DAIRY MERIT AS AFFECTED BY STAGE OF LACTATION IN CROSSBRED COWS

DISSERTATION
SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
Master of Science
IN
DAIRYING
(LIVESTOCK PRODUCTION AND MANAGEMENT)
TO THE KURUKSHETRA UNIVERSITY, KURUKSHETRA

By
KISHOR JADHAV
B.Sc. (Agri.)

DIVISION OF DAIRY CATTLE GENETICS
NATIONAL DAIRY RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
KARNAL (Haryana) INDIA
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Karnal(Haryana),May 29th,1981.

I certify that the research work contained in the dissertation entitled "DAIRY MERIT AS AFFECTED BY STAGE OF LACTATION IN CROSS-BRED COWS" by Kishor Jadhav is an authentic work carried out by him under my supervision and guidance, in partial fulfillment of the degree of Master of Science in Dairying (Livestock Production and Management) of the Kurukshetra University,Kurukshetra.

D.S.Bhatnagar
29/5

(D.S.BHATNAGAR)

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(KISHOR JADHAV)

DEDICATED

TO

MY GRAND FATHER

LATE SHRI GANAPATRAO JADHAV

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CONTENTS

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CHAPTER-I

INTRODUCTION

INTRODUCTION

India has the largest cattle population in world but the per capita availability of milk is very low. As early as 1952 planners could see the decline in per capita availability of milk and the stagnancy of production. Each five Year Plan successively increased outlay for the purpose and the total budgeted outlay on dairy development has so far been close to Rs.1500 crores. Inspite of these large expenditures from the National Exchequer, the total annual milk production in the country during 1970 was 208 lakh tones; the per capita per day availability of milk had fallen to 105 g, a drop of 35 g since 1947. Milk production in India, is steadily increasing and it was 27 million tons in 1978. The total requirement of milk production for a projected population 800 million people by the year 1990 in India has been estimated as 64 million tons of milk per year at the rate of 200g of milk per person per day. This short supply of milk production can be minimised by increasing the number of high yielding and efficient crossbred milch cows.

Ambitious crossbreeding programmes are in progress all over the India for achieving a breakthrough in milk production. The frozen semen of progeny tested sires from Europe, America and Canada is imported and large number of exotic bulls are available for increasing the number of crossbreds. Choice of exotic breed for crossbreeding in a particular area would depend upon several considerations i.e. milk yield potential, milk constituents, body size, disease resistance, heat adaptability, local conditions, availability of feeds and fodder alongwith its cost and the marketing facilities etc.

Though it is desirable to consider the performance of dairy animals in an overall economic efficiency, yet economic efficiency is influenced by location and time trends in relative prices of inputs and outputs. Of the total cost of milk production, feed cost alone accounts about 60-65%. It, therefore, might be useful to consider feed conversion efficiency-dairy merit- as a major factor determining the profitability of a milch cow. Dairy merit refers to the energy ratio of milk output to feed input.

Whyte and Mathur (1968) estimated the feeds and fodder resources for Indian bovine population which clearly indicated that there is a great need for efficient utilization of available feeds and fodder by only those milch animals which can convert feed into milk more conveniently, in addition to the growing stock.

Since individual feed consumption of dairy cows are not generally maintained as routine, the dairy merit is estimated indirectly from body weight and fat-corrected milk, being one of the criteria of measuring the efficiency of milk production. The dairy cows are given their maintenance ration as per their body weight while production ration is based on their level of milk production.

Considering the relative importance of the crossbred cows, which are only the future hope of increasing the total milk production in the country with a sizeable number of high yielding cows, the present study was undertaken with a view, to compare the dairy merit amongst genetic groups of crossbred cows produced at this Institute involving Holstein, Brown Swiss, and Jersey bulls being exotic, Sahiwal and Tharparkar cows as Zebu; to find out the effects of parity, stage of lactation, period and season of calving, age at calving and days on lactation on dairy merit and to establish relationship of lactation dairy merit with part-lactation dairy merit.

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CHAPTER-II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

DAIRY MERIT:

Dairy merit is generally defined as percentage of consumed total digestible nutrients energy that is converted into milk energy.

Edward (1936) measured the efficiency index of a cow, as the ratio of energy in milk to the energy in digestible nutrients, expressed as percentage, in cows. The efficiency index was found to be between 40 to 42 percent in Ayrshire, Jersey and Holstein cows.

Gaines (1940a) considered milk energy yield per unit live weight as a measure of dairy development among cows.

Gaines *et al.* (1940) considered the ratio between the total amount of fat-corrected milk (FCM) per lactation and the live weight of the cows within 31 days after calving as a good measure of "lactation drive" or the "intensity of lactation metabolism". The ratio FCM/W was observed to be practically independent of age and it is stated that "as rapidly as feasible initial weight at each lactation should be made a part of all dairy records and FCM/W, should supersede the biologically unsound principle of age correction". Analysis of variance aplied to the records classified by fatness of cow at calving showed no significant difference between groups, and it was concluded that FCM/W was independent of fatness of cow at calving.

Kleiber and Mead (1941) criticised the use of weight(W) instead of "metabolically effective body size" which is assumed to be proportional to W^b, the value of 'b' being approximately 0.7. They introduced the term "relative lactation capacity" which is defined as, "the energy in milk yielded during a given time and under standard and quasi optimal conditions expressed per day and per unit of the 3/4 power of the body weight". Further they stated that, "it would be preferable to select cows according to relative lactation capacity". However, such selection will unduly favour the smaller animals.

Davis *et al.*(1943) studied lactations among Ayrshire, Guernsey, Holsteins and Jersey cows and recommended that yields for the first eight months of lactation, expressed as milk-energy yield in terms of pounds of four percent fat-corrected milk per day, was more closely related to body weight taken within 31 days after calving than to live weight at any later stage of the same lactation. Ratio of FCM and weight soon after calving was so little affected by age, that age correction was unnecessary. They suggested that this ratio might be used as a criterion for judging the dairy merit of the cows.

Brody (1945) defined dairy merit as the biological efficiency of milk production as measured by the percentage of total digestible nutrients(TDN) energy which was converted into fat corrected milk energy. This can be expressed as,

$$\text{Dairy merit} = \frac{\text{Milk-energy produced}}{\text{TDN-energy consumed}}$$

assuming that 1 lb FCM had an energy equivalent of 340 calories, and 1 lb of TDN had an energy equivalent of 1814 calories. He stated that, "Dairy merit of an animal is numerically equal to the gross energetic efficiency of lactation process. The upper limiting value of this dairy merit ratio is 50 percent, not over-half of the consumed TDN energy can be converted into milk energy. Superior dairy animals convert about one-third, of the consumed TDN energy into milk energy. Good dairy animals convert about one-fourth. A 25 percent dairy merit level pays, approximately, for the dairy man's work, feed and other expenses at the current rate. Really profitable milk production involves higher dairy merit".

He further observed that it was difficult to actually measure TDN consumption and therefore, suggested to calculate dairy merit indirectly by the following formula.

$$\text{Dairy merit(\%)} = \frac{61\ \text{FCM}}{\text{FCM} + 0.173\ W^{0.73}} \times 100$$

Mason *et al.*(1957) measured the overall efficiency of food conversion as the ration of total fat-corrected milk to food units consumed. This was equivalent to dairy merit or Gross Energetic Efficiency, as defined by Brody. They reported that under a given system of feeding, selection for yield would automatically lead to an increase in gross efficiency in that system.

Stone *et al.*(1960) analysed the data from 12 forage experiments involving 175 Holstein-Friesian cows, to study the variation among the cows in their forage appetite and efficiency of feed utilization. The difference among cows in their efficiency was highly significant. Correlation between efficiency with FCM and the TDN consumption was -0.71 and -0.20 respectively.

Erb and Ashworth (1961) suggested to consider size when evaluating dairy merit. Their results showed that breed comparisons on the basis of dairy merit were not of much importance, since individual variation in size of cows with breed was larger than the difference in breed average. The effect of increase in size on milk yield was sufficiently high, which might even result in decreasing dairy merit.

Johansson (1964) suggested that it might be profitable to focus attention on relation of body size to the energetic efficiency of milch cows as milk producers.

Singh and Desai (1964) defined the relative efficiency of milk production (REMP) as yield of milk per unit body weight. Production data for the period 1948-61 on 270 Holstein x Sahiwal cows of Southern Plateau region and 306 Holstein x Sahiwal and

162 Sahiwal of Northern region of India were analysed to test whether REMP could be used as a criterion for selection of cows for improving dairy merit. They reported that though heavier animals produced more milk, production per unit of body weight favoured smaller animals. Selection on the basis of REMP was advantageous as it included selection for general adaptability, inherent capacity for milk production and efficiency of feed utilization. From economic point of view, it appeared that selection of dairy cows on the basis of REMP was more desirable instead of selecting them on the basis of absolute milk yield.

Csomos (1965) in his study on relation between body weight and lactation yield in Hungarian spotted cows concluded that efficiency of food conversion was not appreciably affected by body weight.

Bereskin and Touchberry (1966) proposed first lactation yield as a function of body weight as a measure of performance. They reported lactation yields of milk, milk fat and FCM varied approximately as $W^{0.6}$ (the 0.6 power of body weight at calving).

Freeman (1967) felt that selection for milk production alone would automatically select for increased feed efficiency. This indirect selection was expected to be between 70 and 95 percent as effective as would be direct selection for efficiency if the selection intensity is equal for the two traits.

Hooven <u>et al</u>.(1968) collected milk production, feed consumption and body weight data on 661 lactations of 318 Holstein cows

They defined gross energetic efficiency as the ratio of kilogram of FCM yield per therm of estimated net energy consumed. Body weight changes from calving to end of lactation had a significant effect on efficiency of both least squares analysis of variance on first and overall parity basis. It appeared that changes in efficiency relative to age were smaller than for production.

Pearson and McDowell (1968) while reviewing the work on crossbreeding of dairy cattle in temperate zones observed a strong evidence of positive heterosis for feed conversion efficiency.

Dickinson *et al.* (1969) observed higher positive correlations of efficiency and different measures of production and income were due partially to the part-whole-relationship between level of production and efficiency of feed utilisation.

Dickerson (1970) concluded that selection should certainly not be for larger body size, but should be directed for higher yield relative to body size. He was of the view that there is a great scope for the further improvement in performance criterion of evaluating efficiency of milk production in comparing breeds.

Hodgson (1970) compared the relative efficiency of Holstein-Friesian and Jersey breed in relation to milk yield. He concluded that in order to increase milk production efficiency, selection should not be for larger body size but for higher yeild of milk constituents relative to body size.

Miller *et al.* (1970) while studying the factors affecting feed efficiency of Holstein cows concluded that selection for milk yield would result in improved efficiency of feed conversion.

More rapid increase in efficiency could be achieved by penalising cows which were above average in body weight. Larger cows might, however, possess economic advantages which compensate for their biological efficiency.

Miller *et al.* (1971) studied the association among various measures of economic efficiency-milk output per unit feed input, income over feed cost, feed cost per 100 lb milk produced, milk yield per unit body weight- in first lactation Holstein cows. The correlation among different measures were high indicating that various methods of utilising feed consumption data gave almost similar results while comparing different cows.

Taylor (1971) suggested indirect assessment of optimal performance should be based on interbreed relationship among characteristics of economic importance. He discussed several interbreed relationships and those involving mean mature body size were considered with reference to making breed comparisons for productive efficiency.

Linzell (1972) reported that milk yield and milk energy output were both related to metabolic body size. He supported body weight ($W^{0.75}$) for getting estimate of metabolic body size.

Holmes (1973) observed that milk yield, maintenance and voluntary intake, all varied with metabolic size, $W^{0.75}$. He suggested that there was no nutritional advantage in the use of large cattle for milk production. Analysis of mean weight per breed and mean yield during early lactation, among cows within each breed yielded an exponent of 0.73 ± 0.17 showing thereby that peak milk yield was fairly related with $W^{0.73}$ or $W^{0.75}$. He expressed,

$$\text{Peak milk yield(kg)} = 0.29W^{0.73} \pm 0.17 \quad (r = 0.98).$$

$$= 0.236\ W^{0.75}$$

within cows, the increase in milk yield from Ist to 5th lactation was also closely associated with the increase in $W^{0.75}$.

Taylor (1973) suggested that 305-day milk yield per unit metabolic body weight could be used both within and between breeds without unduly favouring either large or small cows or breeds, producing exactly the same results, as that of selecting for gross feed efficiency(Brody,1945). In absence of feed intake records, the metabolic efficiency for milk production and maintenance of body weight could be presumed equal in different genotypes.

He concluded that, within breed variation in very well managed herds where high levels of feeding were employed, selection for milk yield would definitely tend to favour larger animals, although not the very largest, whereas, selection for yield per unit body weight would favour slightly small sized animals. In case where the level of feeding was lower and not aimed at highest possible yields, selection for milk yield would favour intermediate to large animals; whereas selection for yield per unit body weight would definitely tend to favour smaller animals.

Naito <u>et al.</u>(1974a) studied six indices namely (i) gross energetic efficiency (GEE),(ii) Milk yield per unit body weight (W),(iii) FCM/W, (iv) FCM per wither height, (v) FCM per heart girth, (vi) FCM per K, where, K= 2(6W-FCM). They found that all production-body size indices were highly correlated with gross energetic efficiency.

Raina <u>et al.</u>(1975) in their study on effect of nutrient conversion into milk production concluded that F_1 Brown Swiss-Sahiwal crossbreds producing more milk as compared to Sahiwal on an average constituted large business with larger profits than small animals of the same dairy merit or with the larger number of animals producing less quantity of milk. The amount of increase in profit depended on dairy merit and capacity of cow to utilise extra nutrients.

Gere and Hue (1976) carried out an investigation on the feed efficiency during the first 100 days of lactation of 102 cows in three herds averaging 1943, 1926 and 1201 kg milk during this period and with total average lactation milk yield of 4216, 3602 and 2872 kg. Live weight had a significant effect on feed conversion efficiency for milk production, with heavy cows producing more milk and converting their food more efficiently than lighter cows.

Dickerson (1978) reported that body size was extremely important as the maintenance energy 'overhead' cost for variable rates of reproduction and production in adult female. Increasing output per unit of maintenance overhead cost was a major avenue for improving animal efficiency.

Fitzhugh (1978) concluded that no generalization about the most efficient size of an animal was tenable but production efficiency, whether expressed in biological or economic terms, should be evaluated for the integrated system, not just as individual. When system inputs and output were proportional to size and were not constrained in different ways for different size genotypes, no relation between breeding female size and productive efficiency would be expected.

Chowdhary and Bharat (1979) measured the milk production efficiency using 244 normal lactation yields of Mehasana and Surti buffaloes, in terms of milk yield per kilogram of metabolic body weight per day. The milk production efficiency was measured (Gaines et al.,1940) as given below.

(i) Milk-production efficiency/kg metabolic body weight/lactation(MPEKML).

MPEKML= Lactation yield/body weight$^{0.75}$

(ii) Milk-production efficiency/kg metabolic body weight/day (MPEKMD).

MPEKMD= MPEKML/Lactation length.

They reported that groups according to body weight did not constitute a significant effect. The least squares means showed a declining trend of efficiencies as body weight increased.

EFFECT OF GENETIC GROUP ON DAIRY MERIT:

Edwards (1936) studied records of 2400 cows for the gross physiological efficiency of milk production of different breeds.

He found little difference in gross efficiency of milk production among best representatives of various breeds.

Holts *et al.* (1961) compared the performance of Jersey, Guernsey and Holsteins in terms of FCM/1000 lb of cow, relative lactation capacity, and gross efficiency. They found slower gaining Jerseys produced significantly better than the faster gaining ones as judged by any of the above measures. In contrast, the fast gaining Holsteins produced the best ($P < 0.05$) for FCM and mature equivalent FCM. Their results were:

Parameters	Guernsey	Jersey	Holstein
Records/cows	52/28	95/50	138/66
FCM/Cow(kg)	4415	3890	5624
weight during lactation(kg)	431	402	588
FCM/454.5 kg body wt.(kg)	4884	4440	4373
Relative lactation capacity (kg)(454.5 kg base) (Kleiber & Mead 1945)	4677	4362	4719
Gross efficiency % (Gaines, 1928)	30.48	29.70	29.48

Singh and Desai (1964) reported the values of relative efficiency of milk production, which ranged from 4.2 kg in 1/8 Holstein x Sahiwal to 3.8 kg in 5/8 Holstein x Sahiwal, while in Sahiwal it was 4.4 kg.

Singh and Singh (1967) observed that the relative efficiency of milk production in Holstein-Red Sindhi cows during first lactation was 5.8 kg.

McDowell and McDaniel (1968)compared two-and three-breed crosses among Ayrshire, Brown Swiss, and Holsteins to contemporary purebreds for first lactation income per cow over feed cost under 11 milk price-feed cost combinations. The Ayrshires, Brown Swiss and their cross were significantly lower than two-breed crosses of 1/2 Holstein and three breed crosses for income over feed costs. The 1/2 Holstein, two-breed crosses, were 12 to 14 percent above the parental mean for returns over feed cost but Ayrshire x Swiss showed no advantage.

Dickinson *et al.*(1969)estimated feed efficiency as $\left(\frac{\text{Energy in milk}}{\text{Energy in feed}} \right) \times 100$ to be 60.3, 54.3 and 61.0 percent for Ayrshire, Brown Swiss and Holstein cows respectively.

Hodgson (1970) compared the relativeefficiency of Holstein-Friesian and Jersey breed in relation to milk yield. His results were:

Parameter	Holstein Friesian	Jersey	Holstein Friesian over Jersey(%)
Milk yield (kg)	5,807	3,791	53
Milk fat (kg)	217	197	10
Milk energy(M.Cal)	3,857	3,105	32
Energy per M.Cal of digestible energy required.	0.31	0.32	-3.0

He observed that with the size and productivity of the two breeds, there was little or no advantage of one breed over the other in production of output per unit of input.

Wagon (1971) observed that feed conversion efficiency of Brown Swiss crossbred was maximum under roughage feeding system being 23.18 ± 1.03 percent and 17.53 ± 0.9 percent in Sahiwal itself. Crossbred cows showed nearly 6% higher feed conversion efficiency than the Sahiwals.

Khanna and Bhat (1971) estimated the relative efficiency of milk production as 4.8, 4.5, and 4.4 kg in Sahiwal cows located at Lucknow, Ambala, and Meerut Military Farms respectively.

Hickman and Bowden (1971) found the feed efficiency estimated as TDN per kg FCM to be 0.57 ± 0.11 for Holsteins and 0.61 ± 0.11 for Ayrshires.

Horn (1973) observed that Hungarian Pied x Danish Jersey crosses were 62 to 75 percent higher in first three lactations than Hungarian in FCM yield per kg of live weight.

Murty (1974) observed the dairy merit, the order being 1/2 Friesian, 1/2 Red Dane, 1/2 Jersey, 5/8 Friesian, and 1/8 Friesian. Among purebreds, Jersey was better than Red Dane.

Naito _et al._ (1974b) found the gross energetic efficiency index to be 28.5% in Holstein breed.

Rao _et al._ (1976) conducted a study comprising each of seven Brown Swiss-Sahiwal crossbreds and Sahiwal cows during 300 days lactation length indicated that on an average, crossbreds produced 9.68 kg of milk consuming 10.38 kg of dry matter, 6.27 kg

TDN and 1.28 kg protein per day as against 7.4 kg of milk, 8.28 kg dry matter, 5.07 kg TDN and 0.98 kg protein in Sahiwal cows. Gross and net energetic efficiency in crossbred and Sahiwal was 29.14, 28.23 and 31.2, 31.13 percent respectively.

Sharma *et al.* (1976) reported the results from an experiment while studying the efficiency of feed conversion for milk production in Tharparkar, Sahiwal, Brown Swiss-Sahiwal crossbreds and Murrah buffaloes.

Parameters	Expt. I		Expt. II	
	Tharparkar	Murrah	Sahiwal	Brown Swiss Sahiwal
Body weight(kg)	305	453	313	340
FCM/day(kg)	5.01	9.09	9.62	13.50
Milk yield/day(kg)/ 100 kg B.W.$^{0.75}$	6.04	5.97	12.29	17.39
Gross energetic efficiency	27.54	23.70	20.80	26.62

When dairy merit was concerned, crossbred cows and Tharparkar had more than 1/4th conversion efficiency of TDN energy converted into milk energy. But in terms of total amount of milk produced, crossbreds were more profitable as compared to Zebu, since the number of high yielders required to produce desired amount of milk per day was less as compared to low yielders.

Ram (1977) reported that Brown Swiss crosses exhibited the highest value in various measures of efficiency of milk production followed by Jersey and Friesian crosses at comparable levels of exotic inheritance. In Friesian group, the performance in terms of production and efficiency of milk production of 1/2, 5/8 and 3/4 Friesian crosses was significantly higher than that of 1/8, 1/4 and 3/8 Friesian crosses; while 7/8 Friesian crosses and purebreds Friesians occupied an intermediate position. In the Jersey group, the performance of halfbred Jersey was better than that of purebred Jerseys, while in Brown Swiss group, the performance of F_1 crossbred was followed by that of 3/4 and F_2 crosses and the pure Brown Swiss. The difference between F_1,F_2 Brown Swiss crosses tended to become narrower as the lactation advanced.

Ram *et al.*(1978) carried out study over 300 days to evaluate and compare milk production efficiency in Karan Swiss and Sahiwal cows and Murrah buffaloes. Milk production efficiency was lower in buffaloes than either in Sahiwal or the Karan Swiss cows. There was no significant difference between the two cattle breeds. Their results were:

Parameter	Sahiwal	Karan Swiss	Murrah buffaloes
Body weight(kg)	281 ± 7	356 ± 15	485 ± 16
4 percent FCM(kg/day)	7.55 ± 0.98	9.73 ± 1.03	7.90 ± 0.95
TDN intake(M.Cal/day)	19.79 ± 1.19	25.10 ± 0.05	30.19 ± 0.51
Gross efficiency	28.23 ± 0.27	29.14 ± 0.92	19.89 ± 0.88

Karan Swiss cows proved to be more economic and efficient in conversion of feed nutrients into milk than either Sahiwal cows or Murrah buffaloes.

Arora et.al.(1979) determined gross and net efficiency of total nutrient intake in relation to milk yield in six Karan Swiss cows selected at random, the day they calved being in first to third lactation. These cows during experimental period were under high plane of nutrition. Their observations were as under:

Attribute	Observation
Average body weight(kg)	313.7
Average lactation(days)	300
Average lactation yield(kg)	3901.5
Average milk yield/day(kg)	13.00
Average fat percentage	4.4
Average FCM lactation yield(kg)	4135.11
Average FCM/day (kg)	13.78
Average energetic gross efficiency(%)	33.77
Average energetic net efficiency(%)	49.40

Chowdhary and Bharat (1979) measured the milk production efficiency using 244 normal lactation yields of Mehasana and Surti buffaloes. They reported that Mehasana although a heavier breed was more efficient milk producer than Surti.

Singh (1979) indicated highly significant influence of breed on the first lactation dairy merit; using the least squares analysis of variance method. The Duncan's multiple range test indicated significant differences in Red Sindhi V/S Sahiwal, F_1, F_2 and 3/4 Brown Swiss cross; Sahiwal V/S Tharparkar, F_1, 3/4 Brown Swiss cross and Holstein -Tharparkar; Tharparkar V/S F_1, 3/4 and F_2 Brown Swiss cross; and F_1 Brown Swiss cross V/S F_2 and 3/4 Brown Swiss crossbred groups. The highest positive deviation from mean was observed in F_1 Brown Swiss cross and Holstein-Tharparkar crossbred (0.23 and 0.23); while it was highest negative in Red Sindhi inheritance.

Daniel *et al.*(1980) estimated the efficiency of nutrient conversion to milk production during early lactation in three half bred crosses, namely Brown Swiss-Hariana, Holstein-Hariana and Jersey-Hariana. The value for adjusted metabolisable energetic efficiency ranged from 48.9 to 67.7 percent, but there was no significant difference between breeds.

EFFECT OF STAGE OF LACTATION ON DAIRY MERIT:

Edwards (1936) reported significant effect of stage of lactation on the gross efficiency and found a steady decline in efficiency with the advancement of lactation i.e.from 30.75 (in Ist month) to 29.25 percent(in 11th month).

Miller and Hooven (1969) while studying 1,004 lactations for characterising variations in whole-and-part-lactation measures of feed efficiency, reported steady decline in efficiency throughout the lactation.

Miller *et al.* (1970) observed that changes in weight during lactation were negatively related to efficiency. Part-whole correlations indicated that part-lactation feed efficiency should be measured around the middle of the lactation.

Hooven *et al.* (1972) collected data on milk production, feed consumption and feed efficiency on 425 first lactation cows to determine if a part-lactation measure of feed efficiency would effectively predict total lactation efficiency. The data were summarised by ten 30 days periods (1 to 30, 31 to 60,......, 271 to 300) and a 300-day lactation on total basis. Correlations between 10 part-lactation measures and the total ranged from 0.64 to 0.87 with the highest occuring in period 4 and 5.

Rao *et al.* (1978) observed significant differences in milk production efficiency between different stages of lactation efficiency tended to increase during the first 3 months of lactation in Karan Swiss and Sahiwal cows and during 1st two months in buffaloes. Karan Swiss cows showed larger milkproduction efficiency than Sahiwal during early stages of lactation; however, in lactation the two breeds showed a similar efficiency. The interaction between lactation stage and genetic group was highly significant.

Daniel *et al.* (1980) reported that with advancement of lactation metabolizable energetic efficiency decreased significantly in Brown Swiss-Hariana, Holstein-Hariana and Jersey-Hariana crosses. They were of the opinion that, this might be due to the cows being less efficient in utilizing dietary nutrients for milk production with decline in their milk yields.

EFFECT OF PARITY ON DAIRY MERIT:

Singh and Singh (1967) observed that relativeefficiency of milk production in Holstein-Red Sindhi cows increased upto fifth lactation.

Hooven *et al.* (1968) in their study of feed conversion efficiency among the Holstein cows reported that judging from gross parity means, efficiency increased from first lactation to maturity, but to a smaller extent than lactation yield.

Miller and Hooven (1969)reported that parity in 1,004 lactations of Holsteins had large effects on efficiency of production.

Miller *et al.* (1970) while studying factors affecting feed efficiency of Holstein cows observed that age effects were significant, efficiency increased consistently from first to fourth lactation.

Rao (1977) in his study on efficiency of milk production in crossbred cattle observed that results on overall production and efficiency of milk production based on first three lactations in different genetic groups tended to confirm the findings based on first lactation. The interrelationship of first lactation traits with lifetime traits revealed that first lactation efficiency was highly related to lifetime efficiency.

Choudhary and Bharat (1979) measured the production efficiencies in Mehsana and Surti buffaloes, and found non-significant effect due to parity, which suggested that animals approached, physiological maturity by second calving.

EFFECT OF SEASON AND PERIOD OF CALVING ON DAIRY MERIT:

Hooven *et al.* (1968) found no years effect on first parity efficiency, but was significant on overall lactation basis.

Miller and Hooven (1969) studied variations in part-and the whole-lactation feed efficiency of Holstein cows, observing that influence of season and years was relatively minor. Also, seasonal effects were confounded with those due to weight change.

Miller *et al.* (1970) observed statistically significant effects of season on feed efficiency in Holstein cows, with January-March calving, resulting in highest efficiency. However, seasonal differences were due primarily to fleshing changes. They found that when adjustment for weight changes was made, seasonal differences were not significant.

Chowdhary and Bharat (1979) reported significant effects of year of calving on milk production efficiency in terms of milk yield per kilogram of metabolic body weight per lactation and also milk yield per kilogram of metabolic body weight per day, in Mehasana and Surti buffaloes. However, season of calving affected the milk production/kilogram of body weight/lactation only.

Singh (1979) found non-significant effect of season of calving on dairy merit in overall breed groups and as well among Zebu and exotic-Zebu cattle. The period effect was found to be significant. The breed wise analysis of variance indicated highly significant influence of period on dairy merit in Red Sindhi, Sahiwal, Tharparkar, F_1 Brown Swiss corss; and non-significant in F_2 Brown Swiss cross and 3/4 Brown Swiss crossbred cows.

Daniel (1980) reported that fat corrected milk production differed between periods. The results for dairy merit in the three genetic groups in different periods were as under:-

Period	Holstein x Hariana	Jersey x Hariana	Brown Swiss x Hariana
First	30.3± 2.23	31.0± 0.9	30.7± 1.81
Second	26.1± 2.41	23.0± 2.35	23.3± 2.08
Third	25.2± 1.02	23.8± 2.67	23.1± 3.35

They found non-significant difference between periods, for metabolisable energetic efficiency.

EFFECT OF AGE ON DAIRY MERIT:

Gaines (1940) indicated that milk energy yield per unit live weight in Holstein cows was independent of age (r= -07± 0.09). He concluded that age correction is indirect way of allowing for live weight.

Hasson (1941) reported that economy of milk production, as determined by the relation between yield and feed consumption, was greatly increased by reducing age at first calving.

Miller and McGilliard (1959) used Michigan DHIA-IBM records for 4,677 Holsteins, 1,001 Guernseys, and 501 Jersey to fit constants on production in the first lactation. Their results indicated that delay in calving of heifers is economically disadvantageous and that heavier heifers have little or no advantage over lighter heifers of similar age. Intra-herd partial regression was about 75 lb of milk per month of age.

Stone et al. (1960) in their study of forage intake and efficiency of feed utilization in Holstein cows found the correlation between age and efficiency as 0.12.

Bereskin and Touchberry (1966) reported that age at freshening when included with days carried calf as the only additional covariate, was significantly associated with first lactation yields of milk fat and fat-corrected milk; in their studyof relationship of body weight and age with first lactation yield in Holsteins, Guernseys and three intermediate crossbred groups.

Miller et al. (1970) reported significant effect of age on feed efficiency among Holstein cows.

Bhadula and Desai (1972) measured the efficiency of production in Murrah buffaloes. They found that with the increase in age at first calving the milk production efficiency either for milk production efficiency per kg body weight over the whole lactation (MPEKL) or milk production efficiency per kg body weight per day remained steady upto about 42 months of age and then thereafter, these declined consistently.

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CHAPTER-III

MATERIAL AND METHODS

MATERIALS AND METHODS

Records of crossbred cattle available at National Dairy Research Institute, Karnal were considered for this study.

Location and climate:

The National Dairy Research Institute farm at Karnal is situated on the Grand Trunk Road, 125 kg northwest to Delhi at lattitude of 20.7°F and 77°N, whereas the altitude is 250 mts above sea level. The minimum ambient temperature falls to near freezing point in winter and maximum goes upto 45°C in summer. The annual rainfall is approximately 70 cms. This farm has 400 hectares of irrigated land for intensive fodder production round the year.

Data:

Records of 119 first generation crossbred (39 Holstein - Tharparkar, 12 Holstein-Sahiwal, 34 Brown Swiss-Sahiwal, 20 Jersey-Tharparkar and 14 Brown Swiss-Tharparkar) cows that completed their four lactations during the period 1971 to 1979, constituted the material for this study. The data on milk production, body weight and fat percentage for each month of each of the first four lactations alongwith their age at calving (months) and days in lactation were recorded. Cows having less than 100 days lactation yield were considered as abnormal and were not included in this study.

The years were classified into three periods. This period was taken as period of calving. The periods were classified as:

Period	Years
1	1971-1973
2	1974-1976
3	1977-1979

The year was divided into four seasons which comprised of months as detailed below.

Season	Months
1	July-September
2	October-December
3	January-March
4	April-June

The classification of seasons was based on climatological data. The season was taken as season of calving, as in the case of period. It was assumed that year to year difference due to different conditions of climate, fodder and feed availability, and managerial skill available was small.

Management:

The calves were weaned at birth. The calves were fed colostrum for first five days. The animals were maintained under loose housing system. All the animals were provided with ad libitum green fodder and during monsoon when the dry matter content in green fodder went down, it was supplemented with silage and/or concentrates to meet the nutritive requirements of the animals, if at all necessary. The lactating animals were given a total of one kilogram concentrate mixture in a day as let down ration at the time of milking. Additional concentrate mixture was given to high yielding (above 9 kg/day) cows @ one kilogram for their additional three kilogram milk yield. Animals were milked thrice a day-morning (5.00 to 7.00 hrs), noon (12.00 to 14.00 hrs) and evening (19.00 to 21.00 hrs). Some animals were machine milked while other-s were hand milked. Milk of each animal was recorded at each milking.

ANALYTICAL METHODS:

The dairy merit of each cow was calculated as suggested by Brody (1945) where value in lbs were converted to kg by multiplying the factor 2.2046.

$$\text{Dairy Merit(DM)} = \frac{750 \times \text{FCM produced}}{3999 \times \text{TDN consumed}} \times 100$$

where,

FCM= Milk yield per day corrected at 4 percent fat assuming that one kg FCM had an energy equivalent of 750 calories.

TDN= Total digestible nutrients consumed per day, assuming that one kg TDN had an energy equivalent to 3999 calories.

Fat- corrected milk yield was estimated according to the formula(Perkins,1937).

$$FCM = M\ (0.4 + 0.15\ F)$$

where,

M= Milk yield.

F= Fat percentage

Daily fat-corrected milk yield was calculated.

The total digestible nutrients consumed by the cow was estimated, as suggested by Brody(1945).

$$TDN = 0.305\ FCM + 0.053\ W^{0.73} + 2.1\ \Delta W.$$

where,

FCM= Fat-corrected milk yield per day at 4 percent.

$W^{0.73}$= Body weight raised to 0.73 power i.e. metabolic body weight.

ΔW = Daily gain or loss in body weight.

$$= \frac{(\text{Body weight in preceeding month} - \text{Body weight in succeeding month})}{\text{Average number of days in a month.}}$$

Assumption -The TDN was used for body maintenance, gain in weight and producing milk.

In this formula if body maintenance and change in body weight are held constant, then 0.305 kg TDN is used for producing one kg FCM; when milk yield and body maintenance are held constant, then 2.1 kg TDN is used for one kg gain in live weight. Similarly when milk yield and gain in weight are held constant, then TDN cost of maintenance is 0.083 x $(W^{0.73})$.

The dairy merit of lactation yield and that of ten stages of lactation- first month, second month and so on ......, of each animal, for four lactations were calculated.

Statistical analysis:

Least squares analysis of fitting constants (Harvey,1966) was used to overcome the non-orthogonality of data and to study the effects of stage of lactation, genetic group, period of calving, season of calving, order of lactation, age at calving and lactation length on dairy merit. It was assumed that these traits were normally distributed in this population, hence the angular transformation was not done for dairy merit.

Statistical Model:

For least squares analysis of lactation dairy merit following model was used:

$$Y_{ijklm} = \mu + G_i + P_j + S_k + O_l + b_1(X_{ijklm} - \bar{X}_1) + b_2(X_{ijklm} - \bar{X}_2) + e_{ijklm}.$$

where,

Y_{ijklm} = observation on m th individual under l th order of lactation, k th season of calving, j th period of calving and i th genetic group.

μ= Overall population mean.

G_i=Fixed effect of i^{th} genetic group. (i= 1,.....5).

P_j=Fixed effect of j^{th} period of calving. (j= 1,.....3).

S_k= Fixed effect of k^{th} season of calving. (k= 1,....4).

O_l= Fixed effect of l^{th} order of lactation. (l= 1,.....4).

e_{ijklm}= random error associated with each observation distributed normally and independently with mean zero and variance σ^2. All the interactions in the model were assumed to be zero.

X_{ijklm}= the contineous dependent variate fat the corresponding Y_{ijklm} observation.

$\bar{X}$ = Arithmetic mean of X_{ijklm}.

b_1& b_2= partial regression co-efficient of dependent variable (Y) lactation dairy merit on independent variable(X) i.e. lactation length and age at calving.

The following model was used for least squares analysis of dairy merit of lactation stage.

$$Y_{ijklmn}=\mu+G_i+L_j+O_k+P_l+S_m+b_1(X_{ijklmn}-\bar{X}_1)+b_2(X_{ijklmn}-\bar{X}_2)$$
$$+e_{ijklmn}.$$

where,

Y_{ijklmn}= observation on n^{th} individual under i^{th} genetic group, j^{th} stage of lactation, k^{th} order of lactation, l^{th} period of calving, and m^{th} season of calving.

μ= Overall population mean.

G_i=fixed effect of i^{th} genetic group.
(i= 1,.......5).

L_j=fixed effect of j^{th} stage of lactation.
(j= 1,..... 10).

O_k= fixed effect of k^{th} order of lactation.
(k= 1,......4).

P_l= fixed effect of l^{th} period of calving.
(l= 1,.....3).

S_m= fixed effect of m^{th} season of calving.
(m= 1,......4).

e_{ijklmn}= random error associated with each observation distributed normally and independently with mean zero and variance σ^2. All interactions in the model were assumed to be zero.

X_{ijklmn}=the contineous dependent variate for the corresponding Y_{ijklmn} observation.

$\bar{X}$ = the arithmetic mean of X_{ijklmn}.

b_1& b_2= partial regression co-efficient of dependent variable (Y) dairy merit of lactation stage on independent variable (X) i.e. lactation length and age at calving.

Standard error:

The standard error of mean was worked out from the inverse matrix

$$S.E.=\sqrt{(c^{ii})\ e^2}$$

where,

C^{ii}= corresponding diagonal inverse element for that constant.

e^2 = error mean square.

Duncan's multiple range test :

Duncan's multiple range test (Duncan, 1955) as modified by Kramer (1957) was used to test the mean differences of the various effects affecting the Traits.

Estimation of correlation co-efficient:

In each genetic group under study following correlations were calculated:

1. Correlation of part-lactation dairy merit with lactation dairy merit.

2. Correlation among part-lactation dairy merits.

Correlation was calculated by using the formula:

$$r_{AB} = \frac{\sum_{i=1}^{n} a_i b_i}{\sqrt{\sum_{i=1}^{n} a_i^2 . \sum_{i=1}^{n} b_i^2}}$$

where, A and B are two traits.

a_i^2 = squares of the deviations from the mean for A.

b_i^2 = squares of the deviations from the mean for B.

$a_i b_i$ = cross products of deviations from the mean of the two traits.

Standard error of correlation was calculated by using the formula:

$$SE(r) = \sqrt{\frac{(1-r^2)}{n-2}}$$

The data were analysed by B-4700 computer at the Indian Agricultural Statistical Research Institute, New Delhi and by MICRO-2200 computer at the Dairy Cattle Genetics Division, National Dairy Research Institute, Karnal.

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CHAPTER-IV

RESULTS AND DISCUSSIONS

RESULTS AND DISCUSSIONS

The least squares analysis of variance of lactation dairy merit was worked out and presented in Table 1. This table indicated highly significant differences among genetic groups (Holstein-Tharparkar, Holstein-Sahiwal, Brown Swiss-Sahiwal, Brown Swiss-Tharparkar, and Jersey-Tharparkar). Periods and the seasons of calving were found affecting the lactation dairy merit significantly. Parity had no effect on lactation dairy merit. The regression of dairy merit on age at calving and on the lactation length was non-significant.

It was thought proper to analyse the lactation dairy merit further within genetic group as to see how these genetic groups react to the various environmental factors. The least squares

Table-1: Least squares analysis of variance for lactation dairy merit.

Source of variation	d.f.	M.S.S.
Genetic group	4	150.91^{**}
Parity	3	3.12
Period of calving	2	71.88^{**}
Season of calving	3	64.11^{**}
Regression on age at calving.	1	0.17
Regression on lactation length.	1	8.00
Error	460	10.10

** Significant at 1% level.

analysis of variance (Table-2) for lactation dairy merit when done within genetic group showed that the lactation dairy merit amongst the Holstein-Tharparker crosses and that of the Brown Swiss- Sahiwal crosses were significantly affected, respectively by season and the period of calving. Whereas, parity had no significant effect on lactation dairy merit in all these five genetic groups. It was because while calculating TDN consumption monthly changes in the body weight during lactation were taken into account. Also there was an increase in body weight from one lactation to other, along with the increase in milk production of cows, counter balancing the effect of increased milk production on dairy merit. Regression of lactation dairy merit on age at calving and lactation

Table-3: Least squares analysis of variance for lactation dairy merit in different genetic groups.

Source of variation	H.T.		H.S.		D.C.		J.T.		B.T.	
	d.f.	M.S.S.	d.f.	M.S.S.	d.f.	M.S.S.	d.f.	M.S.S.	d.f.	M.S.S.
Parity	3	0.1662	3	1.94	3	7.24	3	11.47	3	5.99
Season of calving	3	75.79**	3	4.38	3	14.90	3	6.36	3	8.65
Period of calving	1	10.97	1	0.44	2	83.01**	1	0.67	1	1.67
Regression on age at calving	1	0.82	1	4.07	1	10.58	1	2.82	1	12.66
Regression on lactation length	1	14.56	1	30.47	1	0.80	1	0.04	1	10.69
Error	146	15.53	38	11.73	125	16.00	70	7.58	45	9.45

** Significant at 1% level.

Table-[illegible]: Least squares analysis of variance for lactation dairy merit in different genetic groups.

Source of variation	H.F.		H.S.		R.G.		J.T.		B.T.	
	d.f.	M.S.S.	d.f.	M.S.S.	d.f.	M.S.S.	d.f.	M.S.S.	d.f.	M.S.S.
Parity	3	0.1862	3	1.94	3	7.24	3	11.47	3	5.99
Season of calving	3	73.79**	3	4.38	3	14.90	3	6.36	3	8.65
Period of calving	1	10.97	1	0.44	2	83.01**	1	0.67	1	1.67
Regression on age of calving	1	0.82	1	4.07	1	30.58	1	2.82	1	12.66
Regression on lactation length	1	14.36	1	30.47	1	0.80	1	0.04	1	10.69
Error	166	15.83	38	11.73	125	16.00	70	7.50	45	9.45

** significant at 1% level.

length was also found to be non-significant in these five genetic groups.

Genetic group:

The overall mean lactation dairy merit of all the genetic groups under study was 27.27 ± 0.12 percent (Table-3). The least squares means of lactation dairy merit(%) in decending order were 28.82 ± 0.25 (Holstein-Tharparkar), 28.76 ± 0.53 (Holstein-Sahiwal), 26.39 ± 0.14 (Brown Swiss -Sahiwal), 26.20 ± 0.33 (Jersey-Tharparkar) and 26.01 ± 0.40 (Brown Swiss-Tharparkar). On testing lactation dairy merit means between genetic groups it was revealed that no significant differences existed between Holstein-Tharparkar(HT) and Holstein-Sahiwal(HS), and also among Brown Swiss-Sahiwal(BC), Jersey-Tharparkar(JT) and Brown Swiss-Tharparkar(BT). However, the lactation dairy merit of Holstein crossbreds were significantly higher than that of Brown Swiss and the Jersey crossbred cows (Table-4).

Rao (1977) reported Brown Swiss crosses to be superior over Jersey and Friesian crosses for the various measures of efficiency of milk production at comparable levels of exotic inheritance, while in the present study Holstein crosses were found to be superior over Brown Swiss and Jersey crosses. Whereas, Murty(1974) found similar results, i.e. F_1 Holstein crosses were superior over F_1 Jersey crosses.

The dairy merit values in Brown Swiss-Sahiwal reported by Sharma et al.(1976), Rao et al.(1978) and Arora et al.(1979)

Table-3: Mean, Standard error(SE) and co-efficient of variations % (CV) for the lactation dairy merit (%) of different genetic groups in different parities, periods and seasons.

Effect			HF	HS	DC	JF	DF	Overall
Overall		Mean ± SE CV	28.82 ± 0.25 10.87 (156)	28.76 ± 0.53 12.89 (48)	26.59 ± 0.14 6.00 (136)	26.20 ± 0.33 13.57 (80)	26.01 ± 0.40 11.43 (56)	27.27 ± 0.12 9.89 (476)
Parity	1	Mean ± SE CV	28.11 ± 1.83 40.66 (39)	30.42 ± 1.25 14.23 (12)	26.43 ± 1.93 42.58 (34)	25.84 ± 2.16 37.38 (20)	21.90 ± 2.69 45.96 (14)	27.02 ± 0.76 30.65 (119)
	2	Mean ± SE CV	27.90 ± 1.08 24.22 (39)	28.57 ± 2.30 30.31 (12)	26.70 ± 0.39 8.32 (34)	24.52 ± 1.66 30.28 (20)	23.72 ± 0.88 13.88 (14)	26.98 ± 0.29 11.81 (119)
	3	Mean ± SE CV	27.90 ± 1.09 24.47 (39)	27.76 ± 2.18 27.20 (12)	26.34 ± 0.16 3.39 (34)	25.44 ± 1.69 29.71 (20)	26.89 ± 0.80 10.73 (14)	27.53 ± 0.37 14.74 (119)
	4	Mean ± SE CV	27.70 ± 1.89 42.61 (39)	27.04 ± 1.14 16.66 (12)	25.02 ± 2.16 50.34 (34)	26.65 ± 2.25 37.76 (20)	28.80 ± 2.68 34.82 (14)	27.57 ± 0.84 33.13 (119)
Period of calving.	1 (1971-1973)	Mean ± SE CV	-	-	28.28 ± 0.80 20.20 (51)	-	-	28.79 ± 0.57 16.10 (51)
	2 (1974-1976)	Mean ± SE CV	27.47 ± 0.93 25.87 (78)	28.23 ± 2.38 35.77 (18)	25.40 ± 0.88 25.84 (60)	25.44 ± 1.56 40.68 (44)	24.94 ± 0.89 21.41 (36)	26.49 ± 1.00 57.98 (236)
	3 (1977-1979)	Mean ± SE CV	28.33 ± 0.94 29.40 (78)	28.66 ± 2.63 50.23 (30)	24.69 ± 0.43 8.71 (25)	25.78 ± 1.63 37.94 (36)	25.72 ± 0.59 10.00 (20)	26.55 ± 0.20 10.41 (88)

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Season of calving 1 July-Sept.	Mean ± SE CV	26.85 ± 1.03 21.01 (30)	29.08 ± 2.14 14.72 (4)	25.32 ± 0.57 11.03 (24)	24.85 ± 1.58 27.71 (19)	24.27 ± 0.70 11.17 (15)	26.51 ± 0.2 10.21 (92)
2 Oct.-Dec.	Mean ± SE CV	29.90 ± 1.04 18.73 (29)	29.07 ± 2.61 29.78 (11)	26.28 ± 0.63 12.69 (18)	26.45 ± 1.71 20.44 (10)	25.11 ± 0.49 5.13 (7)	28.23 ± 0.27 8.88 (85)
3 Jan.-March	Mean ± SE CV	28.36 ± 0.88 24.04 (60)	27.96 ± 2.69 46.14 (23)	26.99 ± 0.85 20.89 (44)	25.77 ± 1.51 37.06 (40)	25.88 ± 0.95 16.76 (22)	27.66 ± 0.16 7.70 (188)
4 April-June	Mean ± SE CV	26.56 ± 0.97 22.27 (37)	27.67 ± 2.59 29.60 (10)	25.90 ± 0.82 20.00 (40)	25.39 ± 1.68 21.95 (11)	25.96 ± 0.70 9.34 (12)	26.70 ± 0.26 9.50 (110)

Figures in parenthesis indicate the number of observations.

was 28.62%, 29.14% and 33.77%, respectively, which are higher than the dairy merit value (26.59%) in present study while the dairy merit value (23.18%) for Brown Swiss crossbred reported by Wagaon (1971) was lower.

Table-4: Duncan's multiple range test for lactation dairy merit.

Effect	Arranged in descending order
Genetic group	$\underline{HT \quad HS} \quad \underline{BC \quad JT \quad BT}$
Parity	$\underline{O_4 \quad O_3 \quad O_1 \quad O_2}$
Period	$P_1 \quad \underline{P_3 \quad P_2}$
Season	$\underline{S_2 \quad S_3} \quad \underline{S_4 \quad S_1}$

Effects connected by line were not significantly different ($P < 0.05$).

Amongst the crossbreds, when Holstein and Brown Swiss sires are used the progenies are known to have higher body weight/ body size compared to Jersey crosses (Table-5). Body size is considered very important while evaluating dairy merit. In this study cows born to Holstein sires having high body weight were observed to have higher dairy merit while Jersey crosses being lighter in weight and/or smaller in size had lower dairy merit. Dairy merit in Brown Swiss crosses were in between. Erb and Ashworth (1961) were of the view that breed comparisions for dairy merit was not

Table-5: Means and Standard error (SE) and traits parity wise in different genetic groups.

Genetic groups Traits	NT(48) Mean ± SE	MS(12) Mean ± SE	BC(34) Mean ± SE	JT(20) Mean ± SE	BT(14) Mean ± SE
<u>First Parity</u>					
Age at calving(months)	27.05 ± 0.53	36.92 ± 1.71	27.91 ± 0.95	26.80 ± 0.76	26.64 ± 0.64
weight at calving(kg)	328 ± 6	323 ± 11	329 ± 6	301 ± 7	334 ± 10
Days in lactation	316 ± 22	315 ± 5	337 ± 9	322 ± 10	346 ± 23
<u>Second Parity</u>					
Age at calving(months)	38.00 ± 0.62	49.46 ± 1.81	42.00 ± 0.56	39.50 ± 0.78	40.00 ± 0.85
weight at calving(kg)	372 ± 7	357 ± 9	346 ± 5	321 ± 8	356 ± 11
Days in lactation	308 ± 17	308 ± 13	339 ± 16	338 ± 15	321 ± 10
<u>Third Parity</u>					
Age at calving(months)	51.13 ± 0.61	61.08 ± 1.89	54.97 ± 0.67	52.80 ± 1.05	53.00 ± 0.88
Weight at calving(kg)	412 ± 7	376 ± 8	378 ± 8	364 ± 10	393 ± 13
Days in lactation	317 ± 17	328 ± 10	316 ± 10	341 ± 10	344 ± 10
<u>Fourth Parity</u>					
Age at calving(months)	62.18 ± 1.80	75.85 ± 2.11	69.24 ± 0.81	65.20 ± 1.15	60.14 ± 0.98
weight at calving(kg)	443 ± 7	406 ± 11	384 ± 8	367 ± 8	416 ± 12
Days in lactation	301 ± 13	282 ± 14	321 ± 20	334 ± 18	354 ± 34

Figures in parenthesis indicate the number of observations.

of much importance, since individual variation in size of cows with breed was larger than the difference in averages. They also observed the effect of increase in size on milk yield and were of opinion that this might even result in decrease in dairy merit. Whereas, in this study dairy merit was higher among the cows which were heavier, indicating thereby, that it may be profitable if attention on relation of body size to the dairy merit of milch cows is focussed. The heavier cows like Holstein crosses not only produced more milk but had significantly higher dairy merit as well. The Brown Swiss crosses, though produced more milk than Jersey crosses, being medium sized animals, there was no significant difference between Brown Swiss and the Jersey crosses for dairy merit. Here production per unit body weight appeared to favour smaller cows like Jersey crosses. Selection on the basis of dairy merit, therefore, may be advantageous over absolute milk yield in case of general adaptability, inherent capacity for milk production and efficiency of feed utilisation.

Period of calving:

The lactation dairy merit(%) amongst the cows calving during Ist period (1971-73) was significantly higher (28.79 ± 0.57) than those calving during second (1974-76) and the third (1977-79) period of calving. No significant difference in lactation dairy merit was found between second (26.49 ± 1.00) and third (26.55 ± 0.20) period of calving (Table-4).

In Brown Swiss-Sahiwal crossbreds (Table-6) the lactation dairy merit was significantly higher (28.20 ± 0.80) for those calving

Table-6: Duncan's multiple range test for lactation dairy merit in different genetic groups.

Genetic group	Effect	Arranged in descending order
	Parity	$\underline{O_1 \quad O_2 \quad O_3 \quad O_4}$
HT	Period	$\underline{P_3 \quad P_2}$
	Season	$\underline{S_2 \quad S_3} \quad S_1 \quad S_4$ $S_2 \quad \underline{S_3 \quad S_1} \quad S_4$ $S_2 \quad S_3 \quad \underline{S_1 \quad S_4}$
	Parity	$\underline{O_1 \quad O_2 \quad O_3 \quad O_4}$
MS	Period	$\underline{P_3 \quad P_2}$
	Season	$\underline{S_1 \quad S_2 \quad S_3 \quad S_4}$
	Parity	$\underline{O_2 \quad O_1 \quad O_3 \quad O_4}$
BC	Period	$P_1 \quad \underline{P_2 \quad P_3}$
	Season	$\underline{S_3 \quad S_2 \quad S_4 \quad S_1}$
	Parity	$\underline{O_4 \quad O_1 \quad O_3 \quad O_2}$
JT	Period	$\underline{P_3 \quad P_2}$
	Season	$\underline{S_2 \quad S_3 \quad S_4 \quad S_1}$
	Parity	$\underline{O_4 \quad O_3 \quad O_2 \quad O_1}$
DT	Period	$\underline{P_3 \quad P_2}$
	Season	$\underline{S_3 \quad S_4 \quad S_2 \quad S_1}$

Effects connected by line were not significantly different($P < 0.05$).

during 1971-73, than those calving during 1974-76 (25.40± 0.88) and 1977-79 (24.69± 0.43). This is in confirmity with the results of Chowdhary and Bharat (1979) and Singh (1970) who also found significant effect of period of calving on feed conversion efficiency. This variation was attributed to differences among different periods with regards to availability of feed and fodder, prevailing climatic and managerial conditions. However, in other genetic groups no calving took place during 1971-73, as they were not mature enough to calve. In all the five genetic groups under study there was no significant difference in lactation dairy merit among the cows calving during 1974-76 and 1977-1979.

Season of calving:

The lactation dairy merit among the cows calving during October-March was significantly higher than those calving during April-September (Table-4). Miller _et al._ (1970) and Chowdhary and Bharat (1979) reported significant effect of season of calving on feed conversion efficiency.

The lactation dairy merit amongst Holstein-Tharparkar crossbred was 29.90± 1.04 for those calving during October-December, followed by those calving during January-March(28.36± 0.88), the difference being non significant. The lactation dairy merit among the cows calving during April-June was 26.80± 0.97, being significantly lower than those calving during second (October-December) and third (January-March) season of calving. The lactation dairy merit among the cows calving during July-September (26.85± 1.03), however, did not differ significantly from those calving during April-June and October-November (Table [illegible]).

Effect of season of calving on dairy merit with October-March calving resulting in highest efficiency indicated that these differences were due primarily to the efficiency of good quality fodder like berseem which also enhances the level of milk production when compared to other quality fodders. Also seasonal effects might be confounded with those due to weight change.

PART-LACTATION DAIRY MERIT:

Since, the means of part-lactation dairy merit between different genetic groups were found varying significantly [illegible] and [illegible], least squares analysis was carried out within genetic group (Table [illegible]) to find out the effect of stage of lactation, year by period and season of calving.

Table [illegible]: Least squares analysis of variance for part-lactation dairy merit.

Source of variation	d.f.	M.S.
Genetic group	6	[illegible]
Stage of lactation	5	[illegible]
[illegible]	1	[illegible]
Period of calving	2	[illegible]
Season of calving	2	[illegible]
Regression on age at calving	1	[illegible]
Regression on lactation length	1	[illegible]
Error	[illegible]	[illegible]

** Significant at 1% level.

Table-8: Least squares analysis of variance for part-lactation dairy merit in different genetic groups.

Source of variation	HF		HS		BC		JT		HT	
	d.f.	M.S.S.	d.f.	M.S.S.	d.f.	M.S.S.	d.f.	M.S.S.	d.f.	M.S.S.
Stage of lactation	9	1265.07**	9	517.12**	9	550.06**	9	351.17**	9	182.58**
Parity	3	11.35	3	38.49	3	60.67	3	113.90**	3	2.71
Period of calving	1	309.91	1	1.30	2	657.37**	1	2.73	1	11.11
Season of calving	3	387.28**	3	59.46	3	55.58	3	18.10	3	114.76
Regression on age at calving.	1	25.30	1	55.28	1	36.65	1	4.79	1	2.28
Regression on lactation length	1	0.002	1	675.89**	1	304.36	1	81.73	1	110.22
Error	1446	86.69	427	32.61	1280	125.66	760	26.12	507	46.89

** Significant at 1% level.

Table-8 indicated highly significant differences among stages of lactation in all the five genetic groups. Highly significant differences were also observed for parity in Jersey-Tharparkar, for period of calving in Holstein-Tharparkar crossbreds. Regression of part-lactation dairy merit on age at calving and on lactation length were found to have no significant effect except that of lactation length in Holstein-Sahiwal crossbreds.

Genetic group:

The overall part-lactation dairy merit(%) was calculated to be 24.90 ± 0.11 with 28.64 percent co-efficient of variability. Part-lactation dairy merit(%) was found to be higher in Holstein-Sahiwal (26.28 ± 0.32) and in Holstein-Tharparkar (26.26 ± 0.28) which differed significantly from the part-lactation dairy merit observed in Brown Swiss-Sahiwal (24.42 ± 0.20), Brown Swiss-Tharparkar (23.92 ± 0.40) and the Jersey-Tharparkar (23.65 ± 0.34). No significant differences could be observed amongst Brown Swiss-Sahiwal, Brow Swiss-Tharparkar, and Jersey-Tharparkar crossbred cows. The co-efficient of variability among Brown Swiss-Sahiwal cows was comparatively less (29.31 percent) compared to other genetic groups (37.88 to 41.96 percent).

With the increase in the number of crossbreds it becomes a prime importance that which cross is more profitable. This cannot be evaluated only by identifying high yielding animals or breeds or selecting for larger body size considering that the heavier animals produced more milk, but for larger economic gains selection should be directed for those animals who have higher dairy merit or produce more milk relative to body size. This will bring more scope for further improvement in performance criterion, while evaluating dairy merit in comparing breeds.

Miller *et al.* (1970) were of the view that selecting cows for higher yield would automatically result in improving feed conversion efficiency. Rapid increase in efficiency could be achieved by penalising those cows which were above average in body weight. Taylor (1971) discussed several interbreed relationship and mean mature body size while making breed comparisions for productive efficiencies. While Holmes (1973) found no advantage in the use of large cattle for milk production.

It is possible that within breed particularly in well managed herds where high levels of feeding are employed selection for milk yield would definately tend to favour larger animals but then selection for yield per unit body weight would tend to favour smaller animals. Larger animals have an economic advantage in the efficiency.

Stage of lactation:

On testing means of part-lactation dairy merit within genetic group (Table-9), it is apparent that the dairy merit remained highest in second part of lactation in all the genetic groups as is also evident from Fig.I. The part-lactation dairy merit declined gradually but did not differ significantly till the animal completed her 4th/5th part of lactation whatever little difference in the means of part-lactation dairy merit had been shown separately as overall and as well within genetic group (Table 9 and 10).

FIG.1. PART-LACTATION DAIRY MERIT IN DIFFERENT CROSSBRED CATTLE

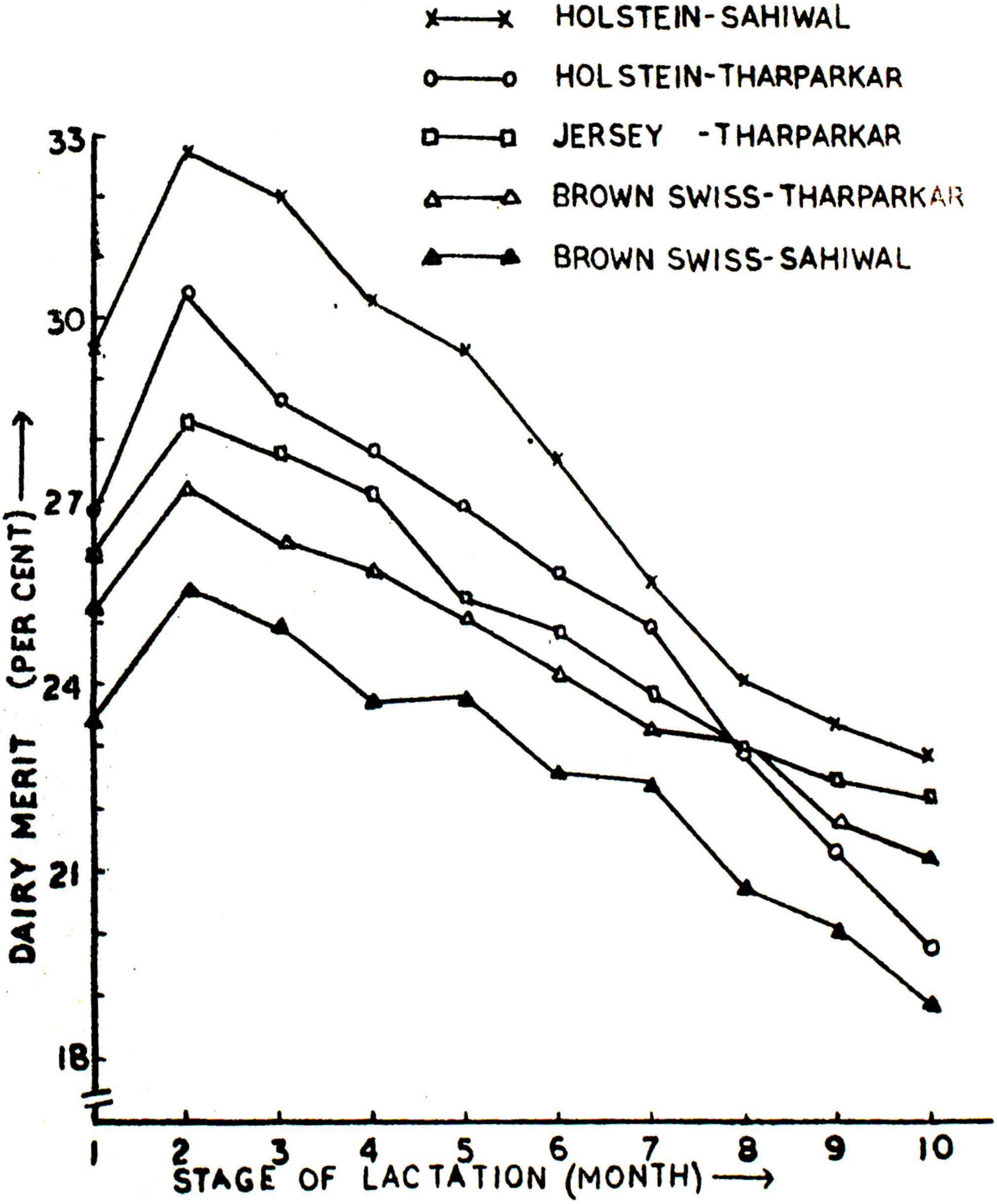

Table-9: Mean, Standard error(SE) and Co-efficient of variations % (CV) for part-lactation dairy merit(%) of different genetic groups in different stages of lactation, parities, periods and seasons.

Effect		HF	HS	BC	JT	BT	Overall
Overall	Mean ± SE CV	26.26 ± 0.28 40.72 (1465)	26.28 ± 0.52 37.88 (446)	24.42 ± 0.20 29.31 (1300)	23.65 ± 0.34 39.71 (761)	23.92 ± 0.40 41.96 (526)	24.90 ± 0.11 28.64 (4498)
Stage of lactation							
1	Mean ± SE CV	26.75 ± 0.94 44.12 (156)	29.44 ± 1.15 15.69 (48)	23.42 ± 0.60 29.86 (136)	26.14 ± 1.05 35.79 (80)	25.17 ± 0.53 34.11 (56)	26.95 ± 0.24 33.94 (476)
2	Mean ± SE CV	29.34 ± 0.94 40.21 (156)	32.67 ± 1.15 14.53 (48)	25.64 ± 0.60 28.27 (136)	28.34 ± 1.05 40.11 (80)	27.19 ± 0.53 30.77 (56)	28.37 ± 0.40 31.08 (476)
3	Mean ± SE CV	28.63 ± 0.94 41.21 (156)	31.98 ± 1.15 15.02 (48)	24.98 ± 0.60 28.00 (136)	27.75 ± 1.05 33.71 (80)	26.30 ± 0.53 31.43 (56)	27.68 ± 0.40 31.83 (476)
4	Mean ± SE CV	27.83 ± 0.94 42.39 (156)	30.32 ± 1.15 15.26 (48)	23.78 ± 0.60 29.41 (136)	27.15 ± 1.05 34.96 (80)	25.88 ± 0.53 33.16 (56)	26.75 ± 0.40 32.92 (476)
5	Mean ± SE CV	26.91 ± 0.94 43.83 (156)	29.50 ± 1.15 15.76 (48)	23.83 ± 0.60 29.35 (136)	25.42 ± 1.05 36.80 (80)	25.08 ± 0.53 34.08 (56)	26.00 ± 0.40 33.89 (476)
6	Mean ± SE CV	25.82 ± 0.94 45.69 (156)	27.70 ± 1.15 16.29 (48)	22.62 ± 0.60 30.92 (136)	24.91 ± 1.05 37.55 (80)	24.24 ± 0.53 36.29 (56)	24.93 ± 0.40 35.33 (476)
7	Mean ± SE CV	24.59 ± 0.95 47.93 (155)	25.70 ± 1.15 16.94 (48)	22.45 ± 0.61 31.41 (134)	23.90 ± 1.05 39.14 (80)	23.32 ± 0.53 39.12 (55)	24.00 ± 0.40 36.68 (473)

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8	Mean ± SE CV	22.88 ± 0.95 51.51 (155)	24.08 ± 1.12 17.28 (45)	20.76 ± 0.62 36.28 (132)	22.97 ± 1.05 40.56 (79)	23.19 ± 0.55 31.32 (52)	22.66 ± 0.41 38.93 (463)
9	Mean ± SE CV	21.29 ± 0.98 54.15 (137)	23.38 ± 1.10 18.91 (41)	20.11 ± 0.67 37.66 (123)	22.52 ± 1.06 40.31 (73)	21.81 ± 0.57 30.04 (50)	21.68 ± 0.43 40.82 (424)
10	Mean ± SE CV	19.77 ± 1.19 54.51 (82)	22.93 ± 0.77 26.42 (24)	18.89 ± 0.87 44.89 (95)	22.22 ± 1.14 36.00 (49)	21.20 ± 0.88 16.52 (33)	21.03 ± 0.53 42.75 (263)
Parity							
1	Mean ± SE CV	25.03 ± 0.41 31.72 (375)	30.49 ± 0.87 90.60 (114)	22.49 ± 0.69 70.90 (321)	26.02 ± 1.29 65.35 (195)	24.32 ± 1.93 30.28 (135)	24.88 ± 0.71 96.92 (1140)
2	Mean ± SE CV	25.02 ± 0.84 64.88 (367)	27.82 ± 1.24 31.24 (111)	22.98 ± 0.44 34.74 (267)	24.10 ± 0.99 57.26 (193)	24.64 ± 0.67 47.06 (138)	24.58 ± 0.31 42.12 (1133)
3	Mean ± SE CV	25.58 ± 0.87 64.62 (361)	26.76 ± 1.03 30.41 (114)	23.16 ± 0.55 43.00 (421)	25.03 ± 1.02 56.56 (192)	24.02 ± 0.65 41.11 (125)	25.18 ± 0.38 50.64 (1124)
4	Mean ± SE CV	25.90 ± 0.48 35.26 (362)	26.00 ± 0.88 93.76 (107)	21.97 ± 1.07 94.81 (379)	25.37 ± 1.38 73.80 (181)	23.93 ± 1.97 35.04 (130)	24.99 ± 0.70 92.94 (1101)
Period of calving 1 1971-1973	Mean ± SE CV	-	-	26.41 ± 0.46 40.70 (478)	-	-	26.17 ± 0.55 45.61 (478)
2 1974-1976	Mean ± SE CV	24.63 ± 0.74 81.37 (739)	27.41 ± 1.16 44.13 (168)	21.95 ± 0.57 63.00 (582)	25.02 ± 0.93 76.80 (425)	24.01 ± 0.57 54.94 (346)	24.18 ± 0.12 24.24 (2260)

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3 1977-1979	Mean ± SE CV	26.13 ± 0.75 77.58 (726)	28.13 ± 1.32 26.98 (278)	21.39 ± 0.40 28.66 (240)	25.24 ± 0.98 71.32 (336)	24.66 ± 0.50 70.03 (180)	24.36 ± 0.26 41.99 (1760)
Season of calving							
1 July-Sept.	Mean ± SE CV	24.66 ± 0.82 55.47 (279)	28.51 ± 1.03 21.45 (38)	22.17 ± 0.19 15.46 (233)	24.73 ± 0.95 50.90 (180)	23.25 ± 0.42 23.13 (143)	24.31 ± 0.30 36.85 (873)
2 Oct.-Dec.	Mean ± SE CV	27.36 ± 0.82 49.37 (270)	28.57 ± 1.30 16.03 (102)	22.73 ± 0.10 8.07 (267)	25.69 ± 1.03 39.21 (96)	23.76 ± 0.47 45.99 (66)	25.74 ± 0.30 32.50 (801)
3 Jan.-March	Mean ± SE CV	25.49 ± 0.70 65.60 (570)	27.13 ± 1.35 35.00 (215)	23.20 ± 0.53 41.32 (421)	25.05 ± 0.90 70.49 (381)	25.21 ± 0.62 73.16 (202)	25.11 ± 0.21 35.42 (1789)
4 April-June	Mean ± SE CV	24.02 ± 0.77 59.39 (346)	26.88 ± 1.28 17.99 (91)	22.50 ± 0.49 38.75 (379)	25.05 ± 1.01 41.20 (181)	25.12 ± 0.42 45.60 (130)	24.47 ± 0.28 36.22 (1035)

Figures in paranthesis indicate the number of observations.

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Table-10: Duncan's multiple range test for part-lactation dairy merit.

Effect	Arranged in descending order									
Genetic group	HS		HT		RC		BT		JT	
	———	———	———		———	———	———	———	———	
Lactation stage	L_2	L_3	L_4	L_5	L_1	L_6	L_7	L_8	L_9	L_{10}
	———	———								
		———	———							
			———	———	———					
				———	———	———				
						———	———	———	———	
									———	———
Parity	O_3		O_4		O_1		O_2			
	———	———	———	———	———	———	———			
Season	S_2		S_3		S_4		S_1			
	———	———	———							
			———	———	———					
					———	———	———			
Period	P_1		P_3		P_2					
			———	———	———					

Effects connected by line were not significantly different($P < 0.05$).

The part-lactation dairy merits connected by line were similar (Table-11).

Edwards (1936), Miller and Hooven (1969) and Daniel et. al.(1980) reported a steady decline in feed conversion efficiency with the advancement of lactation.

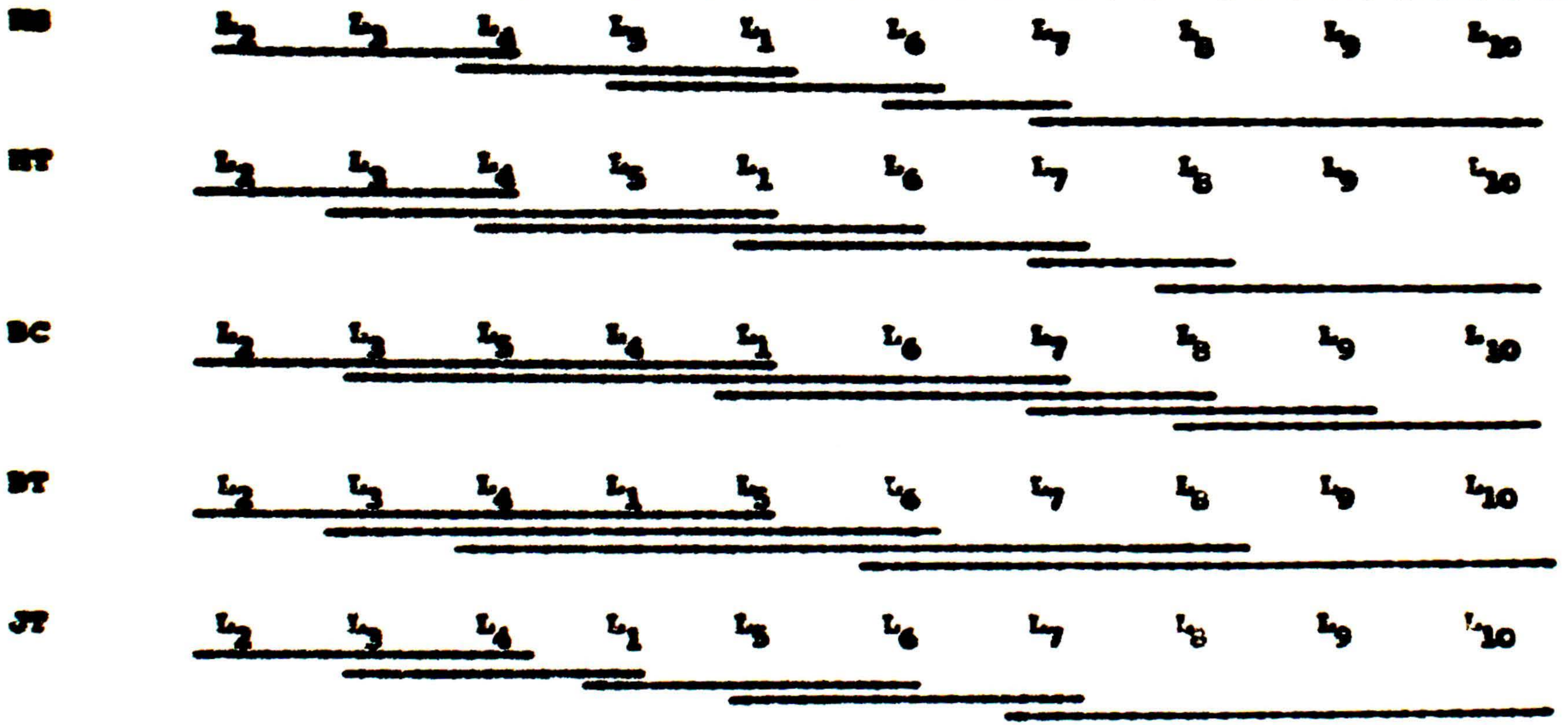
The part-lactation dairy merit during last stage of lactation (8th,9th and 10th part) was found to be significantly lower with higher co-efficient of variability in almost all the genetic groups(Table 9 and 11).

The function of body weight is an important measure of the performance of an animal. Changes from calving to end of lactation play significant rule on efficiency of feed utilization in different and the overall parity basis.

A steady decline in the dairy merit with the advancement of lactation is generally observed. Changes in body weight appeared to be related to the dairy merit.

Cows when properly looked after did not very greatly with the stage of lactation for dairy merit-the decline in dairy merit was not associated with any change in live weight. Records of monthly body weight in all the genetic groups under study indicated a fall in body weight from the first to second part after calving and then there was a small rise in body weight in subsequent parts(Table-12). Incidentally the dairy merit in the second part after calving, was the highest in all the genetic groups, indicating thereby, that the feed efficiency during an early part of lactation remained very high, as the

Table-11: Duncan's multiple range test for part-lactation dairy merit in different genetic groups.



Genetic group	Arranged in descanding order									
[illegible]	L_2	L_3	L_4	L_5	L_1	L_6	L_7	L_8	L_9	L_{10}
HT	L_2	L_3	L_4	L_5	L_1	L_6	L_7	L_8	L_9	L_{10}
DC	L_2	L_3	L_5	L_4	L_1	L_6	L_7	L_8	L_9	L_{10}
DT	L_2	L_3	L_4	L_1	L_5	L_6	L_7	L_8	L_9	L_{10}
JT	L_2	L_3	L_4	L_1	L_5	L_6	L_7	L_8	L_9	L_{10}

Part-lactation dairy merits connected by the line were not significantly different ($P < 0.05$).

Table-11: Body weight (kg) in different stages of lactation in different genetic groups.

Genetic group	Parity	Stage of lactation 1	2	3	4	5	6	7	8	9	10
HF (30)	1	328±5	331±5	330±3	335±4	337±4	342±4	343±4	349±4	358±5	375±6
	2	372±7	368±6	372±5	380±5	388±5	386±6	400±6	412±7	417±7	425±8
	3	412±6	403±5	408±6	410±6	424±6	423±6	434±6	440±6	454±6	461±8
	4	443±7	428±7	441±6	439±6	436±5	439±5	440±5	449±6	462±6	464±7
[illegible] ([illegible])	1	322±11	313±8	320±5	328±6	332±8	331±8	351±9	347±11	361±12	407±27
	2	387±9	380±11	386±12	368±11	372±10	389±11	387±12	400±10	400±11	409±8
	3	374±8	388±8	368±10	382±9	380±9	394±10	406±9	411±9	412±10	416±10
	4	404±11	393±9	396±9	394±7	376±13	411±9	424±9	435±8	434±9	447±12
BC (34)	1	329±6	320±5	318±5	324±5	327±6	326±4	325±4	335±5	338±5	342±5
	2	368±5	337±5	341±5	340±5	349±6	356±4	356±4	361±5	369±6	379±6
	3	378±8	360±7	365±6	371±7	367±7	371±7	370±7	375±8	373±8	384±8
	4	365±8	374±8	378±6	378±8	371±8	372±9	376±8	377±8	395±10	415±10

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JT (20)	1	301± 6	290± 6	300± 6	304± 7	296± 6	304± 4	298± 5	304± 5	314± 6	318± 6
	2	322± 8	301± 6	319± 6	332± 6	324± 6	329± 6	327± 7	338± 7	344± 8	345± 9
	3	364±10	355± 9	354± 8	357± 8	355± 6	358± 8	358± 7	362± 7	370± 8	379± 6
	4	366± 8	360± 6	362± 6	366± 7	368±20	370± 6	379± 8	388±11	388±20	393± 11
BT (18)	1	334±10	320± 8	329± 7	332± 7	330± 9	331±11	333± 9	337± 8	345±10	349± 9
	2	356±11	345± 8	343± 7	344±10	347± 9	353± 7	370±10	377± 8	380± 9	386± 10
	3	393±13	385±10	389± 9	380± 6	378± 7	385± 9	391±11	402±10	411±13	403± 15
	4	416±12	406±10	415±10	408± 9	410± 9	414± 9	423± 9	423± 9	423± 9	430± 10

Figures in parenthesis indicate number of observations.

feed energy was converted into milk energy rather than its conversion to body fat or there was possibility of catabolism of body fat reserves during the early part of lactation and with the advancement of lactation the metabolizable energetic efficiency decreased or the cows became less efficient in utilizing dietary nutrients for milk production with decline in their milk production. Also there was tendency among the cows to put on weight as the lactation advanced, which meant more percentage of energy consumed was diverted towards body fat reserves, while the milk production declined, this lead to decline in feed conversion efficiency.

Nielsen and Vesth (1970) observed that there was a positive correlation between weight of the cow after calving and their yield. At the later stages of the lactation period, weight yield correlation would usually be negative as there was negative correlation between the yield of the cows and their daily growth.

Rao <u>et al.</u>(1978) also observed significant interaction between stage of lactation and the genetic group meaning thereby, that each genetic group behaved differently in different stages of lactation. The decline in dairymerit might be associated with gradual reduction in the amounts of hormones responsible for the activity of the cells of the mammary gland and the lactation in general.

Parity:

The part-lactation dairy merit (%) was found to be lowest in second parity (24.10± 0.98) compared to first (26.02± 1.29), fourth (25.37± 1.38) and third (25.03± 1.02) parity in Jersey-

Tharparkar crossbreds whereas, no significant effect of parity on part-lactation dairy merit could be observed in any of the genetic groups under study.

The lowest part-lactation dairy merit amongst Jersey-Tharparkar cows during second parity might have been due to earlier calving at a lower body weight compared to other genetic groups. These animals being in the growing phase were apparently in great stress of production and the early pregnancy, which has resulted in lowering down the dairy merit of second parity in this genetic group, which can be ascertained from Table-5, giving the age and weight at calving & days in lactation in different genetic groups.

Period of calving:

The Brown Swiss-Sahiwal crossbred cows calving during 1971-73 had the higher dairy merit (26.41± 0.46) than those calving during 1974-76 (21.95± 0.37) and 1977-79 (21.39± 0.40). No significant effect amongst the cows within genetic group under study, calving during the period 1974-76 and 1977-79 could be observed for the part-lactation dairy merit(Table-13).

Season of calving:

The Holstein-Tharparkar cows calving during October-December had significantly higher dairy merit (27.36± 0.82) than those calving in January-March (25.49± 0.70), July-September (24.66± 0.82) and April-June (24.02± 0.77). No effect of season was observed in Holstein-Sahiwal, Brown Swiss-Sahiwal, Brown Swiss- Tharparkar and Jersey-Tharparkar cows (Table 9 and 13).

Table-13: Duncan's multiple range test for part-lactation dairy merit in different genetic groups.

Genetic group	Effect	Arranged in descending order
NT	Parity	$\underline{O_4 \quad O_3 \quad O_1 \quad O_2}$
	Period	$\underline{P_3 \quad P_2}$
	Season	$S_2 \quad \underline{S_3 \quad S_1} \quad S_4$ $\underline{}$
HS	Parity	$\underline{O_1 \quad O_2 \quad O_3 \quad O_4}$
	Period	$\underline{P_3 \quad P_2}$
	Season	$\underline{S_2 \quad S_1 \quad S_3 \quad S_4}$
BC	Parity	$\underline{O_3 \quad O_2 \quad O_1 \quad O_4}$
	Period	$P_1 \quad \underline{P_2 \quad P_3}$
	Season	$\underline{S_3 \quad S_2 \quad S_4 \quad S_1}$
JT	Parity	$\underline{O_1 \quad O_4 \quad O_3} \quad O_2$ $\underline{}$
	Period	$\underline{P_3 \quad P_2}$
	Season	$\underline{S_2 \quad S_3 \quad S_4 \quad S_1}$
BT	Parity	$\underline{O_1 \quad O_2 \quad O_3 \quad O_4}$
	Period	$\underline{P_3 \quad P_2}$
	Season	$\underline{S_3 \quad S_4 \quad S_2 \quad S_1}$

Effects connected by line were not significantly different ($P < 0.05$).

Table-14: Regression constants of dairy merits(%) on age at calving (months) and the lactation length (days).

Genetic group Regression	HF	MS	BC	JF	BT	Overall
			Lactation dairy merit			
Regression on age at calving	0.02120	0.08674	0.09155	-0.05184	0.16683	0.00846
Regression on lactation length	-0.00629	0.01607	0.00105	-0.00036	0.00540	0.00201
			Part-lactation dairy merit			
Regression on age at calving	-0.03846	0.13091	0.05615	-0.02207	0.02273	-0.02312
Regression on lactation length	-0.00003	0.02523**	0.00660	0.00529	0.00562	0.00147

** Significant at 1% level.

Since changes in body weight have been taken care of while calculating dairy merit the differences due to seasons have been minimised to a greater extent because of its confounding effects.

Regression:

Regression of part-lactation dairy merit on lactation length has found significant only in Holstein-Sahival, with the regression constant being 0.02523 (Table-14). This meant that for one day increase in lactation length over 308 ± 8 days, the part-lactation dairy merit would increase by 0.025 percent. While in other crosses both regression of part-lactation dairy merit on lactation length and age at calving were non-significant.

PHENOTYPIC CORRELATION:

Correlation of part-lactation dairy merit with lactation dairy merit:

Significant correlation in the overall genetic group was observed for all the part-lactation dairy merits with lactation dairy merit(Table 15 to 19). Highly significant (P 0.01) correlation of part-lactation dairy merit with lactation dairy merit was observed in Brown Swiss crosses and Jersey crosses, while in Holstein crosses this was found upto 9th part-lactation dairy merit, and for 10th part-lactation dairymerit it was significantly correlated (P 0.05). Values of correlation co-efficient ranged from 0.2250 to 0.7504 in Holstein-Tharparkar, 0.4803 to 0.8018 in Holstein-Sahival, 0.3691 to 0.6151 in Brown Swiss-Sahival, 0.2944 to 0.5935 in Jersey-Tharparkar and 0.3352 to 0.5293 in Brown Swiss-Tharparkar crosses.

Since changes in body weight have been taken care of while calculating dairy merit the differences due to seasons have been minimised to a greater extent because of its confounding effects.

Regression:

Regression of part-lactation dairy merit on lactation length has found significant only in Holstein-Sahiwal, with the regression constant being 0.02523 (Table-14). This meant that for one day increase in lactation length over 308 ± 8 days, the part-lactation dairy merit would increase by 0.025 percent. While in other crosses both regression of part-lactation dairy merit on lactation length and age at calving were non-significant.

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Table-15: Correlation amongst part-lactation dairy merit and with lactation dairy merit in Holstein-Tharparkar crossbred cows.

Part-lactation	Part-lactation										Lactation dairy merit.
	Ist	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	
Ist		0.5958** ± 0.0647 (156)	0.4993** ± 0.0701 (156)	0.4174** ± 0.0733 (156)	0.2553** ± 0.0780 (156)	0.2013* ± 0.0789 (156)	0.1552 ± 0.0773 (155)	0.3014** ± 0.0773 (154)	0.0922 ± 0.0857 (137)	-0.0005 ± 0.1125 (81)	0.5416** ± 0.0677 (156)
2nd			0.7679** ± 0.0516 (156)	0.6548** ± 0.0609 (156)	0.5414** ± 0.0678 (156)	0.4300** ± 0.0728 (156)	0.3788** ± 0.0748 (155)	0.3181** ± 0.0769 (154)	0.2560** ± 0.0832 (137)	-0.0006 ± 0.1125 (81)	0.7347** ± 0.0547 (156)
3rd				0.7606** ± 0.0523 (156)	0.6708** ± 0.0598 (156)	0.5492** ± 0.0673 (156)	0.3732** ± 0.0750 (155)	0.3186** ± 0.0769 (154)	0.2837** ± 0.0827 (137)	0.0685 ± 0.1122 (81)	0.7504** ± 0.0533 (156)
4th					0.7510** ± 0.0532 (156)	0.5968** ± 0.0647 (156)	0.4837** ± 0.0707 (155)	0.3378** ± 0.0763 (154)	0.2756** ± 0.0827 (137)	0.0780 ± 0.1122 (81)	0.7091** ± 0.0568 (156)
5th						0.6951** ± 0.0579 (156)	0.5354** ± 0.0683 (155)	0.4842** ± 0.0710 (154)	0.2819** ± 0.0826 (137)	0.1554 ± 0.1106 (81)	0.6641** ± 0.0602 (156)
6th							0.7291** ± 0.0553 (155)	0.4637** ± 0.0719 (154)	0.3206** ± 0.0815 (137)	0.1882 ± 0.1105 (81)	0.6385** ± 0.0620 (156)
7th								0.6572** ± 0.0611 (154)	0.5191** ± 0.0736 (137)	0.1925 ± 0.1104 (81)	0.6218** ± 0.0635 (155)
8th									0.7086** ± 0.0607 (137)	0.3254** ± 0.1064 (81)	0.6054** ± 0.0646 (154)
9th										0.4105** ± 0.1026 (81)	0.4065** ± 0.0776 (137)
10th											0.2250* ± 0.1096 (81)

* Significant at 5% level. ** Significant at 1% level.

Figures in paranthesis indicates number of observations.

Table-16: Correlation amongst part-lactation dairy merit and with lactation dairy merit in Holstein-Sahiwal, crossbred cows.

Part-lactation	Ist	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	Lactation dairy merit.
Ist		0.6979** ± 0.1056 (48)	0.4979** ± 0.1279 (48)	0.3614** ± 0.1375 (48)	0.3266* ± 0.1394 (48)	0.2259 ± 0.1436 (48)	0.1147 ± 0.1465 (48)	0.0156 ± 0.1525 (45)	0.0968 ± 0.1594 (41)	0.2976 ±0.2083 (23)	0.6051** ± 0.1174 (48)
2nd			0.5866** ± 0.1194 (48)	0.4492** ± 0.1317 (48)	0.4747** ± 0.1298 (48)	0.3818** ± 0.1363 (48)	0.2583 ± 0.1424 (48)	0.2186 ± 0.1488 (45)	0.2560 ± 0.1548 (41)	0.1318 ± 0.2163 (23)	0.7149** ± 0.1031 (48)
3rd				0.6888** ± 0.1069 (48)	0.5493** ± 0.1232 (48)	0.4427** ± 0.1322 (48)	0.2830* ± 0.1450 (48)	0.3008* ± 0.1454 (45)	0.3906* ± 0.1474 (41)	0.2127 ± 0.2132 (23)	0.7207** ± 0.1022 (48)
4th					0.6261** ± 0.1150 (48)	0.3944** ± 0.1355 (48)	0.2808* ± 0.1415 (48)	0.2713 ± 0.1468 (45)	0.3189* ± 0.1578 (41)	-0.0278 ± 0.2181 (23)	0.7177** ± 0.1027 (48)
5th						0.7202** ± 0.1023 (46)	0.6216** ± 0.1155 (48)	0.4857** ± 0.1333 (45)	0.4015** ± 0.1467 (41)	0.1574 ± 0.2181 (23)	0.8018** ± 0.0881 (48)
6th							0.7246** ± 0.1016 (48)	0.6515** ± 0.1157 (45)	0.5228** ± 0.1365 (41)	0.6943** ± 0.1570 (23)	0.7319** ± 0.1005 (46)
7th								0.7900** ± 0.0935 (45)	0.6048** ± 0.1275 (41)	0.4526* ± 0.1946 (23)	0.5806** ± 0.1200 (48)
8th									0.7984** ± 0.0964 (41)	0.4980** ± 0.1892 (23)	0.5270** ± 0.1296 (45)
9th										0.7210** ± 0.1512 (23)	0.5200** ± 0.1368 (41)
10th											0.4803* ± 0.1914 (23)

* Significant at 5% level. ** Significant at 1% level.

Figures in paranthesis indicate number of observations.

Table-17: Correlation amongst part-lactation dairy merit and with lactation dairy merit in Brown Swiss-Sahiwal crossbred cows.

part-lactation	Part-lactation										Lactation dairy merit.
	Ist	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	
Ist		0.6239** ± 0.0675 (136)	0.1599 ± 0.0853 (136)	0.0812 ± 0.0861 (136)	0.1000 ± 0.0860 (136)	0.0007 ± 0.0864 (136)	0.0448 ± 0.0866 (135)	-0.2083 ± 0.0853 (132)	-0.1170 ± 0.0899 (124)	0.0735 ± 0.1034 (95)	0.3858** ±0.0797 (136)
2nd			0.3569** ± 0.0807 (136)	0.3403** ± 0.0812 (136)	0.1802 ± 0.[illegible] (136)	0.0314 ± 0.0863 (136)	0.0541 ± 0.0866 (135)	-0.0048 ± 0.0877 (132)	0.0090 ± 0.0905 (124)	0.1636 ± 0.1023 (95)	0.5000** ±0.0748 (136)
3rd				0.4565** ± 0.0769 (136)	0.1922 ± 0.[illegible] (136)	0.3190 ± 0.0863 (136)	0.0780 ± 0.0864 (135)	-0.0089 ± 0.0877 (132)	0.0247 ± 0.0905 (124)	0.0205 ± 0.1037 (95)	0.3863** ±0.0797 (136)
4th					0.4418** ± 0.0775 (136)	0.3282** ± 0.0816 (136)	0.0688 ± 0.0865 (135)	0.1797 ± 0.0863 (132)	0.1675 ± 0.0893 (124)	0.1623 ± 0.1023 (95)	0.6023** ±0.0690 (136)
5th						0.5973** ± 0.0693 (136)	0.4917** ± 0.0760 (135)	0.4087** ± 0.0800 (132)	0.2165* ± 0.0884 (124)	0.1969* ± 0.1017 (95)	0.6081** ±0.0686 (136)
6th							0.5772** ± 0.0708 (135)	0.4102** ± 0.0800 (132)	0.3356** ± 0.0853 (124)	0.3480** ± 0.0972 (95)	0.6151** ±0.0681 (136)
7th								0.5544** ± 0.0730 (132)	0.3148** ± 0.0859 (124)	0.2313* ± 0.1009 (95)	0.5041** ±0.0749 (135)
8th									0.6141** ± 0.0714 (124)	0.3821** ± 0.0958 (95,	0.5034** ±0.0758 (132)
9th										0.4995** ± 0.0898 (95)	0.3691** ±0.0841 (124)
10th											0.5328** ± 0.0878 (95)

* Significant at 5% level. ** Significant at 1% level.

Figures in paranthesis indicate number of observations.

Table-18 : Correlation amongst part-lactation dairy merit and with lactation dairy merit in Jersey-Tharparker crossbred cows.

Part-lactation	Part-lactation										Lactation dairy merit
	Ist	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	
Ist		0.5548** ± 0.0949 (80)	0.2087 ± 0.1108 (80)	0.2366* ± 0.1100 (80)	0.0676 ± 0.1130 (80)	0.0109 ± 0.1132 (80)	0.0429 ± 0.1131 (80)	0.0502 ± 0.1146 (78)	0.1121 ± 0.1223 (68)	0.1393 ± 0.1476 (47)	0.4622** ± 0.1004 (80)
2nd			0.4643** ± 0.1003 (80)	0.2649* ± 0.1092 (80)	0.0925 ± 0.1127 (80)	0.0955 ± 0.1127 (80)	0.0318 ± 0.1132 (80)	-0.0022 ± 0.1147 (78)	0.2323* ± 0.1197 (68)	0.2685 ± 0.1436 (47)	0.5935** ± 0.0911 (80)
3rd				0.5155** ± 0.0970 (80)	0.3224** ± 0.1071 (80)	0.3833** ± 0.1046 (80)	0.3074** ± 0.1077 (80)	0.0519 ± 0.1146 (78)	0.1336 ± 0.1220 (68)	0.5708** ± 0.1224 (47)	0.5063** ± 0.0976 (80)
4th					0.5763** ± 0.0925 (80)	0.3726** ± 0.1051 (80)	0.3745** ± 0.1050 (80)	0.2553* ± 0.1109 (78)	0.2149 ± 0.1202 (68)	0.1603 ± 0.1471 (47)	0.5191** ± 0.0968 (80)
5th						0.5097** ± 0.0974 (80)	0.4038** ± 0.1036 (80)	0.3442** ± 0.1077 (78)	0.2176* ± 0.1202 (68)	0.0456 ± 0.1489 (47)	0.3948** ± 0.1040 (80)
6th							0.5049** ± 0.0977 (80)	0.3313** ± 0.1082 (78)	0.2582* ± 0.1189 (68)	0.2145 ± 0.1330 (47)	0.3809** ± 0.1047 (80)
7th								0.5468** ± 0.0962 (78)	0.3471** ± 0.1154 (68)	0.2886* ± 0.1427 (47)	0.3695** ± 0.1052 (80)
8th									0.6834** ± 0.0899 (66)	0.4515** ± 0.1330 (47)	0.2944** ± 0.1096 (78)
9th										0.6933** ± 0.1074 (47)	0.3935** ± 0.1132 (68)
10th											0.5344** ± 0.1260 (47)

* Significant at 5% level. ** Significant at 1% level.

Figures paranthesis indicate the number of observations.

Table-19: Correlation amongst part-lactation dairy merit and with lactation dairy merit in Brown Swiss-Tharparkar crossbred cows.

Part-lactation	Part-lactation										Lactation dairy merit.
	Ist	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	
Ist		0.4893** ± 0.1187 (56)	0.3014* ± 0.1298 (56)	0.2705* ± 0.1310 (56)	0.0180 ± 0.1361 (56)	0.1204 ± 0.1351 (56)	0.1256 ± 0.1350 (56)	0.1615 ± 0.1356 (55)	0.0357 ± 0.1399 (53)	0.0296 ± 0.1690 (37)	0.3639** ± 0.1268 (56)
2nd			0.3789** ± 0.1259 (56)	0.4318** ± 0.1227 (56)	0.1819 ± 0.1338 (56)	0.1178 ± 0.1351 (56)	0.0989 ± 0.1354 (56)	0.0278 ± 0.1373 (55)	-0.0336 ± 0.1399 (53)	-0.0210 ± 0.1690 (37)	0.4109** ± 0.1241 (56)
3rd				0.5141** ± 0.1167 (56)	0.4374** ± 0.1224 (56)	0.2414 ± 0.1321 (56)	0.1569 ± 0.1344 (56)	0.2374 ± 0.1334 (55)	0.2650 ± 0.1350 (53)	-0.0900 ± 0.1683 (37)	0.3252** ± 0.1287 (56)
4th					0.5933** ± 0.1095 (56)	0.3605** ± 0.1269 (56)	0.1080 ± 0.1353 (56)	0.1577 ± 0.1357 (55)	0.1111 ± 0.1392 (53)	0.0914 ± 0.1683 (37)	0.4189** ± 0.1236 (56)
5th						0.6280** ± 0.1059 (56)	0.4250** ± 0.1232 (56)	0.3618* ± 0.1281 (55)	0.2069 ± 0.1370 (53)	- 0.0428 ± 0.1689 (37)	0.4165** ± 0.1237 (56)
6th							0.4995** ± 0.1179 (56)	0.2374 ± 0.1334 (55)	0.3774** ± 0.1297 (53)	0.1431 ± 0.1673 (37)	0.3774** ± 0.1260 (56)
7th								0.5446** ± 0.1152 (55)	0.5170** ± 0.1199 (53)	0.3558* ± 0.1580 (37)	0.4656** ± 0.1204 (56)
8th									0.5822** ± 0.1138 (53)	0.4381** ± 0.1519 (37)	0.5293** ± 0.1165 (55)
9th										0.5076** ± 0.1456 (37)	0.4385** ± 0.1258 (53)
10th											0.4190** ± 0.1535 (37)

* Significant at 5% level. ** Significant at 1% level.

Figures in paranthesis indicate number of observations.

Higher correlation of part-lactation dairy merit with lactation dairy merit was found at third part (0.7504) in Holstein-Tharparkar, fifth part (0.8018) in Holstein-Sahiwal, sixth part (0.6151) in Brown Swiss-Sahiwa, second part (0.5935) in Jersey-Tharparkar and eighth part (0.5293) in Brown Swiss-Tharparkar, thus indicating that these part-lactation dairy merit values could be used to predict lactation dairy merit in these crosses.

Range of higher correlation co-efficient was observed from 2nd to 4th part (0.7091 to 0.7504), 3rd to 6th part (0.7177 to 0.8018), 4th to 6th part (0.6023 to 0.6151), 2nd to 4th part (0.5063 to 0.5935) and 7th to 8th part (0.4385 to 0.5293) in Holstein-Tharparkar, Holstein-Sahiwal, Brown Swiss-Sahiwal, Jersey-Tharparkar and Brown Swiss-Tharparkar respectively. This indicated that lactation dairy merit can be predicted more correctly from part-lactation dairy merit of 3rd to 5th part.

The co-efficient of determination is preferred in presenting the results of correlation analysis before coming to any conclusion about the extent of linear relationship between the two correlated variables. The square of correlations of part-lactation dairy merit with lactation dairymerit showed the variability in lactation dairy merit due to a given part-lactation dairy merit in different genetic groups under study. In Holstein-crosses, the co-efficient of determination was very high during middle part of lactation indicating thereby that about 52-56% of variation in lactation dairy merit was due to third/fourth part-lactation dairy merit, whereas in Brown Swiss, Jersey crosses variation in lactation dairy merit due to variation in part-lactation dairy merit was not so large.

Correlation amongst part-lactation dairy merits:

Highly significant correlation with subsequent part-lactation dairy merit was observed in all the genetic groups under study, thus indicating that dairy merit of a part can be predicted from the dairy merit of previous part. As the distance of the part-lactation dairy merit increased from one another the correlation tended to decrease so much so that the correlation amongst them became zero(Table 14 to 19).

Range of correlation co-efficiant of one part-lactation dairy merit with other was observed to be -0.0005 to 0.7679 (Holstein-Tharparkar), -0.0278 to 0.7984 (Holstein-Sahiwal), -0.0089 to 0.6239 (Brown Swiss-Sahiwal), -0.0022 to 0.6933(Jersey-Tharparkar) and -0.0210 to 0.6280(Brown Swiss-Tharparkar).

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CHAPTER-V

SUMMARY

SUMMARY

First four lactation records of 119 first generation crossbred (39 Holstein-Tharparkar, 12 Holstein Sahiwal, 34 Brown Swiss-Sahiwal, 20 Jersey-Tharparkar, and 14 Brown Swiss-Tharparkar) cows along with their monthly milk production, monthly fat percentage and monthly body weight constituted the material for calculating lactation and part-lactation dairy merit. These animals completed all their four lactations during the period 1971-79. The age at calving (months) and days in lactation of each animal were also recorded.

The years were grouped into three periods of three years each viz., 1971-73, 1974-76 and 1977-79. Each year was divided into four seasons viz., July-September, October-December, January-March and April-June. The lactation was partitioned into ten parts, each of 30 days.

Highly significant differences among five genetic groups were observed for both lactation dairy merit and the part-lactation

dairy merit. On testing means no significant difference for lactation dairy merit was observed between Holstein-Tharparkar (28.82 ± 0.25) and Holstein-Sahiwal (28.76 ± 0.53) and also amongst Brown Swiss-Sahiwal (26.59 ± 0.14), Jersey-Tharparkar (26.20 ± 0.33) and Brown Swiss-Tharparkar (26.01 ± 0.40).

Part-lactation dairy merit remained highest in second part of the lactation in all the five genetic groups. Part-lactation dairy merit declined gradually with the advancement of the stage of lactation and did not differ significantly till the animal completed her fourth/fifth part of lactation. The part-lactation dairy merit during the last stage of lactation (8th, 9th and 10th part) was significantly lower in all the genetic groups.

No significant effect of parity on lactation dairy merit could be observed in any of the genetic groups. No significant effect of parity on part-lactation dairy merit, except in Jersey-Tharparkar, was observed. The part-lactation dairy merit in second parity was significantly lower which was due to having more stress of production during growing phase and early pregnancy.

Season and period of calving had no significant effect on lactation and part-lactation dairy merits, except season of calving in Holstein-Tharparkar and period of calving in Brown Swiss-Sahiwal crossbred cows. Holstein-Tharparkar cows calving during October-December had significantly higher dairy merits. Brown Swiss-Sahiwal cows calving during 1971-73 had higher dairy merits compared to other two periods, 1974-76 and 1977-79.

Regression of lactation dairy merit on age at calving and days in lactation was not significant in all the genetic groups. While regression of part-lactation dairy merit on lactation length was significant (b=0.02523) only in Holstein-Sahiwal. In other crosses both the regression of part-lactation dairy merit on age at calving and age at calving were non-significant.

Significant correlation of all the parts-lactation dairy merit with lactation dairy merit was observed. Lactation dairy merit can be evaluated more correctly from third to fifth parts-lactation dairy merit. Correlation of part-lactation dairy merit with following part-lactation dairy merit was highly significant.

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