Sources of variation | d.f. | M.S. | E.M.S. |
|---|---|---|---|
| Between individuals | n - 1 | $s^2_b$ | $\sigma^2_e + k\,\sigma^2_b$ |
| Between records within individuals | k - 1 | | |
| Interaction or Error | (n-1)(k-1) | $s^2_e$ | $\sigma^2_e$ |
| Total | nk - 1 | | |

Where, n = number of individuals

k = number of records of each individual

$$\rho' = \frac{\sigma^2 b}{\sigma^2 b + \sigma^2 e}$$

$$\therefore \rho' = \frac{s^2 b - s^2 e / k}{\frac{s^2 b - s^2 e + s^2 e}{k}}$$

Where, datas are non-orthogonal then between and within analysis is done after Sander's correction factor.

III. Genetic correlation

The genetic correlation between any two traits estimates the extent to which the genes affecting one trait may also affect the other or the extent to which the genes that affect each of these characters are closely linked. The genetic correlation was calculated by the method developed by Hazel (1943) and described by Hazel, Marvel and Reinmiller (1943). The genetic correlation between two traits will be their covariance divided by genetic mean of the two genetic variance estimates.

$$rGA.GB = \frac{\text{cov } GA.GB}{\sqrt{\text{variance } GA \times \text{variance } GB}}$$

The variance of GA and GB and covariance GA.GB are obtained by multiplying sire components of variance and covariance respectively by four.

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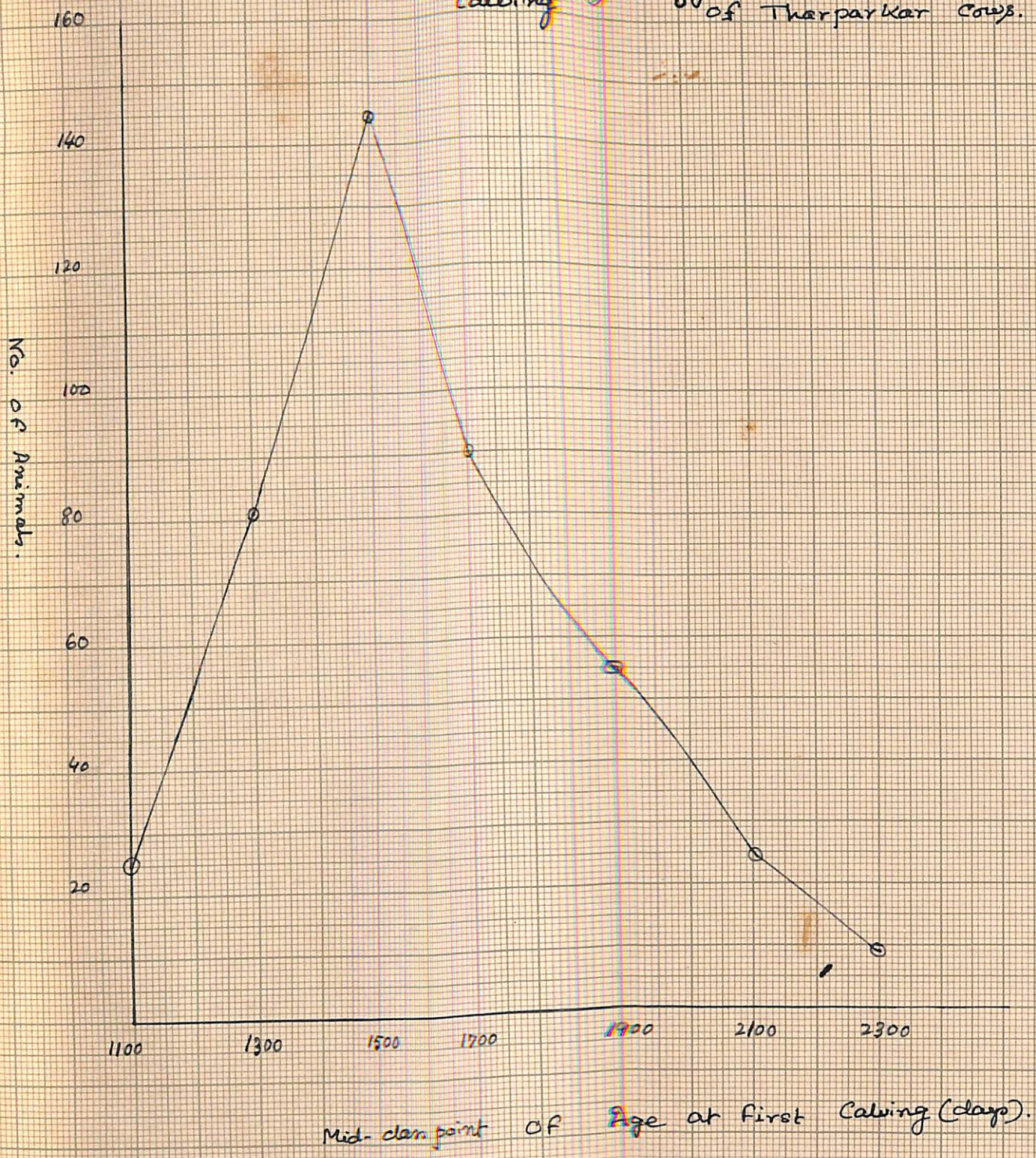
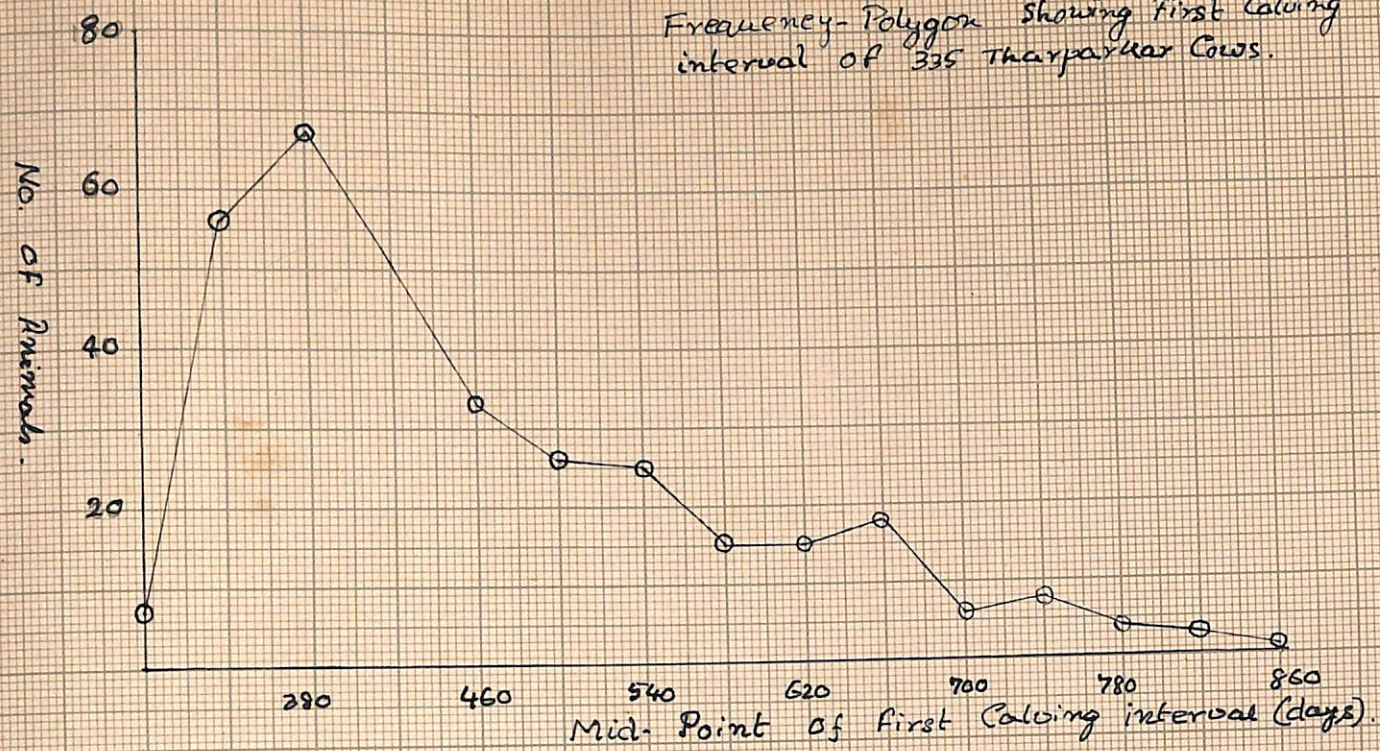
# CHAPTER - IV

# RESULTS

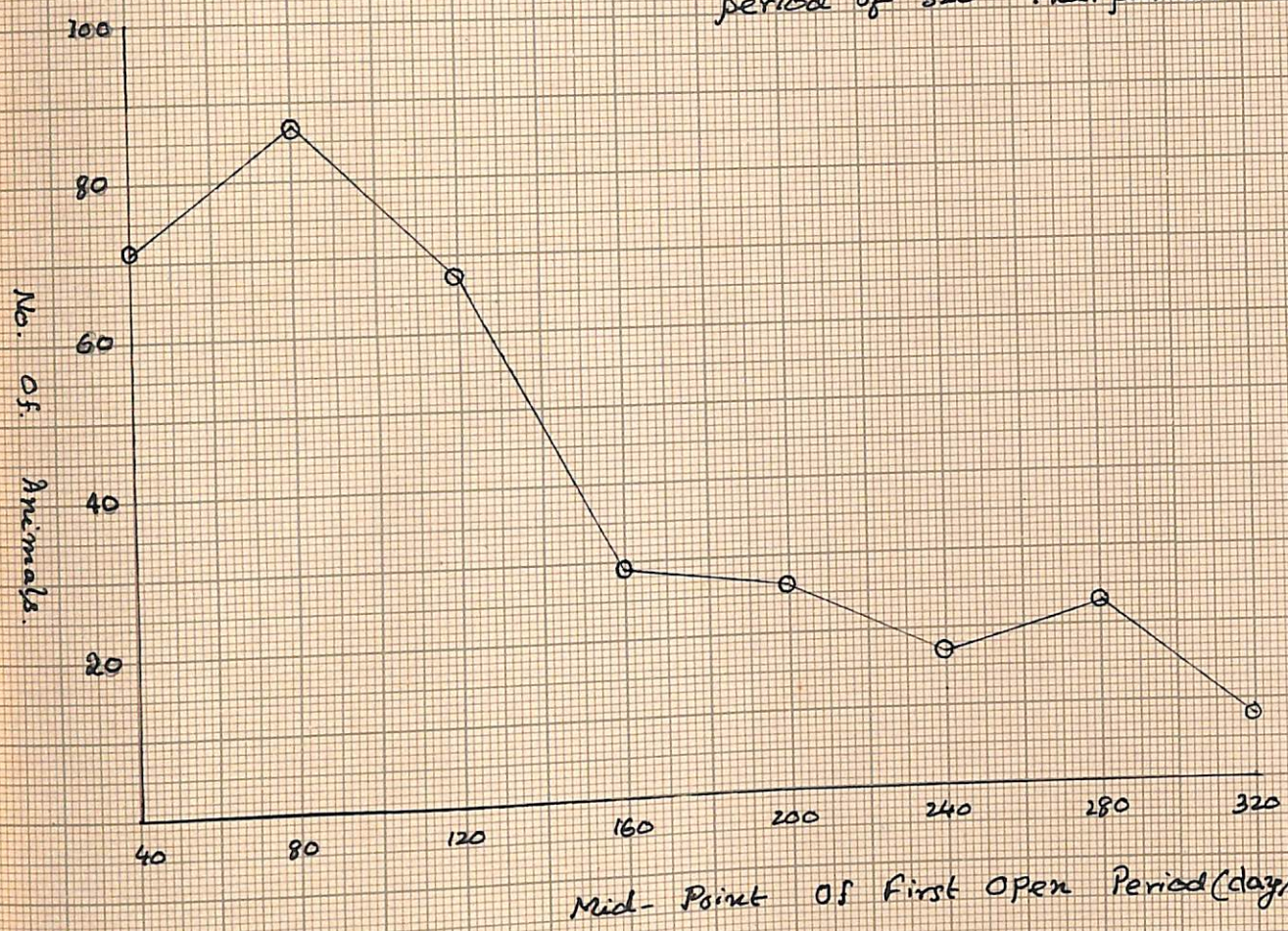
Frequency Polygon showing Age at first calving of Tharparkar cows.



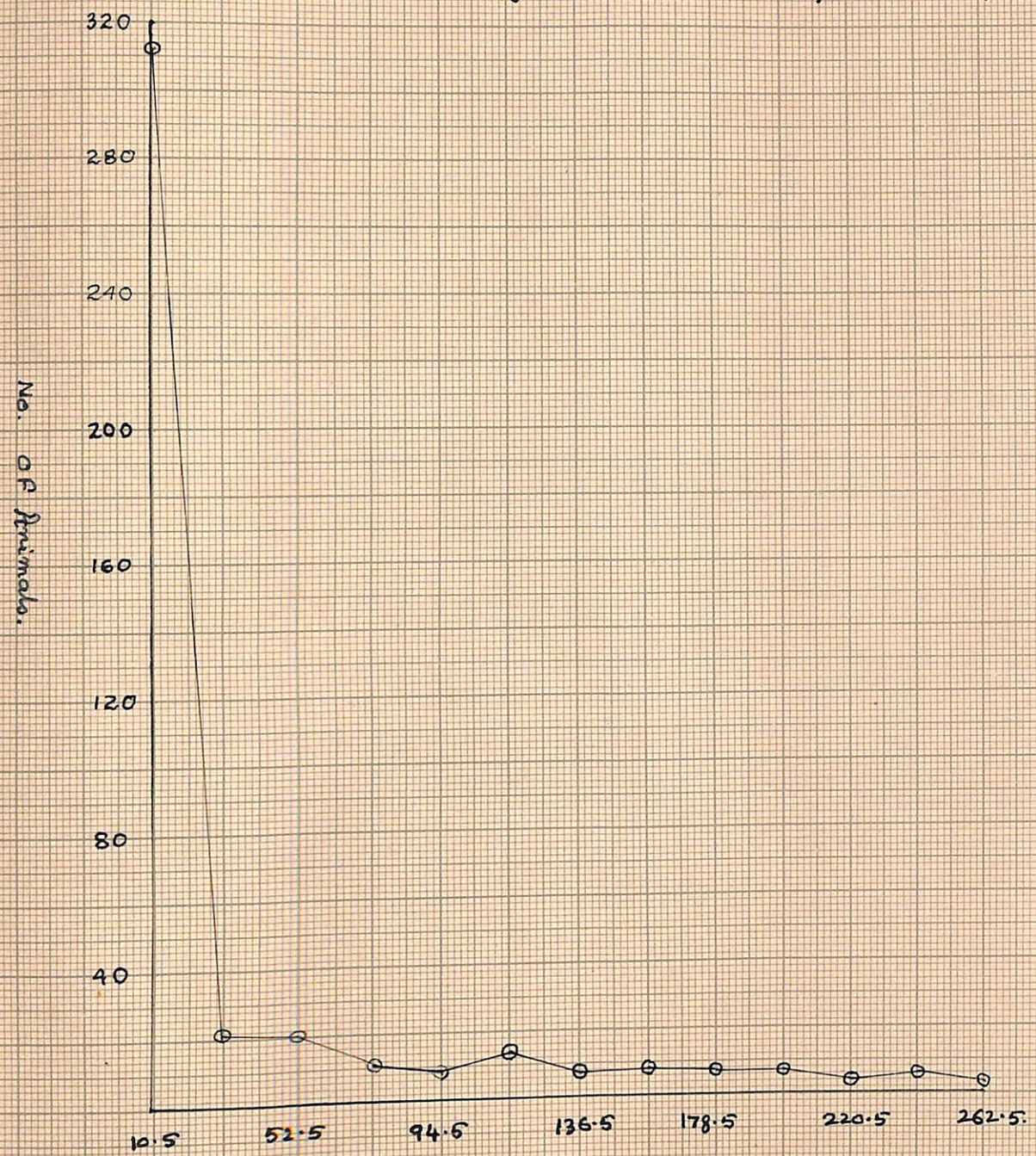
Frequency-Polygon Showing First Calving interval of 335 Tharparkar Cows.




Frequency-Polygon Showing first Open period of 320 Tharparkar Cows.



Frequency-Polygon showing first Insemination period of Tharparkar Cows.



# R E S U L T S

## (A) AVERAGES

### (i) Age at first calving

The average age at first calving from 439 Tharparkar cows at Government Cattle Farm, Patna, was 1603.67 days with its standard error and coefficients of variation of 14.07 days and 18.3 % repectively.

### (ii) Open period

Averages of the open periods following first to seventh calvings along with their standard errors and coefficients of variation are presented in the table - XVI.

T A B L E - XVI

Averages, standard errors and coefficients of variation of open periods of Tharparkar cows at G. C. F., Patna.

| Sequence of calving. | Number of observation. | Arithmatic average (days) | Standard error (days) | Coefficient of variation % |
|---|---|---|---|---|
| I | 363 | 150.37 | 6.25 | 78.9 % |
| II | 276 | 114.09 | 5.3 | 77.1 % |
| III | 207 | 162.07 | 10.3 | 91.5 % |
| IV | 141 | 111.11 | 5.55 | 58.4 % |
| V | 89 | 107.48 | 7.1 | 62 % |
| VI | 57 | 104.80 | 11.57 | 83.2 % |
| VII | 35 | 105.17 | 12.27 | 68.8 % |

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These differences were highly significant statistically as shown by analysis of variance in table XVII.

TABLE - XVII

Analysis of variance of open periods

| Source of variation | d.f. | M.Sq. | F. |
|---|---|---|---|
| Between open periods | 6 | 96756.20 | 8.32 ** |
| Within period | 1161 | 11623.81 | |

** - Significant at 1 % level.

(iii) Insemination Period

Averages of insemination period of breeding heifers and cows in their first to seventh calvings have been presented in table XVIII alongwith corresponding standard errors.

TABLE - XVIII

| Order | Number of observations. | Arithmatic average(days) | Standard error (days). |
|---|---|---|---|
| Breeding heifers | 449 | 46.04 | 4.4 |
| After first calf | 366 | 55.16 | 5.9 |
| After second calf | 277 | 50.96 | 6.4 |
| After third calf | 206 | 45.05 | 5.6 |
| After fourth calf | 140 | 51.37 | 7.1 |
| After fifth calf | 89 | 78.53 | 16.6 |
| After sixth calf | 58 | 69.75 | 20.5 |
| After seventh calf | 35 | 46.51 | 15.9 |

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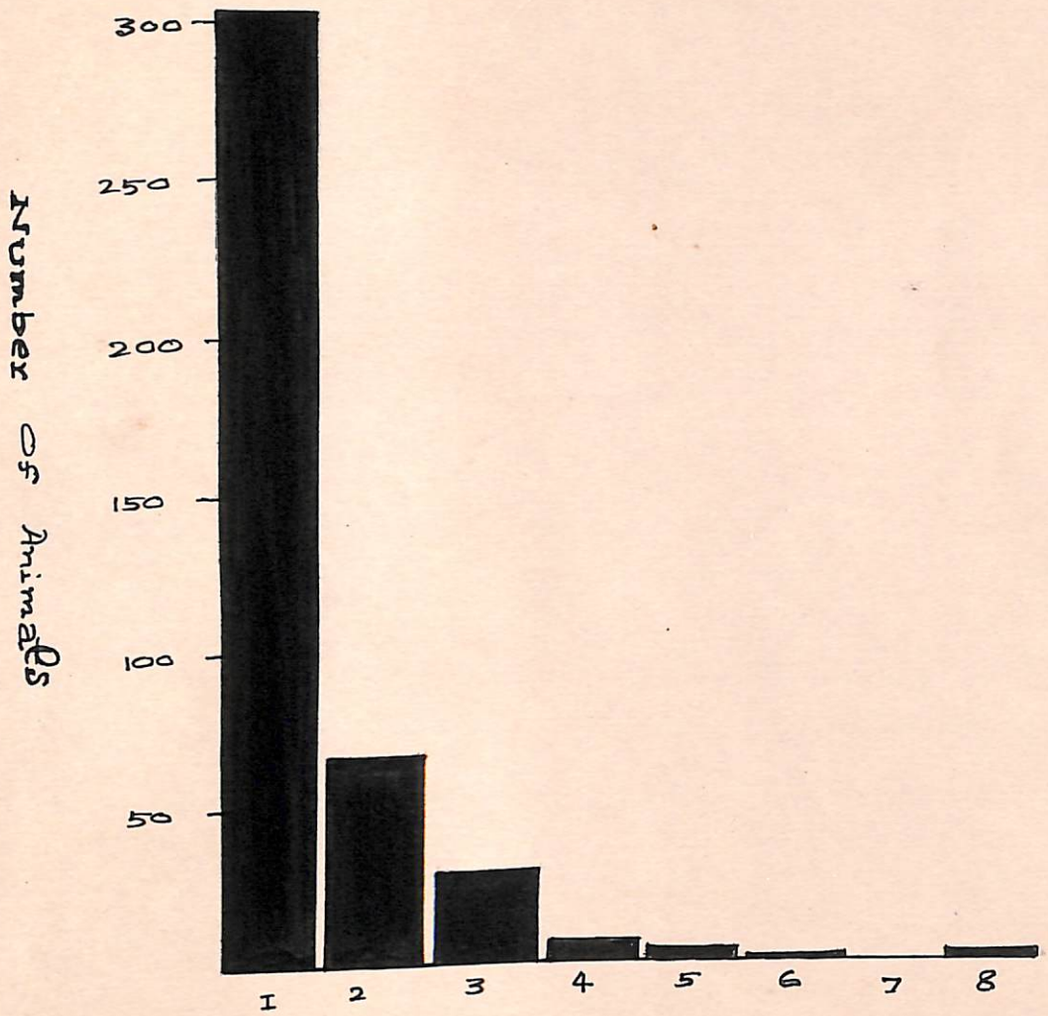
DISTRIBUTION OF NUMBER OF SERVICES
REQUIRED PER CONCEPTION
IN THARPARKAR COWS.




Inseminations.

For breeding heifers.

The differences among average insemination periods were highly significant as shown by analysis of variance in table XIX.

TABLE - XIX

Analysis of variance of insemination periods

| Source of variation | d.f. | M.SQ. | F. |
|---|---|---|---|
| Between insemination periods | 7 | 65826.82 | 5.97** |
| Within period | 1612 | 11024.09 | |

** - Significant at 1 % level.

(iv) Number of services per conception

Average number of services required per conception along with its standard error and coefficient of variation is presented in table XX.

TABLE - XX

| Sequence | No.of observation | Average | Standard error | Coefficient of variation %. |
|---|---|---|---|---|
| Ist conception | 448 | 1.55 | 0.04 | 59.8 |
| 2nd " | 367 | 1.65 | 0.05 | 62.8 |
| 3rd " | 297 | 1.71 | 0.10 | 99.7 |
| 4th " | 209 | 1.74 | 0.09 | 73 |
| 5th " | 139 | 1.83 | 0.10 | 63 |
| 6th " | 89 | 2.12 | 0.17 | 75 |
| 7th " | 57 | 1.90 | 0.17 | 67 |
| 8th " | 35 | 1.63 | 0.19 | 68 |



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The differences among average number of services per conception were statistically not significant as shown in table - XXI.

TABLE - XXI

Analysis of variance of number of inseminations per conception

| Source of variation | d.f. | M.Sq. | F. |
|---|---|---|---|
| Between conceptions | 7 | 3.15 | 1.83 |
| Within conception | 1633 | 1.72 | |

(v) Calving interval

Averages of calving intervals alongwith their standard errors and coefficients of variation are presented in table XXII.

TABLE - XXII

| Sequence | No.of observation. | Arithmatic average(days) | Standard error(days) | Coefficient of variation(%) |
|---|---|---|---|---|
| I | 353 | 494.67 | 13.84 | 52.3 |
| II | 271 | 459.56 | 9.06 | 32.3 |
| III | 205 | 445.84 | 7.36 | 23.6 |
| IV | 137 | 449.24 | 8.54 | 22.2 |
| V | 86 | 468.15 | 16.88 | 33.1 |
| VI | 56 | 460.89 | 23.97 | 38.4 |
| VII | 37 | 444.91 | 5.11 | 6.9 |

The differences among average calving intervals were significant as shown by analysis of variance in table XXIII.

TABLE - XXIII

Analysis of variance of calving intervals.

| Source of variation | d.f. | M.SQ. | F. |
|---|---|---|---|
| Between calving intervals | 6 | 73430.82 | 2.33* |
| Within calving intervals | 1138 | 32830.68 | |

* - Significant at 5% level.

(vi) Number of heats missed

Averages and standard errors of number of heats missed by cows in their insemination periods are presented in table XXIV.

TABLE - XXIV

| Order | No.of observation | Arithmatic average. | Standard error. |
|---|---|---|---|
| Breeding heifers | 448 | 1.59 | 0.17 |
| After first calf | 367 | 1.94 | 0.24 |
| After second calf | 297 | 1.48 | 0.22 |
| After third calf | 209 | 1.30 | 0.19 |
| After fourth calf | 139 | 1.58 | 0.28 |
| After fifth calf | 89 | 2.59 | 0.64 |
| After sixth calf | 57 | 2.45 | 0.84 |
| After seventh calf | 35 | 1.30 | 0.59 |



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The differences among average number of heats missed in different conceptions of cows were highly significant statistically as shown in table - XXV.

TABLE - XXV

Analysis of variance of heats missed .

| Source of variation | d.f. | M.Sq. | F. |
|---|---|---|---|
| Between conceptions | 7 | 72.34 | 4.47** |
| Within conception | 1633 | 16.17 | |

** - Significant at 1 % level.

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## T A B L E - XXVI

Table showing the results of t-test between the various open periods

| Period | Average in days | Comparison of first open period with rest. | Comparison of second open period with rest. | Comparison of third open period with rest. | Comparison of fourth open period with rest. | Comparison of fifth open period with rest. | Comparison of 6th open period with rest. |
|---|---|---|---|---|---|---|---|
| I | 150.37 | | | | | | |
| II | 114.09 | 36.28** | | | | | |
| III | 162.07 | 11.70 | 47.98** | | | | |
| IV | 111.11 | 39.26** | 2.98 | 50.96** | | | |
| V | 107.48 | 42.89** | 6.61 | 54.59** | 3.63 | | |
| VI | 104.80 | 45.57** | 9.29 | 57.27** | 6.31 | 2.68 | |
| VII | 105.17 | 45.20** | 8.92 | 56.90** | 5.94 | 2.31 | 0.37 |

* - Significant at 5 % level.

** - Significant at 1 % level.

## TABLE - XXVII

Table showing the results of t-test between the various insemination periods.

| Order | Average (days) | Comparison of insemination period of heifer with that of rest. | Comparison of 2nd insemination period with that of rest. | Comparison of third insemination period with that of rest. | Comparison of 4th insemination period with that of rest. | Comparison of 5th insemination period with that of rest. | Comparison of 6th insemination period with that of rest. | Comparison of 7th insemination period with that of rest |
|---|---|---|---|---|---|---|---|---|
| Breeding heifers. | 46.04 | | | | | | | |
| After Ist calf | 55.16 | 9.12 | | | | | | |
| " 2nd calf | 50.96 | 4.92 | 4.20 | | | | | |
| " 3rd calf | 45.05 | 0.99 | 10.11 | 5.91 | | | | |
| " 4th calf | 51.37 | 5.33 | 23.37 | 0.41 | 6.32 | | | |
| " 5th calf | 78.53 | 32.49** | 3.79 | 27.57* | 33.48* | 27.16 | | |
| " 6th calf | 69.75 | 23.71 | 13.59 | 18.79 | 24.70 | 17.38 | 8.78 | |
| " 7th calf | 46.51 | 0.47 | 8.65 | 4.45 | 1.46 | 4.86 | 32.02 | 23.24 |

* - Significant at 5 % level.

**- Significant at 1 % level.

## T A B L E - XXVIII

Table showing the results of t-test between the various calving intervals.

| Interval | Average (days) | Comparison of Ist calving interval with that of rest | Comparison of 2nd calving interval with that of rest | Comparison of 3rd calving interval with that of rest | Comparison of 4th calving interval with that of rest | Comparison of 5th calving interval with that of rest | Comparison of 6th calving interval with that of rest. |
|---|---|---|---|---|---|---|---|
| I | 494.67 | | | | | | |
| II | 459.56 | 35.11** | | | | | |
| III | 445.84 | 48.33** | 13.72 | | | | |
| IV | 449.24 | 45.43** | 10.32 | 3.40 | | | |
| V | 468.15 | 26.52 | 8.89 | 22.31 | 18.91 | | |
| VI | 460.89 | 33.78 | 1.33 | 15.05 | 11.65 | 7.26 | |
| VII | 444.91 | 49.76 | 14.65 | 0.93 | 4.33 | 18.24 | 10.98 |

** - Significant at 1 % level.

## TABLE - XXIX

Table showing the results of t-test of number of heats missed between the various conceptions.

| Order | Average | Comparison of Ist no. of heats missed with that of rest. | Comparison of 2nd no. of heats missed with that of rest. | Comparison of 3rd no. of heats missed with that of rest. | Comparison of 4th no. of heats missed with that of rest. | Comparison of 5th no. of heats missed with that of rest. | Comparison of 6th no. of heats missed with that of rest. |
|---|---|---|---|---|---|---|---|
| Breeding heifer | 1.59 | | | | | | |
| After Ist calf | 1.94 | 0.35 | | | | | |
| " 2nd calf | 1.48 | 0.11 | 0.46 | | | | |
| " 3rd calf | 1.30 | 0.29 | 0.64 | 0.18 | | | |
| " 4th calf | 1.58 | 0.01 | 0.36 | 0.1 | 0.28 | | |
| " 5th calf | 2.59 | 1.0* | 0.65 | 1.11* | 1.29* | 1.01 | |
| " 6th calf | 2.45 | 0.86 | 0.51 | 0.97 | 1.15 | 0.87 | 0.14 |

* - Significant at 5% level.

## (B) ESTIMATES OF GENETIC PARAMETERS

### (i) Heritability

Heritability estimates have been calculated by intra-sire regression of daughter on dams.

According to Pillai & Sinha (1967), the value of regression coefficient "b" has been computed by finding out corrected sum of squares for dams and sum of products.

The following formula was used to estimate the regression coefficient and the standard error:-

$$b = \frac{Sxy}{Sx^2}$$

Standard error of the regression coefficient:

$$S.E.(b) = \sqrt{\frac{Sy^2 - b.\ Sxy}{[(n_1 - 1) - 1] \cdot Sx^2}}$$

For computing standard error of "b", the results of corrected sum of squares of dams, the corrected sum of squares of daughters and corrected sum of products have been used which have been shown in the table XXX, for all the six traits.

Heritability has been estimated by doubling the regression coefficient.

The estimates are 0.02 ± .17 for age at first calving, 0.119 ± 0.19 for open period, 0.08 ± 0.07 for insemination period

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0.18 ± 0.059 for number of services per conception, 0.10 ± 0.16 for calving intervals and 0.09 ± 0.10 for number of heats missed as indicated in table XXXI.

TABLE - XXX

Table showing sum of squares for dams, sum of squares for daughters and sum of products.

| Characteristics | Total dam-daughter pair number | Corrected sum of squares for dams. $s_x^2$ | Corrected sum of products Sxy | Corrected sum of squares for daughters $s_y^2$ |
|---|---|---|---|---|
| Age at first calving | 208 | 10923.36 | 112.30 | 16054.32 |
| First open period | 169 | 1386767.7 | 82562.3 | 2067071.6 |
| Insemination period after Ist calf | 172 | 744921.2 | 30503.1 | 1545857.3 |
| No.of services per conception after Ist calf. | 170 | 173.96 | 17.18 | 99.13 |
| Ist calving interval/ | 169 | 3674982.7 | 190454.1 | 4139823.0 |
| No.of heats missed after Ist calf. | 166 | 645.88 | 30.35 | 3297.19 |

TABLE - XXXI

Estimates of Heritability and Standard errors.

| Characteristics | Heritability | Standard error |
|---|---|---|
| Age at Ist calving | 0.02 | 0.17 |
| First open period | 0.119 | 0.19 |
| Insemination period after Ist calf | 0.08 | 0.07 |
| No.of services per conception after Ist calf. | 0.18 | 0.059 |
| Ist calving interval | 0.10 | 0.16 |
| No.of heats missed after Ist calf. | 0.09 | 0.10 |



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(ii) Repeatability estimate:

(a) Open Period

Data on first four open periods from 100 cows analysed have been presented in table XXXII. The repeatability of this character was 0.23.

TABLE - XXXII

Analysis of variance of open periods for repeatability.

| Source of variation | d.f. | Sum of squares | Mean squares. |
|---|---|---|---|
| Between cows | 99 | 848268 | 8568.36 |
| Between records within cows | 3 | 60374.15 | 20124.71 |
| Interaction or Error | 297 | 1137818.85 | 3831.03 |

(b) Insemination period

Repeatability of insemination period for first to fourth calving from 100 cows was estimated as 0.107. Analysis of variance have been presented in table XXXIII.

TABLE - XXXIII

Analysis of variance of insemination period for Repeatability

| Source of variation | d.f. | Sum of squares | Mean squares |
|---|---|---|---|
| Between cows | 99 | 1216723.68 | 12290.13 |
| Between records within cows | 3 | 49266.97 | 16422.32 |
| Interaction or Error | 297 | 2460869.03 | 8285.75 |

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(c) Number of services per conception

Repeatability of number of services per conception for first to fourth calving from 105 cows was estimated as 0.20. Analysis of variance was run for the purpose which has been shown in the table XXXIV.

TABLE - XXXIV.

Analysis of variance of number of services per conception for repeatability.

| Source of variation | d.f. | sum of squares | Mean squares |
|---|---|---|---|
| Between cows | 104 | 236.34 | 2.27 |
| Between records within cows | 3 | 9.54 | 3.18 |
| Interaction or Error | 312 | 351.46 | 1.12 |

(d) Calving interval

Repeatability was estimated by including first to fourth calving intervals from 100 cows. The estimate was 0.16. Analysis of variance was presented in table XXXV.

TABLE - XXXV

Analysis of variance of calving interval for Repeatability.

| Source of variation | d.f. | Sum of squares | Mean squares |
|---|---|---|---|
| Between cows | 99 | 2353986 | 23777.63 |
| Between records within cows | 3 | 58290 | 19430.0 |
| Interaction or Error | 297 | 3919942 | 13198.45 |

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(e) Number of heats missed

Repeatability of number of heats missed for first to fourth calving from 100 cows was estimated as 0.063. Analysis of variance was run for the purpose which has been shown in table XXXVI.

TABLE - XXXVI

Analysis of variance of number of heats missed for Repeatability.

| Source of variation | d.f. | Sum of squares | Mean squares |
|---|---|---|---|
| Between cows | 99 | 1509.72 | 15.25 |
| Between records within cows | 3 | 49.00 | 16.30 |
| Interaction or Error | 297 | 3565.44 | 12.0 |

(iii) Genetic relationships among different measures of Reproductive efficiency.

Genetic correlation coefficients between pairs of different measures of reproductive efficiency are presented in table XXXVII.

All the genetic correlation coefficients were found to be positive except the correlation coefficients between first open period and number of heats missed after first calf which was negative. Most of the correlation coefficients were of high magnitude. From these estimates it can be concluded that there exists genetic relationships between these measures of reproductive efficiency though the magnitude is variable.

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## TABLE - XXXVII

Estimates of coefficient of genetic correlation between pairs of certain measures of reproductive efficiency in Tharparkar female at Government Cattle Farm, Patna.

| Trait | First open period | First calving interval | Insemination period after Ist calf | Number of services per conception after Ist calf | Number of heats missed after Ist calf. |
|---|---|---|---|---|---|
| Age at Ist calving | 0.94 | 0.92 | 0.054 | 0.62 | 0.98 |
| First open period | | 0.84 | 0.03 | 0.07 | - 0.47 |
| First calving interval. | | | 0.89 | 0.83 | 0.54 |
| Insemination period after Ist calf. | | | | 0.66 | 0.82 |
| Number of services per conception after Ist calf. | | | | | 0.87 |

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# CHAPTER - V

# DISCUSSION

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# D I S C U S S I O N

## I. AGE AT FIRST CALVING

The average age at first calving in Tharparkar cows at Government Cattle Farm, Patna, was 1603.67 ± 14.07 days. This result is in agreement with the findings of Singh (1957), Amble et al. (1958), Singh & Sinha (1960), Singh & Chowdhury (1961) on the same breed who reported the same to be 48.7 ± 0.4, 49.4 ± 0.4, 43.5 and 43.5 months respectively. Similar results have been obtained by Johari and Talapatra (1957) on Hariana, Mahadevan (1955) on Red Sindhi, Batra (1961) on Sahiwal, Amble et al. (1958) on Gir and Kankrej herds, who reported the same to be 1546.0 days, 47 months, 1196.8 days, 47.0 ± 0.8 months, 47.4 ± 0.8 months respectively.

Age at first calving of Tharparkars is more than that of European cattle whose age at first calving varies from 24.6 months to 34 months (Turner, 1932; Copeland, 1939; Palsson, 1952; Giuliani, 1953; Dassat, 1953; Bonmi, 1957; Maoli & Mazziotti Dicelso, 1964; Conev, Iocov & Angelov, 1965).

Heritability of age at first calving has been estimated as 0.02 ± 0.17 by the method of intrasire regression of daughter on dam. The estimate of heritability as obtained in the present study was not significantly different from zero as the estimate was associated with relatively large standard error.

On the basis of this genetic parameter it can be said that there is little scope for reducing the age at first calving through selection. Singh (1957) and Prasad (1962) reported heritability of age at first calving in the same breed as (-)0.361 ± 0.099 and 0.08 respectively.

The genetic correlations between age at first calving and each of the other measures of reproductive efficiency were presented in table XXXVII. All the genetic correlation coefficients were positive. Most of the correlation coefficients were of high magnitude except the correlation coefficients between age at first calving and insemination period after first calf.

II. OPEN PERIOD

Averages of the open periods following first to seventh calvings were presented in table XVI.

Kohli & Suri (1960) obtained 230 days as the average of first open period which is longer than the result of present study (160.37 days). Biswal and Rao (1960) obtained 110 days and 157 days as average in Red Sindhi cows in Orissa.

The findings obtained by Herman & Edmondson (1950), El-Sheikh & El-Fouly (1963) and Grekke (1967) are lower than the result of the present study, who reported the same to be 57 days, 88.6 days and 55.7 days respectively.

The estimate of heritability was 0.119 ± 0.11.

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This estimate was similar to that reported by Carman (1955) and Rognoni & Betta (1960). Olds & Seath (1953) got somewhat higher result ($h^2$ = 0.27) than the present estimate. As the present estimate is low, it can be said that selection of good sires or dams will not cause a rapid improvement in this character but management could play a major role.

The repeatability estimate was 0.23. It is in good agreement with the findings of Olds & Seath (1953), Carman (1955), who reported the same to be 0.293 and 0.27 respectively. The result obtained by Rognoni & Betta (1960) is higher than the present result, who reported the same to be 0.47.

All the genetic correlations between open period and each of the other measures of reproductive efficiency were positive except the correlation coefficient between open period and number of heats missed after first calf, which was negative. The genetic correlation between first open period and first calving interval was 0.84. This is so as the open period is one of the components of calving interval.

The genetic correlation between open period and number of services per conception was only 0.07. Lindley et al.(1958) reported that cows bred at shorter open period took more services per conception than those bred after long intervals.

A low positive (0.03) genetic correlation was obtained between open period and insemination period. El-Sheikh & El-Fouly (1963) arranged the ~~fawi~~ various open periods in three groups and



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observed the following corresponding service period :-

| Open period | Service period |
|---|---|
| < 60 days | 122 days |
| 61-90 " | 138 " |
| >90 " | 235 " |

III. INSEMINATION PERIOD

Insemination period is also one of the components of calving interval. Averages of insemination period of breeding heifers and of cows in their first to seventh calvings have been presented in table XVIII. It was observed that insemination period was not affected by age, which is in agreement with the findings of Lewis & Horwood (1950) and Carman (1955).

The estimate of heritability was 0.08 ± 0.07. As the heritability is low, it may be concluded that the genetic make up has a minor role, if any, to control the insemination period and it is mainly dependent upon environmental factors. Similar results were obtained by Pou et al. (1953), Carman (1955) and Lindley et al.(1958), who reported the same to be very low.

Repeatability of the insemination period was estimated as 0.107. Pou et al.(1953) reported that repeatability for this character was 0.11 and Carman (1955) obtained it as 0.27 and 0.06 in two herds of Holstein-Friesians.

High positive genetic coefficients of correlation



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equalling 0.66 and 0.82 were obtained between insemination period and number of services per conception and between insemination period and number of heats missed respectively. Everett et al. (1966) observed almost the same correlation coefficient (0.83 to 0.84) between insemination period and number of services per conception.

IV. NUMBER OF SERVICES PER CONCEPTION

The average number of services per conception for the Tharparkar cows were 1.55 ± 0.04, 1.64 ± 0.05, 1.70 ± 0.10, 1.74 ± 0.09, 1.83 ± 0.10, 2.12 ± 0.17, 1.19 ± 0.17, 1.63 ± 0.19 for first, second, third, fourth, fifth, sixth, seventh and eighth conceptions respectively. The results mentioned above are in agreement with findings of Boyd et al.(1954) on Jersey, Holstein & Guernsey; Tandon (1959) on ½ Jersey x Red Sindhi and Red Sindhi; Singh (1961) on Tharparkar. It is evident from the result that breeding heifers took minimum services for conception. Therefore, heifers showed maximum reproductive efficiency in terms of this character. From second conception it was increasing upto sixth conception, afterwards again a gradual decline took place upto the eighth calving. These findings agree with those of Gowen and Dove (1931), Morgan & Davis (1938), Foot & Ridler(1949) and Singh (1961). But Hilder et al.(1944) and Detkens & Malik (1954) observed that heifers took more services for conception than older or multiparous cows.

Heritability of number of services per conception was

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estimated to be 0.18 ± 0.059. Looking at the estimate of heritability it appears that there is little genetic variability for this trait in the herd. So there is not much scope of improving this character by selection.

Repeatability of this character was 0.20. So, future performance of a cow can not be predicted on the basis of her past performances in this character. Berge (1942), Trimberger & Davis (1945), Tanabe & Casida (1949), Olds et al.(1949), Dunbar & Henderson (1953), Pou et al.(1953), Legates (1954), Carman (1955), Ragab et al.(1956), Rognoni & Betta (1960) and Singh (1961) all reported low estimate of heritability and repeatability for this character.

A positive, high genetic correlation coefficient of 0.87 between number of services for second conception and number of heats missed in second insemination period was observed. This indicates that the two characters could be controlled by same sets of genes.

V. CALVING INTERVAL

For an economic dairy farm the cows must be regular breeder with a calving interval of one year, so that a higher percentage of cows may be in milk at any time of the year.

The average of first calving interval in the present investigation was 494.67 ± 13.84 days with a coefficient of variation of 52.3 %. It is somewhat higher than the findings of

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Singh (1957), Amble et al. (1958a), Prasad (1958), who reported the same to be 433 days, 14.8 months, 131 days ( Mean length of post-partum interval to conception). But it is close to the result of Singh & Chowdhury (1961), who reported the same to be 480.6 days.

The results in this study were found to be in decreasing order upto third calving interval, afterwards again it increased. So cows showed maximum reproductive efficiency in third calving interval.

Calving intervals were found to be affected significantly by the sequance of calving. It is in agreement with the findings of Singh (1958), who reported significant effect of sequence of calving on calving interval in Tharparkar herd.

The heritability estimate of first calving interval was 0.10 ± 0.16. Stonaker (1953) has reported a very high heritability (0.88) of calving interval in Red Sindhi cattle, but the other authors, Amble et al. (1958), Brown et al. (1954), Dunbar & Henderson (1953), Legates (1954), Mishra (1955), Singh (1958) have reported values in agreement with the present study.

The intercalving period in this herd showed a little genetic variability, so selection to improve this trait will not be benefitial. Improving the environment will be of major effect.

Repeatability estimate of this character was 0.16. It is in close agreement with the findings of Ostergaard (1942) on Red Danish, Rennie (1952) on Holstein-Friesian, Patel (1957) on Kankrej and Sahiwal, Singh (1958) on Tharparkar, Amble et al.



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(1958) on Red Sindhi, Gir and Tharparkar, Ahmad (1961) on Hariana and Singh (1964) on Hariana, who reported the same to be 0.13, 0.175 to 0.185, 0.22, 0.33, 0.226, 0.21, 0.17, 0.19, 0.224 and 0.245 respectively. As the repeatability estimate was low, future performance of a cow can not be predicted on the basis of her past performance in calving interval.

Genetic correlation coefficients between calving intervals and each of the other measures of reproductive efficiency were positive and high. Everett et al.(1966) observed significant correlation coefficients between calving intervals and open period, insemination period and number of services required per conception.

VI. NUMBER OF HEATS MISSED IN AN INSEMINATION PERIOD

Averages and standard errors of number of heats missed in different insemination periods are presented in table XXIV. The average for breeding heifers is 1.59 ± 0.17. The cows after first calf missed more number of heats (1.94) in their insemination period. Afterwards it is in decreasing order upto the insemination period of cows after third calf. In the insemination period of cows after fourth calf it again increased. Maximum number of heats were missed by cows after fifth calf, followed by cows after sixth calf.

The heritability estimate of this character was 0.09± 0.10. As the heritability estimate is low, there is little genetic variability for this character in this herd. So there is



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less scope of improving this character by selection. More attention should be given to environmental factors.

The repeatability of this character was 0.063. So prediction of future performance on the basis of previous or present number of heats missed is not likely to be dependable.

Tandon (1958) observed the average of the expected number of heats missed in the first insemination period in Red Sindhi x Jersey cross-bred cows. He also observed that as the Jersey blood increases upto 50 %, the average number of heats missed decreased. The improvement of other components of reproductive efficiency also took place in this case. So a conclusion can be drawn that gene frequency of these characters is more in temperate cattle than Indian cattle and so genetic variance is more in Temperate cattle.

As breeding efficiency has wider implication than individual measures of reproductive efficiency, various workers (Lowe, 1938; Pou et al.,1953; Wilcox et al.,1957; Dohy, 1960; Johnson et al. 1964; Tomar, 1965; and Kubkowski, 1965), have evolved many expression of it.

Correlation of these traits with milk yield is required to be calculated,so that the optimum levels at which milk production is maximum can be known.

From the results it is evident that the genetic variability of these traits in Indian breed is low. Therefore,

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to improve these traits, genes from European breeds should be introduced, so that a larger genetic variability can be obtained.

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# CHAPTER - VI

# SUMMARY

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# S U M M A R Y

The present study deals with the estimation of genetic and phenotypic parameters of some reproductive traits of Tharparkar herd maintained at the Government Cattle Farm, Patna. Data obtained from the records of 14 years from 1950 to 1963 of Tharparkar herd were utilised for the present study. The following traits were studied:-

(a) Age at first calving

(b) Open period

(c) Insemination period

(d) Number of inseminations per conception

(e) Calving interval and

(f) Number of heats missed in an insemination period.

I.(a) Age at first calving:

The average age at first calving in the herd was found to be 1603.67 ± 14.07 days with C.V. of 18.3 %. The heritability was estimated as 0.02 ± 0.17 by intrasire regression of daughter on dam method. According to the result there is no scope for genetic improvement by selection in this character.

(b) Open period:

Averages of the open periods with C.V. following first calving, second calving, third calving, fourth calving,

fifth calving, sixth calving and seventh calving were 150.37 ± 6.25 days, 78.9 %; 114.09 ± 5.3, 77.1 % ; 162.07 ± 10.3, 91.5 % ; 111.11 ± 5.55, 58.4 % ; 107.48 ± 7.1, 62 % ; 104.8 ± 11.57, 83.2%; 105.17 ± 12.27, 68.8% respectively. Heritability estimate was 0.119 ± 0.19. Even repeatability was low i.e. 0.23. So improvement of this character by selection will not be benefitial.

(c) Insemination period:

The averages of insemination periods were 46.04 ± 4.4, 55.16 ± 5.9, 50.96 ± 6.4, 45.05 ± 5.6, 51.37 ± 7.1, 78.53 ± 16.6, 69.75 ± 20.5, 45.51 ± 15.9 days for breeding heifers, cows after first calf, after second calf, after 3rd calf, after fourth calf, after fifth calf, after sixth calf and after seventh calf respectively. Heritability and repeatability estimates were 0.08 ± 0.07 and 0.107 respectively. So genetic make-up has a minor role, if any, to control the insemination period and it is mainly dependent upon environmental factors.

(d) Number of inseminations per conception:

The heifers showed maximum reproductive efficiency in terms of this trait as they took minimum services (1.55 ± 0.04) per conception. From second conception (1.65 ± 0.05), it was in ascending order upto sixth conception (2.12 ± 0.17) afterwards again a gradual decline took place upto the 8th calving (1.63 ± 0.19). Heritability and repeatability estimates were low, i.e. 0.18 ± 0.059 and 0.20 respectively. So there is little scope for selection to improve this character.

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(e) Calving interval:

The maximum calving interval (494.67 ± 13.84) was in the first sequence and the least (444.91 ± 5.11) in the seventh sequence of calving. No definite trend in the rise or fall in the calving interval according to calving sequence was evident. Heritability and repeatability estimates were 0.10 ± 0.16 and 0.16 respectively. As there is little genetic variability for this trait in this herd, there is not much scope of improving this character by selection.

(f) Number of heats missed:

The averages of number of heats missed were calculated as 1.59 ± 0.17, 1.94 ± 0.24, 1.48 ± 0.22, 1.30 ± 0.19, 1.58 ± 0.28, 2.59 ± 0.64, 2.45 ± 0.84 and 1.30 ± 0.59 for breeding heifers, cows after first, second, third, fourth, fifth, sixth and seventh calf respectively. The heritability and repeatability estimates of this character were 0.09 ± 0.10 and 0.06 respectively. As genetic variability is low, more attention should be given to environmental factors.

II. Genetic relationships among different measures of reproductive efficiency:

All the genetic correlation coefficients were positive except the correlation coefficients between first open period and number of heats missed after first calf. Most of the correlation coefficients were of high magnitude except the correlation coefficients between age at first calving and insemination period

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after first calf and those between first open period and insemination period after first calf and with number of services per conception, which were low.

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