CERTIFICATE

Certified that Shri Iqbaluddin, U.P. College of Veterinary Science & Animal Husbandry, Mathura. a candidate for M.V.Sc. Final examination of 1968 in Animal Genetics & Breeding has been working under my supervision during the session and that the accompanying thesis entitled "Studies on Association of Age at First Calving and Part Time Lactation, with First and Subsequent Lactation Yields in Murrah Buffaloes. which he is submitting is his genuine work.

DATED 29/4/68

B P Singh

Signature in full of Supervisor.

Professor of Animal Genetics & Breeding

Prof. of I/c. Animal Genetics Section

L. R. S. U. P. MATHURA.

College.

G/512.

FOR EXTERNAL EXAMINER

STUDIES ON

ASSOCIATION OF AGE AT FIRST CALVING AND PART TIME LACTATION, WITH FIRST AND SUBSEQUENT LACTATION YIELDS IN MURRAH-BUFFALOES

THESIS

SUBMITTED TO AGRA UNIVERSITY IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

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IN

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By

Iqbal Uddin

DEPARTMENT OF ANIMAL GENETICS AND BREEDING
U. P. COLLEGE OF VETERINARY SCIENCE & ANIMAL HUSBANDRY,
MATHURA. (U. P.)

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** **

** TO ALL **

** WHO LOVE **

** PRODUCTIVE ANIMALS **

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APRIL, 1968.

IQBALUDDIN

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INTRODUCTION

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INTRODUCTION

Buffaloes maintain an important place in the rural economy because they provide higher and richer milk as compared to cows. Though the buffaloes constitute only about 30 per cent of the milch cattle (including buffaloes) in India, more than 50 per cent of the milk is produced by them alone. Dastur (1956) and Mohan (1961) indicated that buffaloes contributed 50-70 per cent of total milk resources. A sample survey of milk production in India (Amble et al, 1965) has indicated that cows in rural and urban areas produce 8.40 and 0.47 million metric tons of milk per annum, whereas buffaloes produce 10.06 and 0.69 million metric tons under the same conditions. Practically the entire trade in 'ghee' depends upon the buffaloes.

Knowledge of genetic and phenotypic parameters is necessary for the utilization of modern Animal Breeding procedures in selection programmes for the improvement of the milk production in Indian buffaloes. The ability to predict the succeeding records of a buffalo determine the success of herd culling programme. Usually in such programmes the production is based on the animal's complete lactation record. In actual practice it could be useful to predict the succeeding records prior to the completion of the current lactation records. The animal could then be culled or selected at an earlier period and future planning could be done at an earlier time. The breeding and selection procedure to be followed would be fruitful if the various genetic parameters of the part records are also in conformity with the completed records.

Keeping these facts in view the present investigation was taken up to study the association of part lactation yields with complete lactation yields. Since age at first calving is an important economic trait, the association of part lactation yield with completed lactation yield was considered, with and without inclusion of age at first calving. The prediction procedures were developed to predict the complete records. The heritability and the genetic correlation of part records as well as the total lactation records were estimated to know the extent of genetic variability and the genetic association between them so as to assess the desirability of utilizing as selection criteria the part lactation records in place of total lactation records.

CHAPTER - II.

REVIEW OF LITERATURE

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REVIEW OF LITERATURE

The review of the literature has been taken up into two sub-headings:-

(A) Age at First Calving and its Relationship with Milk Yield,

(B) Part yield and its Relationship with Cumulative Lactation Yields.

(A) AGE AT FIRST CALVING AND ITS RELATIONSHIP WITH MILK YIELD:

Age at first calving is one of the important economic characters. Early first calving can give the following advantages:-

1. Reduction of the non-productive period of an animal's life will reduce the cost of production of first calvers.

2. A large number of calves and lactations can be obtained from an animal within its breeding life.

3. Reduction of age at first calving will reduce the generation interval and thus (a) will increase the rate of genetic gain per unit of time, (b) sires can be progeny tested at an earlier age thus increasing the breeding life of the proven bulls.

Nutrition plays a very important role in increasing or decreasing age at first calving through its effect on the rate of growth of an animal. Therefore, the plane of nutrition should be high for the growing heifers. Because of different nutritional plane, climate, managemental practices and also of differences in the genetic constitution of the different herds, a lot of variations in the age at first calving even for the same breed have been reported.

Sayer (1936) mentioned that it should be possible to lower the age at first calving of Indian cattle by good husbandry in early life.

Dickerson et al (1940), Hansson (1941) reported that age at first calving is also a potent non-genetic factor which influences the milk yield in the first lactation.

In Shahiwal cattle Lecky (1951) observed a low correlation between the age at first calving and milk yield of first lactation.

Larson _et al_ (1951) found significant correlation (r = 0.27) between age at first calving and production upto 84 months. They also found the coefficient of correlation between age at first calving and 305-day production in the first lactation to be 0.06 indicating relative independence of these two variables. They reported that a multiple regression equation combining age at first calving and first lactation production (305 days) for predicting production upto 84 months of age accounted for 41% of the variance of this estimate of life time production. They pointed out, however, that the addition of age at first calving increased only slightly the accuracy of prediction than from first lactation alone.

Mahadevan (1953) concluded that the age at first calving could be lowered by better feeding and management practices in the early life.

Ragab _et al_ (1953) in a study of 923 lactation periods of buffaloes observed that the age at first calving has a highly significant effect on total milk yield. Buffaloes were reaching their maximum milk yield in the third lactation when they were about 6.5 years of age. The average age at first calving was found to be 40.2 months.

Sundaresan et al (1954) from a study of data of Red Sindhi 1/4 Jersey, 3/4 Jersey, 1/4 Brown Swiss and 3/4 Sindhi found a significant negative correlation between first 5 years milk production and age at first calving, but the first lactation production is independent of, or only weekly associated with it. They have also developed multiple regression equations for prediction of life time production by using the following three variables:-

a) Age at first calving,
b) First lactation production,
c) Production upto 10 years of age.

They also emphasized the desirability of early breeding of Indian cattle.

Venkayya and Anantakrishnan (1956) observed the age at first calving of Red Sindhi, Gir and Ayrshire X Red Sindhi to be 42.9, 47.3 and 35.1

months respectively. The coefficient of correlation between age at first calving and first lactation milk yield were +0.44, +0.34, +0.19 in Red Sindhi, Gir, Ayreshire X Sindhi cows and all these were statistically significant. The regression coefficients were also positive and significant. The coefficient of correlation between age at first calving and first lactation length of all breeds were positive and statistically significant.

Alim (1957) in a study of 294 buffaloes at Alexandria reported that early first calving of buffalo heifers did not affect their productive herd life and that the very early bred heifers tend to have lower yields and shorter calving intervals. However, the differences between the productivity and calving intervals of early and late bred animals show too high a standard error to allow any general conclusion to be drawn. The average age at first calving was reported to be 38.5±0.34 months.

Venkayya and Anantakrishnan (1957) reported the age at first calving of Murrah buffaloes to be 44.3 months. These workers also found significant correlation between the age at first calving and the first lactation yield (r = 0.39). They also observed a significant regression of the first lactation yield on the age at first calving. Further these workers reported that the correlation and regression coefficients between the age at first calving and the first calving interval were not significant.

Amble et al (1958) reported the variation in age at first calving from 42 to 49 months for dairy herds and from 47 to over 50 months for village cows and buffaloes in Punjab.

The same workers also reported that there was scope to reduce the age at first calving. Herd and breed differences were also found in the age at first calving and first lactation milk yield.

Zorin and Kocenov (1958) analysed data on age at first calving and the milk yields of Schwyz (Swiss-brown) cows at the studs of two collective farms in the Tula province. They reported that heifers calving for the first time at 22 months of age yielded an average 2671 Kg. of milk in a 300-day lactation, while 3761 Kg. of milk was obtained from heifers whose age at first calving was 48 months. The second lactation yields of late calvers was greater than early calvers, but at the same age the total production of the early calvers was greater.

Rife (1959) studied the data of buffaloes from Indian farms and reported that the average age at first calving was 45.7 months.

Dhinsa (1960) studied the records of 165 Murrah buffaloes and reported the age at first calving as 49.03 months. A not-significant correlation value of 0.06 between age at first calving and milk yield was reported by the author.

Lahousse (1960) in a study with Friesians reported significant coefficient of correlation (+0.297) between age at first calving and first lactation yield. No significant relationship between age at first calving and subsequent calving intervals was found. Age at first calving and average monthly milk yield upto 4th. calving were reported to be negatively correlated.

Menge and Mares _et al_ (1960) has shown that earlier attainment of puberty in Holstein heifers were associated with higher 90-day milk yields and higher butter fat contents.

Agarwala (1961) using data of 27 water buffaloes of India obtained a coefficient of correlation between age at first calving and first, second and third lactation yields of 0.68, 0.12 and 0.03 respectively. The first lactation yield was found to be a reasonable guide to selection for higher yields.

Erb and Ashworth (1961) compared the relative effects of age and weight on yield by standard partial regression coefficient technique. The relationship between yield and age was more than two times as important as between yield and weight.

Singh and Choudhry (1961) estimated correlations of age at first calving with lactation yield and calving interval. Both the estimates were reported to be positive but not significant. The correlation between age at first calving and lactation length was significantly positive for Sahiwal cows.

Danasoury and Bayoumi (1962) reported highly significant correlation (r = 0.402) between age at first calving and first lactation milk yield.

The age at first calving was not significantly affected by month or season of birth, nor was it significantly correlated with length of first lactation, length of first dry period and first calving interval.

Singh and Desai (1962) mentioned the average age at first calving as 50.7 months in a study with Bhadawari buffaloes. They found no significant effect of age at first calving on 305-day milk yield, lactation period, calving interval and dry period.

Belic (1963) working on data from 233 Red pied low land heifers showed that age at first calving was positively correlated with lactation length (r = 0.04) and with first lactation yield (r = 0.22). The average first lactation yield was 4018 Kg., increasing from 3796 Kg. to 4533 Kg. as age at first calving increased from 635 to 1176 day.

Horn and Dunay et al (1963) reported that age at first calving was highly significantly correlated with milk yield (r = 0.222).

Tomar (1963) in his studies of 477 buffalo heifers at the six military farms located in Northern Hot Dry Region has found average age at first calving to be 40.6±0.223 months with a coefficient of variation of 12.01 per cent and correlation between age at first calving and 300-day yield as well as first lactation yield were found to be not significant.

Nardone (1964) mentioned that production tended to increase upto a calving age of 36 months but there did not appear to be any advantage in delaying calving further. Within provinces and seasons there were significant differences in milk yield due to calving age. Differences in method of husbandry on the various farms were considered to have a marked effect on result.

Singh et al (1964) reported that in Hariana cattle age at first calving was significantly correlated with milk yield upto 6, 8 and 10 years of age but not with milk yield in the first or first plus second lactations. They have also given multiple regression equations for predicting longevity and milk yield upto various ages from first lactation yield and age at first calving.

Sidhu (1964) while working with data of

489 cows over a period of 26 years found negative correlation between age at first calving and life time production. The correlation coefficient between age at first calving and subsequent production was -0.27 which was significant at one per cent level of probability.

Dutt et al (1965) mentioned average age at first calving for Murrah buffaloes 42.8±0.65 months. They further found that age at first calving was significantly negatively correlated with milk yield upto 6, 8 and 10 years of age. On the other hand age at first calving was reported to be significantly positively correlated with the milk yield upto age at actual culling. The first lactation production was not affected by age at first calving. They developed five prediction equations for predicting milk yield upto 6, 8 and 10 years of age and upto the age at culling and longevity and reached to the conclusion that along with milk production of first lactation age at first calving should also be given due weightage for improving life time production.

Gautam and Agrawal (1965) reported that age at first calving in Murrah buffaloes is

42.31 ± 1.05 months and age at first calving and producing (milk) ability are not correlated to each other and are influenced much by the individuality.

Montemurro and Cianci (1965) reported mean age at first calving of 28.28 months based on records for 324 Friesian cows in a close herd in Taranto. They also found no significant correlation between age at first calving and milk production but reported that the delayed first mating prolonged the reproductive life.

Montemurro _et al_ (1965) reported not-significant correlation between age at first calving and milk production.

Puri and Sharma (1965) reported that age at first calving had more influence on the estimation of yield upto a certain age than on yield upto a certain numbers of lactations, the first lactation yield being of equal importance in both cases. The first lactation yield accounted for 70 per cent of the variation in total yield upto five lactations in Tharparker and Sahiwal breeds and about 42 per cent in Red Sindhi and crossbred cows. Multiple regression equations to predict yield upto ten years of age on the basis of the first lactation yield and age at first calving explained more than 75 per cent variation in pure breed cows and only 40 per cent in crossbreed cows. The partial regression coefficients indicated that an increase of 73 Kg. milk in the first lactation yield was equivalent to a reduction of one month in age at first calving in the Tharparkar breed. Similar figures in the Sahiwal, Red Sindhi and crossbreed cows were 57, 92 and 126 Kg. milk, respectively.

Gehlon and Sekhon (1966) reported that age at first calving is insignificantly negatively correlated with first lactation milk yield and first dry period in Hariana cows.

Gautam _et al_ (1966) mentioned that producing ability and breeding efficiency were significantly superior in Hariana cows calving at an age of 36 months to less than 39 months as compared to those calving at an age of more than 39 months.

Singh and Sundaresan (1966) on the basis of 345 daughter dam pairs (22 sires) records found not significant phenotypic correlation (r = 0.038) of age at first calving with first lactation yield, but there was significant genetic correlation between age at first calving and first lactation yield (0.795). Since the genetic correlation is high and significant and the phenotypic correlation low, it means that environmental factors are having a pronounced role in the expression of the genetic relationships.

Singh (1966) reported that correlation with age at first calving and breeding efficiency was negative but not significant (-0.0646).

Chandiramani and Dadlani (1967) in their studies based on 88 farm-bred daughters of ten sires concluded that age at first lactation and milk yield were less phenotypically correlated (-0.0726).

Vankov and Aleksiev (1967) examined the performance of 203 Red Danish heifers and 316 Red Danish first crosses in relation to age at first calving and found that the mean 300-day milk yield varied between 3210 Kg. for calving at 35-36 months and 3620 Kg. for 29-30 months and between 2640 Kg. for more than 37 months and 2975 Kg. for 29-30 months but the differences between age groups were not statistically significant.

(B) PART YIELD AND ITS ASSOCIATION WITH CUMULATIVE LACTATION YIELDS:

To find out a criterion of selecting an individual at the earliest possible opportunity without losing efficiency has always been an aim of a successful breeder. In other words the answer lies in the fact that how accurately the life time performance or a full lactation's yield etc. can be predicted on the basis of the part time performance of an animal. For selecting better buffaloes a lot of attempts have been done to enable the breeders to attain the above objective.

Cannon et al (1942) mentioned that prediction of yield is most accurately made from a test taken during the fifth month of lactation and test made in sixth month comes next followed in turn by those made in seventh and fourth months. There is less accuracy in predicting yield when based on tests made in the first or last months and reported the correlation of first, third and fifth month with lactation yield as 0.74, 0.86 and 0.91 respectively.

Kennedy and Seath (1942) reported that

production of first calf heifers during the first four months was a good index of what the complete first lactation would be and also the relative production for the second lactation. The correlation between short time records and the complete first lactation increased from an average of 0.62 for one month to 0.78 for four months. According to them short records were only slightly less valuable than were complete records in predicting production for following lactations.

Mahadevan (1951) has mentioned the relative usefulness of the 180-day record for genetical purposes based on data of 326 cows. The repeatability was found to be slightly higher for the 180-day record than for the total lactation record. 180-day record can be used for measuring cow's milking ability because the number of uncontrolled physiological and environmental factor that enters into the latter part of the lactation is great.

Roth (1951) found that the yield during the first 200 days of the first lactation accounted for 46 per cent of the variation in production during the first five to six years after freshening.

Kliesch and Bankwitz (1952) studied two herds of European cattle in which the first 180 days production in the first lactation accounted for 29 and 52 per cent respectively of the variation in the total yield during the first four lactations.

Alim (1953) in a study with Egyptian buffaloes observed the average production herd life of these animals as five calvings.

Maule (1953) reported that the average milk yield of Indian farm buffaloes ranged from 3150 pounds to 4580 pounds in one lactation.

The heritability estimate of milk yield in Egyptian buffaloes was reported by Asker et al (1953) as 0.24. The same authors in 1955 in a study of Egyptian buffaloes reported the average milk yield for first lactation as 3844 pounds. Maximum yield 5267 pounds was reported to have reached in fourth lactation.

Madden et al (1955) while working with 599 records mentioned average intrasire daughter dam regression which is half of the heritability, for single month milk and fat production and for cumulative month milk and fat production as 0.15, 0.09, 0.25 and 0.19 respectively. Genetic correlations between cumulative part and whole milk and fat production were over 0.9, thus selecting on the cumulative part record would improve production nearly as much as selecting on the complete record itself in Holstein cows. The efficiency values ranging from 0.74 to above unity.

Hofmann (1957) analysed the data using part yields (60 & 100-day yields) of dams and daughters instead of first lactations of heifers and life time yield to find out the breeding worth of bulls and found that when bulls were placed in rank order according to butter fat per-centage on the basis of part yields their position were almost the same as when life time yield were used.

Rendel, et al (1957) while studying the inheritance of milk production characteristics found that 70-day yield was an excellent guide to the total lactation (r = 0.80 and that it could be used as a guide to early selection.

Bogner et al (1958) made a comparison of yields in the first 180-days of lactation with yields in the first 90-110 days and found the correlation between the two periods both for milk yield and butter fat percentage were sufficiently high to justify the use of data obtained from three recordings only as preliminary evidence for bull evaluation.

O'connor and Stewart (1958) found a good agreement in the relative breeding values of the 12 A.I. bulls calculated on 180 and 305-day yields.

Eilfort (1959) has studied various part records of heifer using data from 333 Wurttemberg spotted cows in 263 herds and found yields of less than 200 days were not sufficiently accurate for assessment of life time yield. Environmental factors had a considerable effect on this relationship but it was not worthwhile making corrections for age at first calving, calving interval and month of calving.

Jost (1959) discussed the value of various part lactation records critically and mentioned that for individual animals the estimation of 305-day yields from part lactation yield is inaccurate. For bull evaluation purposes the use of thirty, 100-day records or ten 200-day records is considered to be accurate for assessment of average 305-day milk yields. He also mentioned that the positive correlation obtained between the 305-day yield and part yield were not influenced by the following factors: i) heifer's age at first calving, ii) first calving interval, iii) differences in feeding and management. Length of lactation influenced only fat content for a 200-day period. The environmental influences are not very important in preliminary selection of bulls for breeding.

Johnson (1959) found no significant difference between the heritability estimates for 100, 200 or 305-day lactations except for that between 100 and 305-day estimates for the butter fat content.

Madden <u>et al</u> (1959) while studying with the data based on 3930 Michigan D.H.I.A.-I.B.M. Holstein cows reported that adjacent months are more closely correlated than non adjacent one. The lowest correlation exists between first and second adjacent months. Correlation between single test day milk production and the sum of milk production for fifth month were highest but the correlations were also sufficiently high for the fourth, sixth and seventh months. The milk yield during 4 to 7 months had the lowest variability and therefore, more closely correlated with the total production.

Dhinsa (1960) reported the average milk yield of Murrah buffaloes to be 3873 pounds. As regards the heritability estimates of milk yield, it was found to be 0.324.

Salerno (1960) made a study of 200 lactations of buffaloes. He indicated that the average daily yield to the 20th. day after parturition showed a high positive correlation with 240 days production and could be used as a basis for culling low yielding animals - buffaloes.

Fritz et al (1960) reported that analysis of regression coefficient for the first, third and seventh cumulative months of the Holstein data indicated that season was not an important influence on the part to whole relationship and also found that the correlation between cumulative part and 305-day production ignoring herd differences were not less than 0.7 for the first month, increased steadily as the lactation progressed and were 0.9 by the fifth test day for all breeds.

Lamb and McGilliard (1960) advised that in practice breed, age and season of freshening should be considered in extending partial records to 305 days. Two methods are reported for extending part records. The simplest one is by ratio factor, the other method is by regression of total production on partial production, both linear and quadratic regression equations have been used but Harvey (1956) found the curvi-linearity of accumulated production and stage of lactation to be small enough that the linear regression equation will provide a satisfactory means of extending part production and total production estimated by this method is less variable than actual production.

Kovats (1960) reported on the basis of 700 lactation of Hungarian spotted cows of different ages and levels of production and obtained factors for predicting the 300-day yield from 60, 90, 120, 150, 180, 210, 240 or 270-day yields in 5 successive years and they have claimed that using these factors estimation of 300-day yield even from a 60-day yield gives reliable results.

Hickman (1960) while working from 510 records of 202 Holstein-Friesian and 279 records of 105 Ayrshire cows found simple correlation (phenotypic) coefficient between 180 and 300-day yields were 0.912 and 0.957 for Ayrshires and Holstein-Friesians respectively, regression coefficients were 0.676 and 0.699 respectively. Genetic correlation among successive 60-day periods of lactation, 180-day yield and 300-day yield were all close to 1.00.

Voelker _et al_ (1960) reported that there were no significant differences in slope of the regression lines between complete and incomplete lactations but there was a significant difference in the elevation of the regression lines of production, the incomplete lactations being considerably lower. This suggests that the use of incomplete with complete records for sire evaluation would tend to adjust the production records downwards and give a more accurate picture of the sire's true breeding potential.

Vanvleck _et al_ (1961) explained (on the basis of data collected from November, 1957 to December, 1959) that estimates of cumulative monthly records and of linear functions for extending monthly records increased with the stage of lactation. Genetic correlation of individual monthly yield with total yield were 1.01 in the fifth month, 0.79 in the second month and 0.71 in the tenth month and those for cumulative monthly increased with stage of lactation. The amount of genetic progress in total yield by selection based on single third or fifth month was estimated as 92, 95 and 97 per cent of that based on total yield.

Vanvleck and Henderson (1961) reported the single best months for estimating a complete lactation are the fourth, fifth and sixth, as they account individually for 72 per cent of the variation in total records.

Johnson and Corley (1961) while analysing 8413 HIR records from 38 Brwon Swiss herds in Wisconsin reported the heritability of 0.3 for 100 and 0.34 for 200 days yields of first lactation and reported that partial first lactation records of 100 or 200 days in length will be almost as effective in improving milk as selection based on 305-day first lactation record.

Vanvleck <u>et al</u> (1961) on the basis of

9036 Holstein cow data reported that a single test day record from the fourth, fifth or sixth month of a lactation had a correlation of 0.50 with the succeeding complete lactation, while the correlation between two successive complete lactation yields was 0.55. A linear function of the first five monthly test record predicts complete second record as accurately as the total yield of the first lactation. They concluded that part lactation records are very valuable for predicting total milk production during succeeding lactation and one can cull cows on the basis of a single monthly test as early as the third or fourth month of lactation. The same authors have also suggested that only slightly more seven or eight month records than 10 months records are needed for equal accuracy in sire evaluation and moreover, time advantage overbalance the slight increase of accuracy. They have also recommended a 3-stage programme for evaluating sires used in A.I., the first stage consists of acceptance or rejection of sires based on the part lactation (5 month) records of their daughters, 2nd. stage utilizes both part and complete records of other daughters while third and final stage provides for evaluation dependent on complete records alone.

Vachal (1961) explored the possibility of using part lactation records for the evaluation of bulls based on their studies with 34 heifers from 9 bulls and found highly significant correlation coefficient between the milk yield obtained during the adjusted lactation period of 300 days and part lactations of 60, 90, 120, 150 and 180 days. The agreement was closest for the 180-day period and this was considered to be the most reliable basis for the evaluation of bull.

Searle (1961) has indicated that monthly records of artificially bred cows under New Zealand condition, records accumulated upto a specified test day early in lactation are suitable for progeny testing. Heritability is slightly more for lactation yield than the heritability of part record and the genetic correlation between the part record and lactation yield exceeds 0.90. The rate of progress using records upto 6 month in length may even lead to slightly faster progress than on complete lactation yield. The rate of genetic progress based on part records as compared with the rate of progress from selection based on completed records was estimated by the genetic correlation between part record and lactation yield multiplied by the squareroot of the ratio of their heritabilities.

Vanvleck (1962) has also recommended the use of 150-day age corrected records of daughters for estimating the breeding value of sires. Later he reported the heritability of 150-day record and genetic correlation between 150 days and first lactation as 0.4 and 0.95; 0.03 and 0.66; 0.27 and 0.96; 0.20 and 0.88; 0.59 and 0.91 in Ayrshire, Guernsey, Holstein-Friesian, Jersey, and Brown Swiss breeds respectively.

Tomar (1963) reported the heritability of 300-day milk yield to be 0.1773±0.1259.

Zavertjaev (1963) found correlation between milk yield in the first 30, 60, 90 and 120 days and in the complete lactation increased progressively from 0.48 to 0.86. It is concluded that production in the first 90 to 120 days of heifer lactations could be used in progeny testing.

Dutt *et al* (1964) have calculated

coefficient of correlation of the milk yield in first 15, 75 and 135 days with 305-day lactation yield in Hariana cattle as 0.501, 0.737, 0.859 and the regression of milk yield in pounds on the production upto 15, 75 and 135 days in the same lactation as 7.63, 2.54 and 1.68, all these correlations and regressions were significant at P/_0.01. The coefficient of variation for the first 15 days was comparatively high. They have also evolved three regression prediction equations for predicting the lactation yield:

1. $\hat{Y} = 1284+7.63X_1$
2. $\hat{Y} = 174+2.54X_2$
3. $\hat{Y} = -142+1.68X_3$

Where $\hat{Y}$ is predicted lactation yield;

X_1, X_2 and X_3 are yields in first 15, 75 and 135 days respectively.

Decking (1964) reported the heritability of 100, 200 and 305-day yields over 0.2 in all cases and did not differ significantly. There was a phenotypic correlation of 0.87 between 100 and 200-day yields and of 0.82 between 100 and 305-day yields, corresponding genetic correlations were 0.96 and 0.92.

The figures indicate that the same genes are operating for the different part performances.

Venkataratnam et al (1964) found lactation yield to be highly significantly correlated with maximum initial yield (0.81) in Murrah buffaloes and developed equation for predicting lactation yield from initial yield and lactation length.

Nagarcenkar (1964) reported that lower repeatability of part lactation yield is attributed to environmental influences having more effect on the latter months of lactation. The correlation between 120-day yield in the first lactation and the average yield over the first three lactations was 0.739 ± 0.036. The genetic correlation between the two variables was 0.777 ± 0.355. Almost 55% of the variation in average production over the first three lactation was due to variation in 120-day yields in the first lactation. The efficiency of selection on 120-day yields was estimated to be 52.4, 87.1% of that on completed lactation yields.

Guba (1964) mentioned that there were close correlation between milk yield in 100-day calculated from a 24, 48 and 72 hours test and actual 300-day yield.

Dutt et al (1965) reported on the basis of 96 farmbred Murrah buffaloes of District Dairy Demonstration Farm, Mathura that age at first calving was found to have negative significant correlation with milk yield upto 6, 8 and 10 years (-0.736, -0.551, -0.460 respectively) and also found the corresponding negatively significant regressions (-240.50, -248.72 and -251.34 respectively). On the other hand they have also reported that age at first calving has significant positive correlation with the milk yield upto age at actual culling, longevity and useful life (0.448, 0.646, 0.467 respectively), the corresponding regression coefficients are 517.41, 2.73 and 1.73 respectively. They also evolved five prediction equations for predicting milk yield upto 6, 8 and 10 years of age, upto the age at culling and longevity, on the basis of age at first calving in months and milk production during 305-day first lactation in pounds. They concluded that age at first calving should also be given due weightage along with milk production of first lactation for improving the life time production.

The same authors also calculated coefficient of correlation and regression of 305-day first lactation production on part production of 15, 75 and 135 days, all the estimates were highly significant, and noted that with rise of one Kg. of milk either in first 15 days, 75 days or 135 days yield, there would be an increase of 11.65, 2.4 and 1.5 Kg. of milk respectively in 305-day yield. They further compared the correlation and observed that the simple relationship of 0.453 between 15-day and 305-day yield reduced to 0.215, a partial correlation (significant at P/_0.5) between them when peak yield is held constant, whereas it increases to 0.482 (at P/_0.01) when the 305-day lactation period is kept constant. The negative relations of -0.18 and -0.205 between 15 days and lactation period when peak yield and 305-day yield were held constant respectively. In fact lactation yield and lactation period are closely associated as indicated by partial correlation of - r = 0.528. Therefore, in predicting lactation yield, they found that lactation period can be ignored. They concluded that even 15 days yield are reliable indications of first 305 days yield. The reliability of this relationship increases with the increased duration of part production in Murrah buffaloes.

Krempa (1966) concluded that multiple regression equations for 200 and 160-day lactations and simple regression equations for 140 and 120-day lactation offered a satisfactory basis for the calculation of 300-day yield. 100, 80 and 60-day part lactations are insufficient for full evaluation of sires but satisfactory for preliminary evaluation provided they are based on at least 3 test milkings.

Singh <u>et al</u> (1967) while working with 186 first lactation milk production records suggested that selection on the basis of 135 days milk record may be sufficiently accurate and may increase genetic progress by permitting early evaluations.

Ithaca (1967) while studying physiological and environmental effects on first and second lactation monthly milk and butter fat yields reported that heritability ranged from 0.06 to 0.21 and 0.20 to 0.23 for monthly and cumulative milk yields respectively (735 dam daughter pairs). Genetic correlation between cumulative parts of the lactation and total yields were essentially one.

Lamb <u>et al</u> (1967) reported that the genetic correlations between monthly yields and total production were generally 0.9 or larger. Phenotypic correlation of monthly yields with total production in the same or subsequent lactations were largest in 4 to 6 months. Adding a second month to the first contribute the largest increase in accuracy of predicting that complete lactation and correlation exceed 0.9 by the time the fifth month was added. A succeeding lactation could be predicted nearly as accurately by a part of the first lactation as by the whole first. They further concluded that selection on production for a single month will provide less genetic progress than selecting on the complete record, but cumulating parts should increase relative efficiency with each added month. The same authors have also suggested that breed, age and season of freshening influenced the relationship between total and part production sufficiently to require adjustment in extending records in progress.

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CHAPTER - III.

M A T E R I A L AND M E T H O D S

CHAPTER - III

MATERIAL AND METHODS

I. MATERIAL:

(a) Source of Data:-

The data used under study were collected from the two farms of U.P.

i) State Livestock-cum-Agricultural Farm, Babugarh, Meerut.

ii) State Livestock-cum-Agricultural Farm, Madhurikund, Mathura.

The records kept at these farms are systematic and consisted of the name/or brand mark of the animal, her date of birth, date of service, brand number of the bull used for service, date of calving, date of drying, per day milk yield in pounds (after 1963 in Kg.) during the lactation and complete lactation yield. The brand number of the sire and dam of individual animal is also available. The records also mention about other things like abortion, dystokia, sickness etc. during the lactation.

(b) Managemental Practices:-

The farms are situated in plains of U.P. and more or less similar climatic condition prevails at both the places. Since they are managed by the State, Animal Husbandry Department, the housing, management and feeding practices are on scientific lines. Adequate protection from extreme weather conditions is provided by proper housing facilities. The supply of green fodder is ensured nearly all the year round, either in the form of green fodder or as silage, when green fodder or pasture is not available. Weaning is not practised at these farms, therefore amount of milk suckled by the calf is not known. However, test milking is done every fortnight to find closer estimate of the milk producing capacity of animals. The calves are allowed to suckle their prescribed share according to the stage of lactation and it is presumed that all calves get more or less the same amount of milk during the entire suckling period. Milking is done twice a day.

(c) The Data:-

Both farmbred as well as purchased animals formed the foundation stock of these two farms.

All the available data of Murrah buffaloes were assembled for the present study. The records of both farms were examined and lactation records of less than 250 days and first month yield of first lactation were excluded. The records which were considered abnormal on account of systematic disorders, abortions, death of calf during lactation etc. were also omitted from the present study. Berry and Lush (1939) and Lush et al (1941) discussed the question of omission of records known to be made under abnormal circumstances for which adequate correction cannot be made. The criteria for omission according to them must be simple and impersonal. The records of the purchased animals were not used for all the studies, because the necessary information about sire, date of birth and details of lactations made before purchase could not be ascertained. As far as possible inbreeding has been avoided at the farms under study. The registers containing the daily milk yield and history sheets were consulted for monthly yields of first lactation, complete first lactation and subsequent lactation yields, date of birth and date of first calving.

Milk yields are taken into kilograms, whereas date of birth into months, under the present investigation. Some of the animals were born and maintained at one farm but were transferred to another farm. The records of such animals have been included under the farm where they had completed their first lactation.

II. METHODS:

Depending on the availability of the type of data and their suitability, the following methods were used for calculating various statistical estimates in this investigation.

(a) Averages and Measures of Dispersion:-

They were calculated by the simple formulae:

$$\bar{x}_1 = \frac{\sum x_1}{n_1}$$

$$\bar{x}_2 = \frac{\sum x_2}{n_2}$$

$$\bar{x} = \frac{\sum \bar{x}_1 n_1 + \sum \bar{x}_2 n_2}{n_1 + n_2}$$

Where x_1 and x_2 are two variables used for two different farms and x represents both the farms.

$$S.D.(x_1) = s_1 = \sqrt{\frac{\Sigma x_1^2}{n_1-1}}$$

Formula for x_2 is exactly the same as used for x_1

$$S.E.(\bar{x}_1) = \frac{S.D.}{\sqrt{n_1}} = \frac{s_1}{\sqrt{n_1}} \quad \text{and} \quad S.E.(\bar{x}_2) = \frac{s_2}{\sqrt{n_2}}$$

$$S.E.(\bar{x}) = s\sqrt{1/n_1 + 1/n_2}$$

$$\text{Where } s = \sqrt{\frac{\Sigma(x_1 - \bar{x}_2)^2 + \Sigma(x_2 - \bar{x}_2)^2}{n_1 + n_2 - 2}}$$

Where 's' is the S.D. for both the farms.

$$C.V. = \frac{S.D.}{\bar{x}} \times 100 \text{ (in percentage)}$$

(b) Interrelationships between Characters:-

Relationship between traits have been estimated by finding out phenotypic correlations and regressions. The correlation and regression coefficients have been calculated as described by

Snedecor (1956). The formulae used are:-

$$\text{Correlation Coefficients} = r = \frac{\sum xy}{\sqrt{\sum x^2 X \sum y^2}}$$

$$\text{Regression Coefficients} = b = \frac{\sum xy}{\sum x^2}$$

Where 'x' is independent variable and 'y' is dependent variable and x,y denote their deviations from their respective means.

The significance of correlation coefficient was seen directly from the Table given by Fisher and Yates. The significance of regression coefficients were tested by analysis of variance method as given below:-

ANALYSIS OF VARIANCE FOR TESTING THE SIGNIFICANCE OF REGRESSION

Source	d.f.	S.S.	M.S.S.	"F" Value
Total	n-1	$\sum y^2$		
Due to regression	1	$b.\sum xy$	$b.\sum xy = A$	$\frac{A}{B}$
Deviation from regression	n-2	$\sum y^2-(b.\sum xy)$	$\frac{\sum y^2-(b.\sum xy)}{n-2} = B$	

Where n is number of paired observation.

Multiple regressions were calculated by the methods as given by Snedecor (1956).

$$b_{Y1.2} = \frac{(\sum x_2^2)(\sum x_1Y)-(\sum x_1x_2)(\sum x_2Y)}{D}$$

$$b_{Y2.1} = \frac{(\sum x_1^2)(\sum x_2Y)-(\sum x_1x_2)(\sum x_1Y)}{D}$$

Where $D = (\sum x_1^2)(\sum x_2^2)-(\sum x_1x_2)^2$

They were tested by analysis of variance method as described earlier.

To study simultaneously the effects of four independent variables on dependent variable, partial regression coefficients were calculated by finding out the elements of an inverse matrix. The model and procedure used are as follows:-

$$Y_i = \mu+\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_4x_4+\Sigma_i$$

Where Y_i is the first five cumulative lactation yields (life time production).

U is average of the lifetime production.

B_1, B_2, B_3 and B_4 are the partial regression coefficients of first month yield, first three months cumulative yield, first five months cumulative yield of first lactation and age at first calving respectively.

Let m, b_1, b_2, b_3 and b_4 be the least square estimates, then expected value becomes:

$$\hat{Y}_i = \bar{Y}+b_1x_1+b_2x_2+b_3x_3+b_4x_4$$

By minimising the error sum of squares the normal equations obtained are given below in matrix notation:-

$$[A] = \begin{bmatrix} \Sigma x_1^2 & \Sigma x_1x_2 & \ldots\ldots & \Sigma x_1x_4 \\ \Sigma x_2x_1 & \Sigma x_2^2 & \ldots\ldots & \Sigma x_2x_4 \\ \Sigma x_3x_1 & \ldots & \Sigma x_3^2 & \Sigma x_3x_4 \\ \Sigma x_4x_1 & \ldots\ldots & & \Sigma x_4^2 \end{bmatrix} \times \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \end{bmatrix} \begin{matrix} =\Sigma x_1Y \\ =\Sigma x_2Y \\ =\Sigma x_3Y \\ =\Sigma x_4Y \end{matrix}$$

or

$$[A]\,[b] = [XY]$$

$$[b] = [A^{-1}]\,[XY]$$

(c) <u>Prediction Equations:-</u>

Prediction equations based on part yields of first lactation have been developed to predict first lactation and upto subsequent five lactations cumulative yields with and without considering the age at first calving. Without age the model of the prediction equation used will be:

$$Y = a + \beta(x - \bar{x}) + e$$

Where "a" is the average of the parameter to be estimated.

"β" is regression coefficient of total yields (first lactation and subsequent upto five lactation cumulative yield) on part lactation yields of first lactation.

"e" is the random error which is independent of x and normally distributed with 0 mean, σ^{-} variance.

When age at first calving is also considered along with the part yields of the first lactation to predict the total yields then the model will be:

$$Y = a + \beta Y_{1.2}(x_1 - \bar{x}_1) + \beta Y_{2.1}(x_2 - \bar{x}_2) + e$$

Where "a" alpha is the average of the parameter to be estimated.

β are partial regression coefficients.

x_1, x_2 and Y are part yield or first lactation, age at first calving and the total yield to be predicted, respectively.

e is $N(0, \sigma)$.

In the present investigation for the purpose of life time production first five lactation cumulative yields have been considered.

Simultaneous equations have been formed by taking into consideration four variables i.e. first month, first three months cumulative, first five months cumulative yields of first lactation and age at first calving, to predict life time production. The model being:

$$Y = \mu + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 \text{ .... } e \quad jk$$

Where e is $N(0 - \sigma)$.

For testing the prediction value of these prediction equations R^2 have been calculated which is equal to:-

$$R^2 = \frac{\text{Corrected S.S. due to regression}}{\text{Corrected S.S. of total}}$$

Where "R" is the multiple correlation coefficient. The multiple correlation is the correlation between observed and expected values. Thus it gives the information about the suitability of prediction equation.

(d) Heritability:-

The heritability of monthly yields of first lactation have been calculated by paternal half sib correlation method. This method has been described in detail by Hazel and Terril (1945). The total variance and covariance in each sample were separated into components as described by Snedecor (1956) and given below:-

COMPOSITION OF MEAN SQUARES

Source of Variation	d.f.	Mean Square	Expectation of Mean Square
Between Sire	n-1	$B+\bar{K}A$	$\sigma^2_B + \bar{K}\,\sigma^2_A$
Within Sire	n(K-1)	B	σ^2_B

Heritability by half-sib correlation is $\frac{A}{A+B} \times 4$

Estimates of heritability if unbiased must be equivalent to the ratio of genetic variance to the total variance.

The standard error of the half-sib correlation is:-

$$\frac{B(B+\overline{K}A)}{(A+B)^2 \Big/ \sqrt{1/2(\overline{K}-1)\overline{K}n}}$$

Where B = Variance within sires;

A = Variance between sires;

$\overline{K}$ = Average number of progeny under each sire group;

n = Number of sires considered.

As the sires did not have the same number of daughters so the value of $\overline{K}$ would be slightly smaller than the average number of daughter per sire. The formula used for determining $\overline{K}$ has been given by Hazel and Terril (1945).

$$\overline{K} = \frac{(\Sigma K)^2 - \Sigma K^2}{K(n-1)}$$

Where K is the series of observations made by daughters under each sire, and

n is the number of groups or sires.

(e) <u>Genetic Correlation:-</u>

The genetic correlations have been estimated by the procedure described by Hazel *et al* (1943).

Genetic variance and covariance can be obtained by dividing sire variance and covariances by halfsib correlationship from the Table of Analysis of Variance. Symbolically:-

$$r_{G_i G_j} = \frac{Cov.G_i G_j}{\sqrt{(\sigma^2 G_i)(\sigma^2 G_j)}}$$

Where "i" and "j" represent two characters.

CHAPTER - IV.

RESULTS AND DISCUSSION

CHAPTER - IV

RESULTS AND DISCUSSION

I. AGE AT FIRST CALVING:

(a) Averages:-

The average age at first calving of 182 buffalo heifers at the two State Livestock-cum-Agricultural Farms, located in the Western U.P. was found to be 49.60±1.27 months with a coefficient of variability 16.21 per cent. The range of age at first calving was from 32.2 months to 76.9 months. The averages for age at first calving for buffaloes maintained at each farm have been presented in Table 1.

TABLE 1. AVERAGE AGE AT FIRST CALVING IN MONTHS

Name of the Farm	No. of Observa-tions	Mean	S.D.	S.E.	C.V. (%)
Babugarh	122	48.38	7.32	0.66	15.13
Madhurikund	60	52.07	9.35	1.21	17.96
Overall	182	49.60	8.04	1.27	16.21

The average age at first calving at Babugarh and Madhurikund farms was 48.38 and 52.07 months with a coefficient of variation of 15.13 and 17.96 per cent respectively. The average age at first calving reported in the present study is fairly similar to the ones reported in literature by Amble et al (1958), Dhinsa (1960), Singh and Desai (1962). However, the estimates given by Ragab et al (1953), Venkayya and Anantakrishnan (1957), Tomar (1963), Gautam and Agrawal (1965) and Dutt et al (1965) are lower than the ones obtained in the present investigation.

The coefficient of variation indicates that the variability present in the population for this trait could be utilized to reduce the age at first calving. Sayer (1936), Mahadevan (1953) and Amble et al (1958) have also reported that it could be possible to lower the age at first calving of Indian cattle by good husbandry in early life.

(b) Relationship between age at first calving and milk yield:

i) Correlation coefficients:- Phenotypic correlations of the age at first calving with milk yield in first lactation, first two cumulative, first three, first four and first five cumulative lactations have been presented in Table 2.

TABLE 2. PHENOTYPIC CORRELATIONS OF AGE AT FIRST CALVING WITH MILK YIELDS.

Name of the Farm	First lactation yield	First 2 cumulative lactation yield	First 3 cumulative lactation yield	First 4 cumulative lactation yield	First 5 cumulative lactation yield
Babugarh	0.0360	-0.0401	0.0767	0.1390	0.1782
Madhurikund	0.1932	0.3353*	0.3569	0.3129	-
Overall	0.0867	0.0429	0.1303	0.1544	-

* - Significant at 5% level of probability.

The correlation between age at first calving and milk yield in first two cumulative lactation was significant at Madhurikund farm. All other estimates of correlation coefficients were not significant. The estimates when pooled over farms were not significant. These estimates indicate that in general age at first calving had no significant effect on milk yield. Dhinsa (1960), Singh and Desai (1962), Tomar (1963), Gautam and Agrawal (1965), Singh and Sundaresan (1966), Singh (1966) have also reported that age at first calving had no effect on milk yield. On the other hand, Ragab _et al_ (1953) observed that the age at first calving has a highly significant effect on total milk yield; Venkayya and Anantakrishnan (1957) found significant correlation between the age at first calving and the first lactation yield. Agrawala (1961) obtained significant correlation between age at first calving and first lactation yields only. Dutt _et al_ (1965) reported that first lactation production was not affected by age at first calving, but age at first calving was significantly negatively correlated with milk yield upto 6, 8 and 10 years of age in Murrah buffaloes, on the other hand age at first calving was reported by the same authors to be positively correlated with the milk yield upto the age at actual culling.

ii) Regression Coefficients:- The estimates of regression coefficients on age at first calving of milk yields of first lactation and subsequently cumulative lactations upto first five lactations have been calculated and reproduced in Table 3. The regression estimates followed the pattern of correlation coefficient estimates discussed earlier. Robertson (1950) and Lecky (1951) found that the effect of age at first calving on yield in the first lactation in Fulani cattle in Nigeria was very small, and the regression was not significant.

TABLE 3. REGRESSION COEFFICIENTS OF MILK YIELDS ON AGE AT FIRST CALVING.

Name of the Farm	First Lactation yield	First 2 Cumulative lactation yield	First 3 Cumulative lactation yield	First 4 Cumulative lactation yield	First 5 Cumulative lactation yield
Babugarh	2.0281	-3.7214	9.8121	22.3779	31.6206
Madhurikund	6.9161	16.4448*	20.9928	35.3238	-
Overall	4.1918	3.4362	13.9926	24.0348	-

* - Significant at 5% level of probability.

Sundaresan et al (1954) have reported not significant effect of age at first calving on milk production upto 10 years of age in Kansas State College Jersey breeds whereas significant negative effects are reported by the same authors in Red Sindhi and 1/4 Jersey X 3/4 Red Sindhi breeds, though these results are based on only seventeen observations. Venkayya et al (1956) reported significant positive effect of age at first calving on first lactation milk yield in Red Sindhi, Gir, Ayrshire X Sindhi cows. Dutt et al (1965) reported that regression of first lactation production on age at first calving was not significant, but its regression was significantly negative on milk yield upto 6, 8 and 10 years. On the other hand regression of the milk yield upto the age at actual culling on age at first calving was significantly positive in Murrah buffaloes.

It is evident from the above study that in the selection of Murrah buffaloes of these two farms for milk yields, consideration of age at first calving may not be of any importance, but on the other hand animals of high yields but of low age at first calving may be preferred to those maturing late, as age at first calving will not be having any adverse effect on milk yield, though it will certainly reduce the unproductive period of life by minimizing the cost of raising the heifers to their productive life. It will also shorten the generation interval which will improve the rate of progress per unit of time.

II. PART LACTATION YIELDS OF FIRST LACTATION:

(a) Averages:- The averages for milk yield in part lactation, total lactation and cumulative lactation milk yields are given in Table 4-A, and

4-B of the animals maintained at Babugarh and Madhurikund farms. Weighted average for milk yield of varying duration is also given in Table 4-C of the two farms combined. The coefficient of variability within first lactation has decreased with the increase in period of lactation. Similarly the coefficient of variation in cumulative milk yield records of longer duration was lower than for cumulative milk yield records of lesser period. The coefficient of variation of milk yield obtained in this study was lower than the ones reported for tropical breeds of cattle by Sikka (1931), Lecky (1951) and Robertson (1950), but are slightly higher to these reported by Mahadevan (1958) for European cattle. Maule (1953) reported the average milk yield of Indian farm buffaloes ranged between 3150 pounds to 4580 pounds, Venkayya et al (1957), Tomar (1963) have also reported the average milk yield during the first lactation in buffaloes which agree well with the ones obtained in the present investigation. However, Dhinsa (1960) reported the average milk yield of Murrah buffaloes to be 3873 pounds which was higher than the present value. Singh and Desai (1962) obtained lower values in Bhadawri buffaloes than in the present findings.

TABLE 4-B. AVERAGES OF MILK YIELDS OF DIFFERENT DURATIONS IN Kg.

Traits	No. of Obser-vations	Mean	S. D.	S.E.	C.V. (%)
MADHURIKUND FARM					
Ist. month of Ist. lactation	60	135.74	31.23	4.03	23.01
Ist. three months cumulative of Ist. lactation	60	451.94	86.81	11.22	19.21
Ist. five " "	60	769.02	142.21	18.37	18.49
Ist. seven " "	60	1058.85	184.90	23.89	17.46
Ist. lactation	60	1442.79	334.73	43.25	23.20
IInd. "	35	1563.77	287.05	48.57	18.36
IIIrd. "	25	1603.16	355.20	71.04	22.16
IVth. "	14	1612.47	326.37	87.26	20.24
Ist. two lactation cumulative	35	2921.76	464.71	78.63	15.91
Ist. three " "	25	4475.16	599.19	119.84	13.39
Ist. four " "	14	5970.47	711.55	190.25	11.92

TABLE 4-C. AVERAGES OF MILK YIELDS OF DIFFERENT DURATIONS IN Kg.

Traits	No. of Obser-vations	Mean	S. D.	S.E.	C.V. (%)
		OVERALL			
Ist. month of Ist. lactation	182	133.63	37.30	5.67	27.91
Ist. three months cumulative of Ist. lactation	182	432.93	106.70	16.84	24.65
Ist. five " "	182	737.98	170.94	26.97	23.16
Ist. seven " "	182	1024.34	227.05	35.84	22.17
Ist. lactation	182	1470.19	388.72	61.34	23.04
IInd. "	130	1603.64	402.87	79.66	25.12
IIIrd. "	99	1616.76	456.93	105.69	28.26
IVth. "	76	1617.90	405.80	120.04	25.08
Ist. two lactation cumulative	130	3101.79	655.70	129.66	21.14
Ist. three " "	99	4753.81	889.36	205.70	18.71
Ist. four " "	76	6520.23	1149.33	339.97	17.63

(b) Relationship between Part and Complete Cumulative Lactation Yields:

i) Correlation Coefficients:-

For the purpose of part yields, first, first three, first five and first seven months cumulative yields of first lactation have been considered, whereas complete lactation yields were first lactation and upto the subsequent first five cumulative lactations. The correlation estimates have been presented in Table 5. All the estimates of correlation between the part and cumulative lactation records at Babugarh Farm and overall were statistically significant. However at Madhurikund farm a very low positive correlation was observed between first, first three and first five months cumulative yields of first lactation and first four lactation cumulative yields.

In general, the estimated values of correlation of first month have declined with the cumulative lactation records. Similar trend was observed for correlation of part lactation records of third, fifth and seventh months with cumulative lactation yields upto five lactations. With the increase in cumulative part lactation yields, the correlation coefficients with a particular total lactation yield

TABLE 5. PHENOTYPIC CORRELATIONS OF PART YIELDS OF FIRST LACTATION WITH LACTATION CUMULATIVE YIELDS.

Traits	First lacta-tion	First 2 lact-ation cumula-tive	First 3 lact-ation cumula-tive	First 4 lact-ation cumula-tive	First 5 lact-ation cumula-tive
BABUGARH FARM					
Ist.month yield of Ist. lactation	0.7148	0.6065	0.4559	0.3776	0.3070
Ist.three months cumulative yield of Ist.lactation	0.7535	0.6801	0.5518	0.4956	0.4138
Ist. five " "	0.8022	0.7520	0.6357	0.5637	0.4613
Ist. seven " "	0.8436	0.7985	0.6797	0.6017	0.5405
MADHURIKUND FARM					
Ist.month yield of Ist. lactation	0.5216	0.4784	0.4217	0.1699 NS	
Ist.three month cumulative yield of Ist.lactation	0.6207	0.4531	0.4294	0.2028 NS	
Ist.five " "	0.7184	0.5239	0.5553	0.4615 NS	
Ist.seven " "	0.8134	0.5831	0.6478	0.5874	
OVERALL					
Ist. month yield of Ist. lactation	0.6691	0.5858	0.4468	0.3634	
Ist.three month cumulative yield of Ist. lactation	0.7227	0.6433	0.5254	0.4732	
Ist.five " "	0.7824	0.7175	0.6189	0.5563	
Ist.seven " "	0.8362	0.7661	0.6716	0.6007	

NS - Not significant

Figures with no suffix are either significant at 5% or 1% level.

have increased. The results obtained in the present investigation are approaching to those reported earlier by Madden et al (1955); Jost (1959); Salerno (1960); Fritz et al (1960); Hickman (1960); Vachal (1961); Pirchner (1961); Zavertjaev (1963); Dutt et al (1964) and Dutt et al (1965), except Salerno (1960) and Dutt et al (1965) who utilized buffalo data while the rest of the workers used cattle data. Generally all of them have considered only first lactation yield for the purpose of cumulative yields. Lamb and McGilliard (1967) have reported a little higher correlations between cumulative months and total production for the same lactation in Holstein cows than those found in the present study.

Phenotypic correlations between segments of lactation indicate the accuracy with which the complete records can be estimated from a part. The correlations of cumulative monthly yields with complete cumulative lactation yields were found to be increasing rapidly with added months. A correlation value of around 0.6 was obtained between first month yield and first lactation yield. In order to obtain the same degree of relationship in first two, first three and first four cumulative lactation yields, the part yields of first three, first five and first seven months cumulative of first lactation respectively, have to be considered.

From the correlation estimates it appears that the reliability of prediction on part yield basis will increase by incorporating several months cumulative milk yield records. Madden et al (1955) had also mentioned somewhat the same trend. Lamb and McGilliard (1967) reported that the accuracy of predicting the total yields continued to increase rapidly with added months. Correlation reached 0.90 by the fourth month for first lactation, by the fifth month for second lactation and 0.97 or more by the eighth month for all records.

ii) Regression Coefficients:-

Regression coefficients of complete first lactation and subsequent upto first five cumulative lactation yields on part yields of first lactation have been calculated and presented in Table 6. All the estimates were statistically significant either at 5% or 1% level of probability at Babugarh Farm. In the case of Madhurikund Farm first month, first three cumulative months and first five cumulative months

TABLE 6. REGRESSION COEFFICIENTS OF LACTATION CUMULATIVE YIELDS ON PART YIELDS OF FIRST LACTATION

Traits	First lactation	First 2 lactation cumulative	First 3 lactation cumulative	First 4 lactation cumulative	First 5 lactation cumulative
	/ BABUGARH FARM /				
First month of Ist.lactation	7.3855	11.2160	11.8167	12.5256	12.2371
First three months cumulative of Ist.lactation	2.6990	4.4574	5.4786	6.3423	6.3164
First five " "	1.8052	3.1245	4.0443	4.6716	4.5777
First seven " "	1.4203	2.4997	3.2307	3.8128	3.9920
	/ MADHURIKUND FARM /				
First month of Ist.lactation	5.5909	7.5064	7.6022	5.5232	NS
First three months cumulative of Ist.lactation	2.3934	2.4730	2.7840	2.2955	NS
First five " "	1.6911	1.9263	2.5115	3.5992	NS
First seven " "	1.4726	1.6266	2.3037	3.5899	
	/ OVERALL /				
First month of Ist.lactation	6.9730	10.5624	10.9428	12.0359	
First three months cumulative of Ist.lactation	2.6327	4.0968	4.8620	6.0002	
First five " "	1.7793	2.9276	3.7375	4.5907	
First seven " "	1.4317	2.3580	3.0598	3.7967	

NS - Not significant.

Figures with no suffix are either significant at 5% or 1% level.

yields of first lactation were having practically no effect on first four cumulative lactation yields. This might be either due to the fact that very small number of buffaloes had been kept at Madhurikund Farm who had completed their first four lactations completely or the animals at this farm were relatively more affected by environment in their latter part of life as compared to those at Babugarh Farm.

The regression estimates explain that with the rise of one Kilogram of milk either in first month, first three cumulative months, first five cumulative months and first seven cumulative months of first lactation yields there would be a corresponding increase of 7.39, 2.70, 1.81 and 1.42 Kgs. of milk in first lactation, 11.22, 4.46, 3.12 and 2.50 Kgs. of milk in first two cumulative lactations, 11.82, 5.48, 4.04 and 3.23 Kgs. of milk in first three cumulative lactations, 12.53, 6.34, 4.67 and 3.81 Kgs. of milk in first four cumulative lactations and 12.24, 6.32, 4.58 and 3.99 Kgs. of milk in first five cumulative lactation yields respectively in the case of Babugarh Farm. The corresponding increase of milk yields at Madhurikund Farm were 5.59, 2.39, 1.69, 1.47 Kgs. of milk for first lactation, 7.51, 2.47, 1.93, 1.63 Kgs. of milk in first two cumulative lactations, 7.60, 2.78, 2.51, 2.30 Kgs. of milk in first three cumulative lactations and 5.52, 2.30, 3.60 and 3.59 Kgs. of milk in first four cumulative lactation yields respectively. So also it could be explained for overall estimates.

The present findings are in close approximation to those reported earlier by Sundaresan et al (1954), Madden et al (1959), Fritz et al (1960), Vanvleck and Henderson (1961), Dutt et al (1964), Dutt et al (1965), Puri and Sharma (1965) and Krempa (1966). However, Sundaresan et al (1954) and Puri et al (1965) found a significant regression of production upto ten years of age (in Red Sindhi and Kansas State College Jersey breeds) and total yield upto five lactations (in Tharparkar, Sahiwal and Red Sindhi breeds) on first lactation yield respectively, whereas Madden et al (1959), Fritz et al (1960), Vanvleck and Henderson (1961), Dutt et al (1964) and Krempa (1966) reported the same relationship between part yields and complete lactation yields (in Holstein and Hariana cows). There was no such report available for Murrah buffaloes except one by Dutt et al (1965). They reported a significant relationship between part yields and 305-day yield of the first lactation and also between 305-day first lactation yield and milk yield upto 6, 8 and 10 years of age.

III. HERITABILITY AND GENETIC CORRELATIONS:

(a) Heritability:-

The heritability was estimated from paternal half-sib correlation method based on 137 half-sibs from 13 sires. The estimates for monthly and first 300-day records of first lactation yield have been given in Table 7.

TABLE 7. HERITABILITY ESTIMATES OF THE PART FIRST LACTATION MILK YIELDS.

Part Yields of First Lactation	d.f.	Heritability	S.E.
First month	136	0.764	0.360
Third month	136	0.824	0.378
Fifth month	136	0.608	0.328
Seventh month	136	0.524	0.308
Ninth month	127	0.388	0.308
300-day	136	0.468	0.280

Dhinsa (1960) and Tomar (1963) had also reported the heritability of 300-day milk yield in buffaloes. The estimates were 0.1773 and 0.324 respectively. The heritability of part yields of first lactation had shown a declining trend as the lactation progressed. This may be due to higher environmental variance with the increase in lactation length. Since the estimates were not significantly different from each other, no definite conclusion to this effect could be drawn. It might be desirable to analyse large amount of data to establish such a trend as observed in the present study.

The findings were in accordance with those reported earlier by Madden et al (1955) from a daughter-dam analysis, in which their estimates were approximately equal for all months except for the last two which were lower than the others. The estimates for the various months were not significantly different. Johnson and Corley (1961) and Decking (1964) had also reported that the heritability of 100, 200 and 305-day yields were all over 0.2 and did not differ significantly. However, these results are somewhat contrary to those reported by Pirchner (1961), Searle (1961), Vanvleck and Henderson (1961), Singh et al (1967) and Lamb et al (1967). Pirchner (1961) mentioned that heritability coefficients for 2, 3 and 4 months yields were slightly lower than heritability of 305-day yield, whereas those of 6 and 8 months were approximately equal to it, while Searle (1961) showed that heritability of part yields were more than total yields. But Vanvleck and Henderson (1961) found that heritability estimates of milk increased to 0.19 at 5 months after which decreases in the estimates occurred, whereas Singh et al (1967) had shown a gradual increase in heritability estimates of part yields, they reported the heritability of 15, 75 and 135-day production to be 0.22±0.19, 0.39±0.22 and 0.63±0.27 respectively. The heritability of monthly production of milk increases steadily with each successive month during the first lactation reaching 0.25 by the tenth month and heritability of cumulative production of milk increases gradually with each added month of the first lactation to 0.22 for the lactation total, but the trend is reversed for lactation after the 2nd. which remained somewhat constant around 0.25, had been reported by Lamb et al (1967). All these estimates, however, pertain to cattle.

(b) Genetic Correlation:-

Variance and covariance components from the paternal half-sib analysis were used to estimate genetic correlations. The genetic correlations between first month and 300-day, first three cumulative months yield and 300-day of first lactation were 1.0291 and 1.0245 respectively. The estimate of genetic correlations between part yields and complete lactation yield above unity had also been reported by Madden et al (1955), Vanvleck and Henderson (1961) and Lamb et al (1967). The estimates of genetic correlation between part yield and total lactation yield, not different from unity had been reported by Robertson (1954) and Hickman (1960), Vanvleck and Henderson (1961), Searle (1961), Singh et al (1967) and Lamb et al (1967). However, the sampling error might also be a cause of very high correlation (above unity) in the present investigation.

High genetic correlation between part and whole lactation might be interpreted as the genes which affect production in the early parts of the lactation also affect other parts of the lactation similarly (Decking, 1964). A somewhat contrary view had been expressed by Vanvleck and Henderson (1961). He reported that "some genes which influence early and late production do not also influence total yield, although most of the genes for production influence monthly yield as well as total yield." Because of high genetic correlation between part yield and total lactation yield, selection on the basis of part records may be accurate enough and may even increase genetic progress by permitting earlier evaluation of buffaloes. The reduction in generation interval would permit greater improvement per unit of time.

IV. PREDICTION EQUATIONS:

Various simple and multiple regression equations to predict production upto complete first lactation and subsequently upto five cumulative lactation yields were calculated on the basis of part yields (first month, first three, first five and first seven cumulative months) of first lactation, with and without considering the age at first calving as a second independent variable and presented farmwise in Table 8 to 12. The significance of regression estimates had been tested by "F" test. The fit of prediction equations had been tested by calculating the R and R^2 values for each equation and had also been given in the above Tables (8 to 12). It measures the relationship between the actual and estimated

TABLE 8. PREDICTION EQUATIONS FOR FIRST LACTATION MILK YIELD

WITHOUT AGE AT FIRST CALVING			WITH AGE AT FIRST CALVING		
Prediction Equation	R	R^2	Prediction Equation	R	R^2
			BABUGARH FARM		
$504.39+7.3855X_1$	0.71	0.51	$467.42+7.3811X_1+0.7770X_4$	0.71	0.51
$340.40+2.6990X_2$	0.74	0.57	$428.11+2.7104X_2+(-1.9210X_4)$	0.74	0.57
$179.00+1.8052X_3$	0.80	0.64	$293.60+1.8153X_3+(-2.5213X_4)$	0.81	0.65
$52.90+1.4203X_3{}^1$	0.84	0.71	$153.86+1.4262X_3{}^1+(-2.2103X_4)$	0.85	0.72
			MADHURIKUND FARM		
$683.89+5.5909X_1$	0.52	0.27	$585.73+5.4133X_1+2.3479X_4$	0.53	0.28
$361.12+2.3934X_2$	0.62	0.39	$278.05+2.3444X_2+2.0206X_4$	0.62	0.39
$142.30+1.6911X_3$	0.72	0.52	$98.72+1.6750X_3+1.0748X_4$	0.72	0.52
$-116.46+1.4726X_3{}^1$	0.81	0.66	$-290.46+1.4687X_3{}^1+3.4208X_4$	0.82	0.68
			OVERALL		
$538.39+6.9730X_1$	0.67	0.45	$494.60+6.9526X_1+0.9378X_4$	0.67	0.45
$330.40+2.6327X_2$	0.72	0.52	$347.92+2.6366X_2+(-0.3868X_4)$	0.72	0.52
$157.09+1.7793X_3$	0.78	0.61	$204.62+1.7862X_3+(-1.0607X_4)$	0.78	0.61
$3.65+1.4317X_3{}^1$	0.84	0.70	$50.09+1.4364X_3{}^1+(-1.0335X_4)$	0.84	0.70

X_1, X_2, X_3, $X_3{}^1$ and X_4 - first month yield, first three, first five, first seven months cumulative yields of first lactation and age at first calving respectively.

(NS - Not significant).

N.B. The above symbols stand for subsequent Tables also.

TABLE 9. PREDICTION EQUATIONS FOR FIRST TWO LACTATION CUMULATIVE MILK YIELD

WITHOUT AGE AT FIRST CALVING			WITH AGE AT FIRST CALVING		
Prediction Equation	R	R^2	Prediction Equation	R	R^2
/ BABUGARH FARM /					
$1588.15+11.2160X_1$	0.61	0.37	$1604.03+11.2122X_1+(-0.3105X_4)$	0.61	0.37
$1177.93+4.4574X_2$	0.68	0.46	$1395.43+4.4611X_2+(-4.4587X_4)$	0.68	0.46
$797.71+3.1245X_3$	0.75	0.57	$1063.38+3.1308X_3+(-5.5024X_4)$	0.77	0.60
$522.66+2.4997X_3^1$	0.80	0.64	$298.73+2.5014X_3^1+4.5194X_4$	0.80	0.64
/ MADHURIKUND FARM /					
$1937.77+7.5064X_1$	0.48	0.23	$1638.45+6.4296X_1+8.2112X_4$	0.50	0.25
$1841.42+2.4730X_2$	0.46	0.21	$1626.58+2.0752X_2+7.2451X_4$	0.47	0.22
$1495.17+1.9263X_3$	0.52	0.27	$1379.21+1.7525X_3+4.5612X_4$	0.53	0.28
$1256.14+1.6266X_3^1$	0.58	0.34	$1122.29+1.5069X_3^1+4.7803X_4$	0.59	0.35
/ OVERALL /					
$1641.71+10.5624X_1$	0.58	0.34	$1607.37+10.5531X_1+0.7105X_4$	0.58	0.34
$1283.24+4.0968X_2$	0.64	0.41	$1443.33+4.1343X_2+(-3.5097X_4)$	0.65	0.42
$895.00+2.9276X_3$	0.72	0.52	$1109.62+2.9622X_3+(-4.7801X_4)$	0.72	0.52
$628.09+2.3580X_3^1$	0.77	0.59	$791.24+2.3740X_3^1+(-3.5737X_4)$	0.76	0.58

TABLE 10. PREDICTION EQUATIONS FOR FIRST THREE LACTATIONS CUMULATIVE MILK YIELD.

WITHOUT AGE AT FIRST CALVING			WITH AGE AT FIRST CALVING		
Prediction Equation	R	R^2	Prediction Equation	R	R^2
BABUGARH FARM					
$3174.28+11.8167X_1$	0.46	0.21	$2322.31+12.1695X_1+16.2398X_4$	0.47	0.22
$2375.96+5.4786X_2$	0.55	0.30	$1783.82+5.5037X_2+11.7609X_4$	0.56	0.31
$1728.18+4.0443X_3$	0.63	0.40	$1195.49+4.0501X_3+10.6958X_4$	0.64	0.41
$1360.52+3.2307X_3{}^1$	0.68	0.46	$862.33+3.2356X_3{}^1+10.8652X_4$	0.69	0.47
MADHURIKUND FARM					
$3864.96+7.6022X_1$	0.42	0.18	$2964.10+5.9658X_1+12.9885X_4$	0.47	0.22
$3232.75+2.7840X_2$	0.42	0.18	$2937.18+2.166X_2+10.3182X_4$	0.46	0.21
$2592.91+2.5115X_3$	0.56	0.31	$2576.44+2.4702X_3+0.8577X_4$	0.56	0.31
$2124.33+2.3037X_3{}^1$	0.65	0.42	$2213.70+2.5206X_3{}^1+(-5.6186X_4)$	0.66	0.43
OVERALL					
$3228.11+10.9428X_1$	0.45	0.20	$2625.54+10.8347X_1+12.1402X_4$	0.46	0.21
$2566.11+4.8620X_2$	0.53	0.28	$2282.75+4.7869X_2+6.2342X_4$	0.54	0.29
$1891.43+3.7375X_3$	0.62	0.38	$1751.28+3.7081X_3+3.1980X_4$	0.62	0.38
$1496.46+3.0598X_3{}^1$	0.67	0.45	$1413.40+3.0423X_3{}^1+2.6028X_4$	0.67	0.45

TABLE 11. PREDICTION EQUATIONS FOR FIRST FOUR LACTATIONS CUMULATIVE MILK YIELD.

WITHOUT AGE AT FIST CALVING			WITH AGE AT FIRST CALVING		
Prediction Equation	R	R^2	Prediction Equation	R	R^2
BABUGARH FARM					
$4822.00+12.5256X_1$	0.37	0.14	$3651.39+12.6277X_1+23.6598X_4$	0.40	0.16
$3706.59+6.3423X_2$	0.50	0.25	$2860.02+6.2638X_2+18.0750X_4$	0.51	0.26
$2944.72+4.6716X_3$	0.57	0.32	$2247.10+4.6092X_3+15.2932X_4$	0.57	0.33
$2416.33+3.8128X_3^1$	0.60	0.36	$1806.02+3.7637X_3^1+13.6078X_4$	0.61	0.37
MADHURIKUND FARM					
$5233.03+5.5232X_1$	N.S. 0.17	0.03	$4029.53+0.1403X_1+35.0640X_4$	N.S. 0.32	0.10
$4921.10+2.2955X_2$	N.S. 0.20	0.04	$3883.40+0.7737X_2+31.6193X_4$	N.S. 0.32	0.10
$3212.49+3.5992X_3$	N.S. 0.46	0.21	$2779.42+3.1428X_3+14.2792X_4$	N.S. 0.48	0.23
$2254.57+3.5899X_3^1$	0.59	0.35	$2126.47+3.4711X_3^1+4.5779X_4$	0.59	0.35
OVERALL					
$4795.66+12.0359X_1$	0.36	0.13	$3705.03+11.8861X_1+22.2699X_4$	0.39	0.15
$3747.62+6.0002X_2$	0.47	0.22	$2965.14+5.8641X_2+16.9285X_4$	0.49	0.24
$2906.36+4.5907X_3$	0.56	0.31	$2268.99+4.5034X_3+14.1393X_4$	0.57	0.32
$2361.65+3.7967X_3^1$	0.60	0.36	$1821.29+3.7330X_3^1+12.2176X_4$	0.61	0.37

TABLE 12. PREDICTION EQUATIONS FOR FIRST FIVE LACTATIONS CUMULATIVE MILK YIELD.

WITHOUT AGE AT FIRST CALVING			WITH AGE AT FIRST CALVING		
Prediction Equation	R	R^2	Prediction Equation	R	R^2
BABUGARH FARM					
$6608.28+12.2371X_1$	0.30	0.09	$5240.39+11.9289X_1+29.1187X_4$	0.35	0.12
$5446.10+6.3164X_2$	0.41	0.17	$4397.51+6.0902X_2+23.7959X_4$	0.44	0.19
$4740.81+4.5777X_3$	0.46	0.21	$3724.10+4.4403X_3+23.2203X_4$	0.48	0.23
$3931.13+3.9920X_3^1$	0.54	0.29	$2879.54+3.9082X_3^1+23.6027X_4$	0.56	0.31

values and thus explains the fit of prediction equations.

From prediction equations for predicting first lactation yield at Babugarh Farm, it is evident (Table 8) that the R^2 values had increased with the added records for predicting total lactation yields and it ranged from 0.51 to 0.71. It means that even the first month yield accounted for 51 per cent variation in the complete lactation yield of first lactation. The increase in R^2 values were gradual with the added records. With the inclusion of age at first calving, there had been very little increase in R^2 values for the prediction equation as compared to the one without considering it.

The prediction equations to predict first lactation yield developed for Madhurikund Farm were also followed the same pattern i.e. R^2 values gradually increased with the added part records and was very little affected with the inclusion of age at first calving. So also was the case with the overall estimates with one exception that there were no changes at all in the R^2 values with the inclusion of age at first calving in the prediction equations.

It would be inferred that even first month yield could be a reliable indication of first lactation yield. The reliability of this relationship increases with the increased duration of part production. Somewhat the same type of findings had also been reported earlier by various authors. Cannon et al (1942) obtained most accurate results from a test taken during fifth month of lactation though Madden et al (1959) concluded that the fourth to seventh months had the lowest variability and therefore, were better for predicting the total production. They had developed factors from the ratio of total to cumulative part production and from the regression of total on part production and found that regression method was better. Fritz et al (1960) reported that age at first calving had no effect on relationship between part and whole yields, and developed regression factors to estimate 305 or 365-day lactation yield. They reported that first few cumulative months were good to predict complete lactation yield. Kovats et al (1960) working with 700 lactations of different ages and level of production (like in the present investigation) reported that 300-day yield could be predicted even from 60-day yield. Vanvleck and Henderson (1961) had also explained that the best single months for estimating a complete lactation were fourth, fifth and sixth, as the correlation between the predicted record and the complete record was 0.85, however, all these findings pertain to cattle. The only available report in Murrah buffaloes was that of Dutt et al (1965), they developed prediction equations to estimate milk yield in first lactation from part yields, which were in close agreement with that found in the present study.

It is evident from other prediction equations developed to estimate first two, first three, first four and first five cumulative lactation yields for Babugarh Farm that correlation between the predicted record and the observed complete record of a particular total lactation yield to be predicted was gradually increasing with the increase in cumulative part lactation yields. But the correlation was decreasing with the increase in the number of complete lactations cumulated to be estimated with respect to a particular part yield.

In these prediction equations also with the inclusion of age at first calving there had been very little increase in R^2 values as compared to the one without considering the age at first calving. The R^2 values were ranging from 0.37 to 0.64, 0.21 to 0.47, 0.14 to 0.37, and 0.09 to 0.31 in first two, first three, first four and first five cumulative lactation yields to be predicted respectively. All the estimates were statistically significant.

The prediction equations developed for Madhurikund farm also followed, in general, the same pattern with the exception that regression estimates used in prediction equations for predicting first four cumulative lactation yields on the basis of only part yields upto first five cumulative months and while considering age at first calving even upto first seven cumulative months part yields of first lactations were statistically not significant. Although the R^2 values were generally found to be increasing with the increase in the cumulative part yield. The overall estimates showed the same trent as was found at Babugarh Farm.

To obtain the estimated value from the prediction equations, the cumulative part production was multiplied by the corresponding regression coefficient of the whole yield to be predicted on part yield, in case where only part yields were considered, whereas part yields and age at first calving were considered, both were multiplied by their respective partial regression coefficients, and subsequently in both the cases the given constant was to be added. The value thus obtained would give the predicted or estimated value of whole yield under consideration.

Life time milk production - yields of first five cumulative lactations (Alim, 1953; and Eilfort, 1959) had also been tried to predict on the basis of simultaneous effect of first month, first three and first five cumulative months yield of first lactation and age at first calving. For this purpose partial regression coefficients had been calculated. The partial regression of life time production on first month yield was 12.53±5.47, while rest three independent variables were kept constant. Accordingly -4.49±6.60, 7.24±4.18 and 21.28±25.38 were partial regression coefficients of first three and first five cumulative months yield of first lactation and age at first calving respectively. From these partial regression estimates prediction equation had been formed to predict life time production. The equation is given below:-

$$\hat{Y} = 1826.02+12.53x_1+(-4.48x_2)+7.23x_3+21.27x_4$$

The regression estimate of this equation was significant as revealed from analysis of variance (F value = 5.61**). The square of multiple correlation coefficient that is R^2 value of this prediction equation was 0.33.

The practical use of the prediction equations can be explained by taking a specific example. The buffalo at Babugarh farm branded 58/32 had produced 155.47, 483.90 and 796.03 Kgs. of milk in her first month, first three and first five cumulative months of first lactation, her age at first calving was 35.5 months. Now on the basis of these information, suppose one wanted to know as to how much milk was expected from this buffalo in her life time. The answer to this could easily be given by solving the already given prediction equation by substituting these informations. By substituting the values of variables in the equation we got the expected value to be 8106.90 Kgs., which was not much different from that of the actual production (difference between the predicted and actual values being only about 7%).

By the study of all the prediction equations we might reach the conclusion that the accuracy of predicting the total yields continued to increase with added months of part yield, but the same was decreasing as the number of complete yields to be predicted were increasing with respect to a particular part yield.

Various authors had also concluded earlier somewhat in the same directions. Krempa (1966) concluded that multiple regression equations for 200 and 160-day lactations afforded a satisfactory basis for predicting milk yield, Kennedy et al (1942) mentioned that short time records had a definite value in culling or in progeny performance testing and such records were only slightly less valuable than complete records in predicting the following lactations. Madden et al (1955), Johnson et al (1961), Searle (1961), Vachal (1961), Zavertjaev (1963), Singh et al (1967) and Lamb et al (1967) had also concluded that selection on the basis of part yields would be sufficiently accurate and would increase genetic progress by permitting early evaluations.

Roth (1951) found that the yield during the first 200-days of the first lactation accounted for

46 per cent of the variation in production during the first five to six years after freshening, while Kliesch and Bankwitz (1952) mentioned in two European herds that first 180-day production in the first lactation accounted for 29 and 52 per cent respectively of the variation in the total yield during the first four lactations and Nagarcenkar (1964) reported that almost 55 per cent of variation in average production over the first three lactations was due to variation in 120-day yield in first lactation. These findings were fairly in accordance with those reported in the present investigation. However, the 52 per cent of variation in the total yield during the first four lactations was accounted by the first 180-day production in the first lactation as reported by Kliesch and Bankwitz (1952) in one European herd was higher with those reported in this study.

On the other hand we could also arrive at the conclusion that in general, age at first calving imparts almost nothing in predicting complete lactation yields along with the part yields of the first lactation, as is indicated by the R^2 values which increased little due to the inclusion of age at first calving as second independent variable in the prediction equations. This finding further supports the inference already drawn from correlation and regression studies of age at first calving.

Various workers had also developed multiple regression equations with age at first calving and either first lactation or part yields of the first lactation to predict various estimates of life time production. Larson et al (1951) reported that the addition of age at first calving increased only slightly the accuracy of prediction than from first lactation production alone. However, Sundaresan et al (1954) in Kansas State College Jersey breeds, Eilfort (1959) in Wurttem Berg spotted cows and Dutt et al (1965) in Murrah buffaloes (for first lactation only) mentioned that the addition of age at first calving in the regression equations would not affect the accuracy of prediction. These findings were supporting that what we had also inferred in the present study. Although Sundaresan et al (1954) found that addition of the second variable age at first calving in Red Sindhi and 1/4 Jersey X 3/4 Red Sindhi increased the accuracy of prediction, Dutt et al (1965) had also reported that inclusion of age at first calving as second variable along with the first lactation yield to predict milk yield upto 6, 8 and 10 years of age had a definite effect as the respective regression estimates were negatively significant in Murrah buffaloes. Puri and Sharma (1965) developed multiple regression equations and concluded that age at first calving along with the first lactation yield in cattle had more influence on the estimation of yield upto a certain age than on certain number of lactations. However, these findings were contrary to those reported in the present investigation.

CHAPTER - V.

S U M M A R Y

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S U M M A R Y

The present study was conducted to find out the earliest part time milk yield which could predict the total yield of the first lactation, first two, first three, first four cumulative lactations or even the lifetime production (first five cumulative lactations) of Murrah buffaloes, so that selection can be exercised at an earlier stage to avoid unnecessary delay in the evaluation of the animal. Age at first calving being an important economic character has also been studied to find out any possible association of this important character with the milk yield. Attempts have also been made to include the age at first calving in the prediction equations as a second independent variable.

For this purpose, data of the two farms viz. State Livestock-cum-Agricultural Farm, Babugarh and State Livestock-cum-Agricultural Farm, Madhurikund have been analysed. 122 buffaloes for first lactation, 95 for second, 74 for third, 62 for fourth and 50 for fifth lactation from Babugarh Farm and 60, 35, 25 and 14 upto first four lactations from Madhurikund Farm respectively have been observed for their performances in the character under study. The whole study has been divided into the following four parts: I - Age at first calving, II - Part lactation yields of first lactation, III - Heritability and genetic correlation and IV - Prediction equations.

I. Age at First Calving:

Average age at first calving at Babugarh Farm based on data of 122 buffaloes was 48.38±0.66 months and that of Madhurikund Farm based at 60 buffaloes was 52.07±1.21 months. Overall average age at first calving was 49.60±1.27 months. The coefficients of variation have been found to be 15.13, 17.96 and 16.21 per cent respectively for the two farms and their overall estimates.

Attempts have been made to find out the phenotypic correlations of age at first calving with the first lactation and subsequent lactations (upto first five cumulative lactation yields). Estimates for the two farms separately and their overall combined figures indicated that milk yield is not affected by the age at first calving in these populations. Even then it is desirable to include age at first calving in the selection programme so that along with the increase in milk yield the unproductive period of the life of an animal could also be reduced. In addition to this, the reduction of the generation interval will enhance the rate of genetic gain per unit of time and t he period of proving of a sire will reduce, thus increasing the opportunity of utilizing the proven bulls extensively before they become either old or die.

II. Part Lactation Yields of First Lactation:

Average complete first lactation yield at Babugarh farm based on 122 observations was 1483.66±37.36 Kgs., whereas that of Madhurikund farm based on 60 observations was 1442.79±43.25 Kgs. The corresponding overall average was 1470.19±61.34 Kgs. The coefficient of variation for the two farms and for overall combined figures was 27.80, 23.20 and 23.04 per cent respectively.

Phenotypic correlations and regressions of part yields of first lactation and complete first and various complete subsequent cumulative lactation yields have been calculated. These figures indicate that the correlation of part yield with complete cumulative lactation yield increases progressively with the increase in the duration of part yields showing thereby that the reliability of prediction of lifetime production and other future yields of an animal will increase by incorporating several months cumulative part yield records.

III. Heritability and Genetic Correlation:

Heritability of monthly yields of first lactation and of first 300-day yield has been estimated for these two farms from paternal half-sib correlation method. The estimates based on 137 half-sibs from 13 sires. Heritability estimates have shown a declining trend with the increase in the duration of the lactation, but these estimates are not significantly different from each other. However, no definite conclusion to this effect could be drawn as it might be desirable to analyse large amount of data.

Genetic correlations between first month and 300-day yield, first three cumulative months and 300-day yield of first lactation have been found to be 1.0291 and 1.0245 respectively. These genetic correlations appear to be high enough to predict 300-day yields efficiently and therefore, animal can be selected or rejected even after the completion of first month of lactation and thus advantage can be drawn by rejecting uneconomical or undesirable animals at such an early stage of production.

IV. Prediction Equations:

Various simple and multiple regression equations to predict complete first lactation yield and subsequent cumulative lactation yields (upto first five cumulative lactations) on the basis of part yields of first lactation, with and without considering the age at first calving have been calculated. The significance of regression estimates and fit of prediction equations have also been tested by "F" test and R^2 values respectively.

It is evident from prediction equations

that correlation between the predicted record and the observed complete record of a particular total lactation yield was gradually increasing with the increase in cumulative part lactation duration. But the efficiency of prediction was decreasing with the increase in the number of complete lactations cumulated with respect to a particular part yield. On the other hand with the inclusion of age at first calving as a second independent variable there has been very little increase in R^2 values for the prediction equations when compared to the one without considering it.

Lifetime milk production has also been predicted on the basis of simultaneous effect of first month, first three and first five cumulative months yield of first lactation and age at first calving. The equation being:

$$\hat{Y} = 1826.02+12.53x_1+(-4.48x_2)+7.23x_3+21.27x_4$$

with a R value of 0.57

These equations clearly show that the accuracy of prediction of the complete cumulative lactation yields increases with the increase in the duration of the part yield. Inclusion of age at first calving in the prediction equations as a second independent variable has not been of any extra advantage, probably because of its low correlations with the milk yield.

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B I B L I O G R A P H Y

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APPENDIX

APPENDIX

TABLE (a) PARTIAL REGRESSION COEFFICIENTS OF CUMULATIVE LACTATION YIELDS ON PART YIELDS OF FIRST LACTATION KEEPING AGE AT FIRST CALVING CONSTANT.

Traits.	First Lactation	First 2 Cumulative lactation	First 3 Cumulative lactation	First 4 Cumulative lactation	First 5 Cumulative lactation
BABUGARH FARM					
First month of Ist.lactation	7.3811	11.2122	12.1695	12.6277	11.9289
First 3 cumulative months of first lactation	2.7104	4.4611	5.5037	6.2638	6.0902
First 5 " "	1.8153	3.1308	4.0501	4.6092	4.4403
First 7 " "	1.4262	2.5014	3.2356	3.7637	3.9082
MADHURIKUND FARM					
First month of Ist.lactation	5.4133	6.4296	5.9658	0.1403 NS	
First 3 cumulative months of first lactation	2.3444	2.0752	2.1663	0.7737 NS	
First 5 " "	1.6750	1.7525	2.4702	3.1428 NS	
First 7 " "	1.4687	1.5069	2.5206	3.4711	
OVERALL					
First month of first lactation	6.9526	10.5531	10.8347	11.8861	
First 3 cumulative months of first lactation	2.6366	4.1343	4.7869	5.8641	
First 5 " "	1.7862	2.9622	3.7081	4.5034	
First 7 " "	1.4364	2.3740	3.0423	3.7330	

NS - Not significant.

Figures with no suffix are either significant at 5% or 1% level.

TABLE (b) PARTIAL REGRESSION COEFFICIENTS OF CUMULATIVE LACTATION YIELDS ON AGE AT FIRST CALVING, KEEPING PART YIELDS OF FIRST LACTATION CONSTANT.

Particulars (Regression of)	Traits Kept Constant: Ist.month yield of first lactation	Ist.3 cumulative months yield of Ist.lactation	Ist.7 cumulative months yield of Ist.lactation	Ist.7 cumulative months yield of Ist.lactation
BABUGARH FARM				
First lactation yield on age at first calving	0.7770	-1.9210	-2.5213	-2.2103
First 2 cumulative lactation yield on age at Ist.calving.	-0.3105	-4.4587	-5.5024	4.5194
First 3 " "	16.2398	11.7609	10.6958	10.8652
First 4 " "	23.6598	18.0750	15.2932	13.6078
First 5 " "	29.1187	23.7959	23.2203	23.6027
MADHURIKUND FARM				
First lactation yield on age at first calving	2.3479	2.0206	1.0748	3.4208
First 2 cumulative lactation yields on age at Ist.calving	8.2112	7.2451	4.5612	4.7803
First 3 " "	12.9885	10.3182	0.8577	-5.6186
First 4 " "	35.0640	31.6193	14.2792	4.5779
OVERALL				
First lactation yield on age at first calving	0.9378	-0.3868	-1.0607	-1.0335
First 2 cumulative lactation yield on age at first calving	0.7105	-3.5097	-4.7801	-3.5737
First 3 " "	12.1402	6.2342	3.1980	2.6028
First 4 " "	22.2699	16.9285	14.1393	12.2176

TABLE (c) PARTIAL REGRESSION COEFFICIENTS OF LIFETIME PRODUCTION ON PART YIELDS OF FIRST LACTATION AND AGE AT FIRST CALVING

Traits.	Life time production	S.E.
First month yield of first lactation	12.5255	5.47
First three cumulative month yield of first lactation	-4.4875	6.60
First five " "	7.2368	4.18
Age at first calving	21.2777	25.38