II. REVIEW OF LITERATURE

A. NON-GENETIC FACTORS INFLUENCING MILK PRODUCTION

Milk production in a herd of buffaloes, as many other productive traits, is greatly influenced by many well-identified environmental factors. A group of these factors express the features of the environment to which the animals are subjected, *e.g.* year and seasonal differences in climatic conditions, vegetation and management. Another group of these factors arises from changes in the physiological activities that occur in the body of the animals, *e.g.* age at first calving, age at calving, parity and length of service period, dry period and calving interval. These two groups of environmental factors are usually referred to as external and internal environmental factors, respectively. Environmental factors, in general, mask the actual genetic merit of the animal and obscure the genetic differences between individuals in a particular herd or even between different herds of the same species. Also, they may modify the magnitude of different components of variance. Accordingly, the evaluation of the size of the effects of these factors is of special importance for the animal breeder in planning and achieving genetic improvement of his animals.

The relative importance of the environmental factors that affect milk production from buffaloes was the object of different investigators. In the present study, milk production is presented in terms of milk yield and length of lactation period. It was not intended, in this context, to make full citation for all the known non-genetic factors influencing these two aspects. Only effects of year of calving, month and season of calving, age at first calving, age at calving and parity were reviewed. This is because they were supposed to be the major factors that influence milk production records used in this work.

1. Milk Yield

<u>Year of calving</u>:

Effects of year of calving on milk yield from buffaloes were studied in different regions of the world. In Egypt, year of calving was found by many investigators to be one of the important environmental factors that affect milk yield in buffaloes. El-Kimary (1966) found that year differences in milk yield was pronounced. Alim (1967) working on 2738 lactation records, reported that effects of year of calving on milk yield were significant and accounted for 6.19% of the total variance. Ragab, Abdel-Aziz and Fahmy (1970) showed that year of calving was a highly significant source of variation in milk yield. Soliman (1976) with data comprising 2874 lactation records came to the same findings when considering either monthly, initial (first 2-month) or total milk yield. Also, Mourad (1978) using records of three herds of buffaloes, found that year of calving exerted highly significant ($P < 0.01$) effects on both initial (first 70-day) and total milk yield, it accounted for 11.8 and 9.4% of the total variance of the two traits, respectively. In line with these findings, significant effects for the year of calving on 305-day and total milk yield were observed by Abdel-Aziz and Abdel-Ghany (1978) and Abdel-Aziz and Hamed (1979). Alim (1978) indicated that year of calving affected milk yield significantly

($P < 0.01$) and was responsible for 10.6% of its total variance. Results of Ashmawy (1981) on four herds raised at different locations showed that the effect of periods of year of calving constituted a highly significant ($P < 0.01$) source of variation in initial (first 60-day), 305-day and total milk yield and that it was responsible for 7.9, 5.3 and 4.4% of the total variance of the three traits, respectively. Similarly, El-Irian (1981) with milk production records of three herds reported highly significant influence for year of calving on 305-day milk yield of the first lactation. The same author observed that year-of-calving effects were highly significant on monthly milk yield of the first lactation up to the 7th month, but non-significant on milk yield of the 8th month. He added that the contribution of year of calving to the total variance of monthly milk yield ranged from 24.2 to 86.5%. El-Chafie (1981) with two herds noticed that 100-, 200- and 300-day partial milk yield varied significantly with year of calving.

On the other hand, Mokhtar (1971) with a herd of Egyptian buffaloes reported that year of calving showed non-significant effects on milk yield of the first lactation produced by daughters of his experimental animals.

Year of calving effects on milk yield of Indian buffaloes were reported by different research workers. Singh and Dhillon (1975) found that year-of-calving effects on milk yield of the first lactation was highly significant. Also, Kanaujia and Balaine (1975), Baus and Chai (1978a), Bhat and Patro (1978) and Kumar and Bhat (1978b) observed that differences in milk yield due to year of calving periods were highly significant.

Studies of Ashfaq and Mason (1954) on Pakistani buffaloes and those of Dassat, Depaolis and Sartore (1966) on Italian buffaloes claimed little effects for year of calving on milk yield produced by these buffaloes.

Month and Season of Calving:

Effects of month and season of calving on milk produced by buffaloes of Egypt, India, Pakistan and Italy were reported by different investigators.

For buffaloes of Egypt, results of Sidky (1952) and Ragab, Asker and Ghazy (1954) showed that autumn and winter calvers produced more milk than summer and spring calvers. Similarly, Ragab and Sourour (1963) reported that buffaloes calved during the months from September to February (i.e. during autumn and winter) were the best producers for milk yield. In this respect, results of Kamal (1956), Khishin, Issawy and Afifi (1968) and Soliman (1976) indicated that winter calvers scored higher average milk yield than summer ones. However, Abdel-Aziz and Hamed (1979) found that autumn calvers (September-November) produced the lowest milk compared with those calving in the other seasons of the year. In this respect, Khishin et al. (1968), Soliman (1976) observed that buffaloes calved in spring produced the highest milk yield when compared with those calved at the other three seasons of the year. The same findings were obtained by Ashmawy (1981) who found that for both 305-day and total lactation production, buffaloes calved in spring had the highest milk yield while autumn calvers produced the lowest milk yield. However, Zaher (1944) observed that summer calving was favourable for milk yield than winter calving. El-Tawil, Mokhtar, Galal and Khishin (1976) found that summer (March-August) calvers produced more milk in the two lactations they studied than winter (September-February) calvers. In consistent with these findings, Mourad (1978) indicated that buffaloes calving during spring (March-May) and summer (June-August) gave higher milk production than those calving during autumn (September-November) and winter (December-February) for the total lactation yield. Similarly, results of Khishin et al. (1968) revealed that total lactation milk yield of buffaloes calved during months from March to August (i.e. during spring and summer) was higher than that of buffaloes calved during months from September to February (i.e. during autumn and winter). El-Irian (1981) reported that buffaloes calving during winter produced significant more milk yield per lactation than those calving during summer and autumn. Average total milk yield of buffaloes calving in winter and spring was higher than that of those calving during summer and autumn. Salem (1983) observed that summer and spring calvers produced higher total milk yield than that of those calving during winter and autumn. But he found that buffaloes calving during summer and autumn produced more 305-day milk yield than that calving during spring and winter. The differences between seasons were non significant.

Seasonal differences in milk yield of Egyptian buffaloes were attributed to differences in the availability of green fodder, weather conditions especially atmospheric temperature and manegerial systems (Ragab et al., 1954; Mokhtar, 1971; and Ashmway, 1981). Kamal (1956) stated that the high atmospheric temperature causes a reduction in milk yield. Afifi (1961) stated that high milk production shown for winter and spring calvers of his study may be attributed to suitable factors to which the animals were subjected during lactation such as plenty of Egyptian clover, mild weather and unfavourable conditions for diseases and parasites. El-Tawil et al. (1976) indicated that differences in dry matter content of the Egyptian clover between early and late cuts was of prime importance in the effect of season of calving on milk yield.

For buffaloes of India, Venkayya and Ananta-krishnan (1957) noticed that summer calvers were slightly superior in milk production than those calved in winter and rainy seasons. Sankunny (1964) reported that Murrah buffaloes which calved in March and July gave the highest yields of milk compared with those calved in October-February. Goswami and Nair (1965) found that buffaloes calving during summer (February-May) yielded significantly more milk than winter (October-January) calvers in two farms and significantly yielded more milk than those calved in rainy season (June-September) in a third farm. They added that calvers in rainy season were in general low milk yielders. Findings of Singh (1966) gave evidence that milk of the first lactation averaged the highest for buffaloes calved in summer and that it was higher for those calved in winter season than for those calved in monsoon season. Singh and Dhillon (1975) with same breeds of Indian buffaloes and their grades observed that females calved during January to April produced significantly more milk than those calved during August to December.

For buffaloes of Pakistan, Ashfaq and Mason (1954) proved that milk yield was higher for lactations started in winter than for those started in summer (April-October). They added that the differences in milk yield of winter and summer calvers were associated with the comparative efficiency of buffaloes in controling their body temperature. They suggested that in hot weather, daily wallowing or spraying with water is essential to keep good milk production. For Italian buffaloes, Roy Choudhury and Deshmukh (1975) found that buffaloes calving from September to March yielded significantly more milk than those calving from April to August.

When considering initial milk yield, Asker, El-Itriby and Fahmy (1962) found that buffaloes calved during autumn produced the highest initial milk yield when compared with those calved during the other three seasons. On the other hand, Soliman (1976) and Mourad (1978) reported that buffaloes calving during autumn had the lowest amount of initial milk yield. The same authors showed that the highest initial milk yield was recorded by winter calvers and that spring calvers excelled summer ones in this respect. In agreement with findings of Soliman (1976) and Mourad (1978), Ashmawy (1981) found that buffaloes calving in months of autumn had, on the average, lower initial milk yield than those calving during the other three seasons while the highest initial milk yield was obtained from buffaloes calving in winter. Results of the same author showed that initial milk yield of winter and spring calvers was more than that of summer and autumn calvers. Also, Salem (1983) observed that winter calvers produced the highest initial (first 90-day) milk yield as compared with those calved in the other three seasons of the year. In this respect, Ragab et al. (1973) showed that buffaloes calved in autumn and winter started their lactation at a higher level of milk production than those calved in spring and summer. El-Chafie (1981) with two Egyptian herds of buffaloes, found that summer (March to August), calvers had higher 100-,200- and 300-day partial milk production than those calving during winter (Sept. - Feb.) season. However, El-Irian (1981) indicated that buffaloes calved during summer (July - September) and spring (April - June) produced higher partial (first 60-day) milk yield than those calved during autumn (October - December) and winter (January - March). The same author, observed that autumn calvers produced the lowest partial milk yield.

Effect of season of calving on initial milk yield was attributed by Ashmawy (1981) mainly to type and amount of feed available and to varia - tion in the environmental temperature and humidity during the different seasons of calving. The same author interpretted the higher initial milk yield of winter and spring calvers than that of summer and autumn calvers to be due to that Barseem (Trifolium alexandrium) which constitutes the major source of nutrients to lactating animals is abundant during months of December through May, while during autumn and summer lactating buffaloes depend mainly on concentrates. This coupled with weather conditions permitted animals to consume larger amounts of feed during winter and spring while intake during summer and autumn was limited.

For the Egyptian buffaloes, Sidky (1952), Hilmy (1954), Ragab et al. (1954) and Alim (1954) observed that month of calving did not show any significant effect on milk yield. Asker and El-Itriby (1958) reported that the effect of month of calving on milk yield was negligible. This is in agreement with findings of Sidky (1952), Hilmy (1954), Ragab et al. (1954) which proved that month of calving was a minor source of variation in milk yield. It was found to be responsible for 1.7, 3.1 and 0.12 of the total variance by the three authors, respectively. Sourour (1962) studied the effect of month and season of calving on partial milk yield for the first eight months and found no significant effects. The same results were reported for the effect of month and/or season of calving on total milk yield by Alim (1967), Khishin et al. (1968), Shalash, Rakha and El-Dessouky (1968), El-Tawil et al. (1976), Abdel-Aziz and Abdel-Ghany (1978) and Alim (1978). El-Irian (1981) indicated that the effect of season of calving on monthly, cumulative monthly and 305-day milk yield of the first lactation were not significant. Similarly, season of calving was found to have no significant effect on 305-

day and total milk yield by Salem (1983). On the other hand, Ragab, Abdel-Aziz and Kamal (1973) observed that season of calving had highly significant effects on monthly milk yield up to the 13th month of lactation but it accounted for small percentage of the total variance (ranged from 0.47 to 1.26%). Also, Soliman (1976) reported highly significant effects on monthly milk yield up to 12th months. Similarly, significant influence of month of calving on milk yield was found by Shalash *et al*. (1968). Also, El-Kimary (1966), Soliman (1976), Mourad (1978), Abdel-Aziz and Hamed (1979) and Ashmawy (1981) observed that season of calving exerted highly significant effects on milk yield, but accounted only from 0.2 to 1.6% of the total variance. El-Irian (1981) indicated highly significant effects for season of calving on total milk yield from the 2nd to the 8th lactation ($P < 0.01$).

The non-significant effects of month or season of calving on milk yield and their little contribution to its total variance, that were observed in most of the reports on Egyptian buffaloes, may be attributed to the mild weather that prevails during most months of the year and the reasonable standard of feeding under which the animals are maintained all over the year (Asker et al., 1958) or due to the fact that all herds studied were either commercial or experimental which are well fed or kept under favourable conditions (Khishin et al., 1968).

Bhatnagar, Lohia and Monga (1961), Arora, Batpai and Muley (1962) and Sharma and Singh (1974) with Murrah buffaloes observed no significant effects for month of calving on milk yield. Dassat et al. (1966) with Italian buffaloes reported that the effect of month of calving on milk yield was so low that it did not reach significance. Similarly, Venkayya and Anantakrishnan (1957) with Murrah buffaloes found no significant effects for both month and season of calving on milk yield. Vankataratnan and Venkayya (1964), Singh and Singh (1967), Gopalan, Malhotra and Mehrotra (1971), Raizada, Singh and Tiwari (1971), Kanaujia and Balaine (1975), Basu and

Chai (1978a) and Kumar and Bhat (1978b) with Murrah and other Indian buffaloes came to the same findings for the effect of season of calving on milk yield. They failed to find any significant effect in this respect. On the other hand, like Egyptian buffaloes, few reports showed significant effects of either month or season of calving on milk yield of Indian and Italian buffaloes. Effects of month of calving on milk yield of Murrah buffaloes were shown to be significant by Sankunny (1964). The same observation was also reported for the effect of month of calving on the first lactation yield of different breeds of Indian buffaloes and their grades by Singh and Dhillon (1975). Similarly, Ashfaq and Mason (1954) found that influences of month and season of calving on milk yield of Pakistani buffaloes were significant. Also, Goswami and Nair (1965) and Roy Chaudhury (1970) reported significant seasonal effects on milk yield of Murrah and Italian buffaloes, respectively. Roy Chaudhury and Deshmukh (1975) obtained similar significant effects for the effect of both month and season of calving on milk yield of Italian buffaloes.

Age at first calving:

Age at first calving was found to be one of the important sources of variation in milk yield produced by buffaloes raised at different areas.

Khishin *et al*. (1968) classified milk production records of different lactations in a hërd of Egyptian buffaloes according to age at first calving into five classes of three months interval. They found that buffaloes calved for the first time at 35-37 months of age gave the highest total milk yield than those of classes of either earlier (less than 35 months) or later ages (38-40, 41-43 and over 43 months). Results of those authors revealed a general trend indicating that total milk yield increased with advance of age at first calving up to 35-37 months and declined thereafter. Mokhtar (1971) in another herd of Egyptian buffaloes reported a similar trend (a trend of curve-linearity effect) for the effect of age at first calving on 305-day milk yield of the first lactation, but buffaloes that gave the highest yield calved for the first time at older ages. He found that 305-day milk yield increased with advance of age at first calving up to 44-50 months for dams and 39-45 months for their daughters and decreased thereafter. Also, Tomar and Desai (1968) indicated the presence of curve linearity in the effect of age at first calving on milk yield of Indian buffaloes in a military farm. They observed that the 300-day milk yield of the first lactation increased with advancing age at first calving up to 36 months and decreased rapidly thereafter. However, different trend for age-at-first-calving effects on milk yield was shown in Egyptian buffaloes, Alim (1957) found that buffaloes calving for the first time at an average of 28.6 months had the highest milk yield at the first lactation compared with later calvers. Afifi (1961) with data of the first four lactations, indicated that early calvers of 30-36 months old at first calving excelled those of 37-42 and of 43-over months in total lactation yield by 19 and 16%, respectively.

Age at first calving was found to have highly significant effects on total milk yield of the Egyptian buffaloes by Ragab _et al_. (1953) and Afifi (1961). Also, Singh and Dhillon (1975) detected significant effects for age at first calving on milk yield of Indian buffaloes. Similarly, Ragab and Sourour (1963) reported significant effects of age at first calving upon milk yield during some months of lactation in Egyptian buffaloes. Effects of age at first calving on the first lactation yield were also detected by Mathur and Roy-Choudhury (1973) in Italian buffaloes. On the other hand, studies of Alim (1953), Alim and Ahmed (1954), Alim (1967), Khishin _et al_. (1968), Mokhtar (1971) on Egyptian buffaloes; Singh and Desai (1962) on Indian buffaloes; and Iqbaluddin, Singh and Dutt (1970), Roy Choudhury (1971) on Italian buffaloes failed to show any significant effect for age at first calving on milk yield.

Coefficients of regression of milk yield of the first lactation on age at first calving and of the correlation between the two variables were reported to be positive and significant by Ragab _et al_. (1953) in the Egyptian buffaloes and Venkayya and Anantakrishnan (1957) in Indian buffaloes. Also, Dutt, Singh and Desai (1965) and Singh (1966) found that age at first calving was positive and significantly correlated with milk yield of the first lactation in Indian buffaloes. El-Chafie (1981) indicated that the phenotypic correlation coefficients between age at first calving on one side and 200- and 300-day milk yield was positive and highly significant ($P < 0.01$). On the contrary, coefficients of regression and correlation between age at first calving and milk yield of first lactation were found to be non-significant in the Egyptian and Indian buffaloes by Hilmy (1954) and Singh (1968), respectively. In addition, Iqbaluddin *et al*. (1970) and Khire, Kadu, Belorkar, Thatta and Kaini (1977) with Indian buffaloes as well as Roy-Choudhury (1971) with Italian buffaloes found that the association between milk yield of the first lactation and age at first calving was non-significant.

Age at Calving and Parity:

Age of the buffaloe at calving is usually measured by the number of years that the buffaloe lived till that calving or in terms of the number of calvings or lactations it gave (parity). Age of the buffalo at calving (or parity) has been considered to play a prominant role in the variability of the initial, partial or total milk yield by many investigators in different countries.

For buffaloes of Egypt, Ghazy (1953), Ragab et al. (1953), Hilmy (1954), Afifi (1961), Ragab and Sourour (1963), Bedeir (1965), Soliman (1976), Mourad (1978) El-Irian (1981), Ashmawy (1981) and Salem (1983) showed that total milk yield increased with advance of age or parity (lactation sequence) till the mature yield was reached and then declined. The same finding was also reported for daily milk yield (Ibrahim, 1950); for initial milk yield (Bedeir, 1965, Ragab et al., 1973; Soliman (1976), Mourad, 1978, El-Irian, 1981; Ashmawy, 1981 and Salem, 1983), for monthly milk yield up to the 12th and 6th month of lactation (Soliman, 1976 and El-Irian, 1981 respectively) and for 305-day milk yield (Ashmawy, 1981 and Salem, 1983). Singh and Desai (1962) and Sekhon and Gehlon (1966) with Indian buffaloes as well as Dassat et al. (1966) and Roy-Choudhury and Deskmukh (1975) with Italian buffaloes obtained a similar trend for the effect of age (expressed in terms of parity) on lactation milk yield. Considering only milk yield of the first 6 months of lactation Maymone (1942) with Italian buffaloes, was able to detect the same trend for the effect of sequence of lactation (parity). All these results reveal the curve-linearity effects of age at calving expressed in either absolute years or in trems of parity (lactation number) on milk yield of the Egyptian, Indian and Italian buffaloes.

The increase of milk yield with advance of age expressed in parity (lactation number) till reaching the peak of production was stated to be a result of growth in size of the animals and greater digestion and udder capacity (Hilmy, 1954; El-Irian, 1981 and Salem, 1983). Soliman (1976) noted that the major reason of that increase is due to the advancement of age is accompanied with development of physiological functions and growth of the udder capacity until the animals arrive the mature age and weight. Ashmawy (1981) attributed such increase to the full development of body weight and size of the animal which is associated by the increase in the size and functions of digestive and circulatory systems, mammary glands and the other body systems. The same author added that the amount of feed intake and feed utilization therefore, is greatly increased and this is associated with increasing the efficiency of milk synthesis and secretion of the udder glandular tissues. The decrease of milk production with advance of age after reaching the maximum production was reported by Hilmy (1954), El-Irian (1981) and Salem (1983) to be mainly due to senility. Ashmawy (1981) reported that with advanced age after reaching the mature body weight and size, the physiological activity of all body systems started to decrease and the secretory tissue of the udder is partially degenerated leading to a decrease in the amount of milk production.

Ragab _et al_. (1953) with a herd of Egyptian buffaloes found that the maximum milk production was achieved when buffaloes were 6.5 years of age. Hilmy (1954), Khishin _et al_. (1968) reported later age (7.2 years) for reaching the maximum milk yield in other two herds of buffaloes in Egypt. However, Ibrahim (1950) found that the daily milk yield in buffaloes increased with advance of age until the maximum production was reached at the 9th year of age. The effect of age on milk production in the Egyptian buffaloes was also studied in terms of lactation number (parity) by different investigators. Maximum of total or 305-day milk yield was reached in the 2nd lactation by Ragab et al. (1973), in the 3rd lactation by Ragab et al. (1953), in the 4th lactation by Hilmy (1954), Afifi (1961), Ragab and Sourour (1963), Khishin et al. (1968) and Salem (1983), in the 5th lactation by El-Irian (1981) but in the 6th lactation by Soliman (1976), Mourad (1978) and Ashmawy (1981).

When considering initial milk yield, the peak production was recorded in the 4th lactation by Salem (1983), in the 5th lactation by Mourad (1978) and El-Irian (1981) and in the 7th lactation by Soliman (1976) and Ashmawy (1981). Also, maximum monthly milk yield up to the 12th month of lactation was reported to be recorded in the 5th, 6th and 7th lactation by Soliman (1976). El-Irian (1981) indicated that the maximum monthly production up to the 10th month of lactation was reached in the 5th lactation.

With buffaloes in Indian, the highest milk yield was recorded in the 3rd lactation by Basu and Ghai

(1978a), in the 4th lactation by Agarwala (1962), Singh and Desai (1962), Sekhon and Gehlon (1966) and Kumar and Bhat (1978b) and in the 5th lactation by Dave (1938) and Rao, Singh and Dutt (1970). With buffaloes in Italy, Maymone (1942) studied the effect of age on milk yield of the first 6 months of lactation and found that the peak production was shown in the 4th lactation.

All the above results of the different reports cited showed that the maximum milk production was attained by buffaloes of different herds in the same country and in different countries at varying ages or lactation sequences. This could be possibly be due to differences in age at first calving, length of dry period and/or the genetic differences among the different herds studied as stated by Ashmawy (1981). The differences in the managerial procedures followed could be added in this respect.

For the Egyptian buffaloes, Soliman (1976), Mourad (1978), Ashmway (1981), El-Irian (1981) and Salem (1983) found that age of calving in buffaloes, expressed in terms of parity, constituted a considerably highly significant ($P < 0.01$) source of variation in both initial and total milk yield. Parity was reported by Soliman (1976), Mourad (1978) and Ashmawy (1981), respectively, to be responsible for 33.1, 5.5 and 33.7% in the total variance of initial milk yield and for 10.6, 11.2 and 10.8% in the total variance of total milk yield. Similarly, Ashmawy (1981) reported that lactation order had highly significant effects on 305-day milk yield and contributed to its total variance by 13.9%. This contribution in nearly similar to the contributions of parity in the total variance of total milk yield which were reported above by Soliman (1976), Mourad (1978) and Ashmawy (1981). Results of Ashmawy (1981) revealed that parity effects contributed more to the total variance of either 305-day or total milk yield than did collectively all the other factors included in the model of analysis. This signifies that parity effects were the most important environmental factors that influenced both 305-day and total milk yield of the buffaloes studied. El-Irian (1981) came to the same conclusion with respect to total milk yield, parity accounted for 71.4% of its total variance. In line with all the results cited above, Ragab et al. (1973) showed that differences in monthly milk yield due to parity effects were highly significant ($P < 0.01$) up to the 7th month of lactation but accounted only for 1.4 to 6.6%. These results are in fair agreement with those of Soliman (1976) which indicated that effects of parity on monthly milk yield during the twelve months of lactation were always highly significant ($P < 0.01$) and amounted to 1.9-13.0% of the total variance. In the same respect, El-Irian (1981) indicated that the effect of parity from the 2nd to the 8th lactation on monthly and cumulative monthly milk yield (partial milk yield) was highly significant ($P < 0.01$) up to the 10th month and accounted for 24 to 74.5 and 28.0 to 71.4% of the total variance of monthly and cumulative monthly milk yield, respectively. Like all the previous investigators of Egypt, Bahatmagar et al.(1961), Singh and Dutt (1964), Raizad et al. (1971), Basu and Ghai (1978a) and Kumar and Bhat (1978b) reported significant effects for parity or age on milk yield of Murrah and other Indian buffaloes. Roy-Choudhury and Deshmukh (1975) indicated that the differences in lactation milk yield between the first and the second lactations were significant in Italian buffaloes.

On the contrary, Singh and Desai (1962) with Bhadawari (Indian) buffaloes, Alim (1967) with Egyptian buffaloes and Roy Choudhury (1971) with Italian buffaloes were not able to detect either marked or significant influence of age at calving on milk yield. This is in consistence with results of Maymone and Mallossini (1961) who reported that no significant differences between lactations in the milk yield of the ascending phase of lactation in the Italian buffaloes were detected.

The relationship between parity or age of the lactating buffaloes and their milk yield was investigated by evaluating the regression coefficient of milk yield on parity or age and/or the correlation coefficient between the two variables by different research workers in Egyptian, Indian and Italian buffaloes. Ibrahim (1950) reported sizable positive correlation coefficient of 0.632 between daily milk yield and age of buffaloes in Egypt. Highly significant ($P < 0.01$) positive correlation coefficients between age and lactation milk yield were also obtained by Ragab et al. (1953), Hilmy (1954) and Afifi (1961). The estimates evaluated, in this respect, by those authors were 0.609, 0.304 and 0.302, respectively. However, results of Ragab et al.(1953) and Afifi (1961) did not prove the dependency of total milk yield on age at calving or parity. They showed low and non-significant estimates for the regression coefficient of milk yield on age (0.019 and 0.172, respectively) in two different herds. Hilmy (1954) reported low dependence was 0.091 but significant. In agreement with findings of Ragab et al. (1953) and Afifi (1961), Mourad (1978) showed that the total milk yield per lactation was not significantly dependent on age, the linear and quadratic regressions of total milk yield (0.818 and -0.0035, respectively) were not significant. The same findings were reached by Singh and Desai (1962) in Indian buffaloes, Alim (1967) in Egyptian buffaloes and by Iqbaluddin et al. (1970) and Mathur and Roy-Choudhury (1971) in Italian buffaloes. Contrary results were obtained for association between initial milk yield and age by Mourad (1978) who indicated that the linear and quadratic regression coefficients of initial milk yield on age (3.82 ± 0.43 and -0.12±0.002 kg/month, respectively) were highly significant. Similarly, Salem (1983) reported highly significant regression coefficients for initial, 305-day and total milk yield on age being 1.02±0.49, 3.15±1.32 and 4.71±1.56 kg/month, respectively.

2. Lactation Period

Length of lactation period is one of the most important aspects of milk production from buffaloes. Positive phenotypic and genetic association has been established between it and the total milk yield per lactation in buffaloes of different regions (Venkataratnan and Venkayya, 1964; Asker, Bedeir and El-Itriby 1965; Alim, 1967 & 1978; Rao et al., 1970; Jawarker and Johar, 1975; Soliman, 1976; and Basu and Ghai, 1978b). As a result of that, buffaloes with longer lactation period are expected to produce more milk per lactation than those with shorter lactation period. Thus, within the standard limits of calving interval, length of lactation period should be the longest but without shortening dry period than the optimum length.

Year of Calving:

Length of lactation period was found by different research workers to vary with year or period of years of calving. Year-of-calving effects on length of lactation period were reported to be significant in some cases and non-significant in some others. Soliman (1976), Mourad (1978), Alim (1978) and Ashmawy (1981) reported highly significant effects of year of calving on length of lactation period in Egyptian buffaloes. Similarly, El-Irian (1981) in Egypt found highly effects for year of calving on the length of the first lactation period. Significant effects for year of calving on length of lactation period were also reported in Italian buffaloes (Kanaujia and Balaine, 1975) and in Murrah buffaloes (Jawarker and Johar, 1975 and Basu and Ghai, 1978b). On the reverse, Abdel-Aziz and Abdel-Ghany (1978) and Kumar and Bhat (1978) with Egyptian and Murrah buffaloes, respectively found that effects of year of calving on length of lactation period were not significant. El-Irian (1981) with buffaloes of three Egyptian farms, reported similar results of the effect of year of calving on length of lactation period of lactations from the second to the eighth.

Significant effects of year of calving on length of lactation period was attributed by Kanaujia and Balaine (1975) in Italy to differential nutritional and management practices prevalent over different times.

Year-of-calving effects were found, in most of the cited work, for a low percent (0.4-2.96%) of the total variance in length of lactation period. They were indicated to account for 2.9, 0.4, 0.52 and 2.96% by Kanaujia and Balaine (1975), Soliman (1976), Mourad (1978) and Ashmawy (1981). El-Irian (1981) using records of the second to the eighth lactations of buffaloes in three Egyptian farms, found, also that year of calving contributed to the total variance of length of lactation period by only 2.44%. However, findings of Alim (1978) revealed that year of calving effects was a pronounced source of variation in length of lactation period, since they accounted for 6.77% of its total variance. At the same time, El-Irian (1981) indicated that effect of year of calving on length of the first lactation was responsible for 75.14% of the total variance.

Month and season of calving:

Effects of month and/or season of calving on length of lactation period in buffaloes was detected in different regions of the world.

For the Egyptian buffaloes, Sidky (1952) in a general study, found that autumn and winter calvers showed longer lactation period than those calved in other months of the year. Ragab, Asker and Ghazy (1954) reported similar observations, they reported that autumn and winter calvers had longer lactation period than summer and spring ones. Khishin _et al._, (1968) stated that the longest lactation period was reached by winter (December-February) calvers while the shortest lactation period was recorded by summer calvers. Results of Abdel-Aziz and Abdel-Ghany (1978) and Salem (1983) showed the same trend. When grouping lactation records according to month of calving, Khishin _et al._ (1968) noticed that buffaloes calved in December scored the longest lactation period while those calved in June had the shortest length of lactation period. In this respect, findings of El-Irian (1981) revealed that buffaloes calved in autumn gave lactations with longer period than those calved in any other season of the year. However, Soliman (1976) and Mourad (1978) found that the maximum length of lactation period was reached by spring calvers while autumn calvers recorded the minimum length of lactation period. Similar trend for the effect of season of calving on length of lactation period was observed by Ashmawy (1981) who noted that buffaloes calved in autumn and spring seasons recorded the shortest and longest lactation period, respectively.

Considering Indian buffaloes, observations of Agrwala (1964) revealed that length of lactation period was at its maximum length for buffaloes calved in monsoon and summer seasons, but at its minimum length for those calved in winter season. Also, Singh (1966) reported that summer calvers showed longer lactation length than either monsoon or winter calvers. Basu and Ghai (1978b) obtained the same findings with Murrah buffaloes. They gave evidence that summer (April - June) calvers had a significantly longer lactation than calvers of other seasons of the year. In this respect, Gurnani, Nagarcenkar and Gupta (1976) indicated that Murrah buffaloes calving in rainy season (July-October) recorded significantly shorter length for lactation period than those calving in either winter (November-February) or summer (March-June) season. With Bulgarian buffaloes, Polihronov, Vankov and Aleksiev (1967) showed that the longest lactation were for buffaloes calving in December to May period.

Seasonal variation due to month of calving were found by Ragab <u>et</u> <u>al</u>. (1954) to have highly significant effects on length of lactation period in Egyptian buffaloes. In line with these findings, Soliman (1976), Mourad (1978), Alim (1978), Ashmawy (1981) and Salem (1983) with different herds of Egyptian buffaloes proved that differences in length of lactation period due to season of calving were highly significant ($P<0.01$). Similarly, Bhatnagar <u>et</u> <u>al</u>. (1961), Goswami and Nair (1965), Gurnani <u>et</u> <u>al</u>. (1976), and Basu and Ghai (1978b) with buffaloes of countries other than Egypt, reported significant influence for the effects of season of calving on the length of lactation period. On the other hand, Afifi (1961), Venkataratnan and Vankayya (1964), Desai and Kumar (1964), Khishin <u>et</u> <u>al</u>. (1968), Sharma and Singh (1974), Kanauji and Balaine (1975), Abdel-Aziz and Abdel Ghany (1978) and Kumer and Bhat (1978a) failed to detect any significant influence of season and / or month of calving on length of lactation period in different herds of buffaloes raised in different countries.

Although season of calving was evidenced by different investigators to have highly significant effects on length of lactation period of the Egyptian buffaloes, yet results proved that season of calving was not a major source of variation in this trait. It was responsible for 2.3, 2.66, 1.39, 2.04 and 2.62-4.61% of its total variance as reported by Soliman (1976) Alim, Mourad (1978), Ashmawy (1981) and El-Irian (1981), respectively.

__Age at first calving:__

The literature consulted on Egyptian and Indian buffaloes revealed that length of lactation period differed with changes in age at first calving. Afifi (1961) found that buffaloes calved for the first time when they were 30-36 months always recorded longer lactation period than those calved for the first time at later ages. However, results of Khishin _et al_. (1968) indicated that the longest lactation period was scored by buffaloes calving for the first time when they were 35-37 months of age. These results showed that length of lactation period increased with the increase of age at first calving from less than 35 months to 35-37 months, and undergoes a general decrease thereafter.

Age at first calving was generally found to be positively associated with length of lactation period in Egyptian buffaloes (Ragab et al., 1953) and in Murrah buffaloes (Venkayya and Anantakrishnan, 1957). Ragab et al. (1953) calculated the regression coefficient of length of first lactation period on age at first calving as 0.135 (being highly significant) and the correlation coefficient between the two variables as 0.096. Venkayya and Anantakrishnan (1957) found that the same two coefficients were positive and significant. Results of Ragab et al. (1953) in this respect, showed that age at first calving did not affect length of lactation period to a great extent. However, Afifi (1961) and Khishin et al. (1968) indicated that effects of age at first calving on length of lactation period of different lactation were not significant.

<u>Age at calving and parity</u>:

Results of Ragab <u>et al</u>. (1953) showed tha young buffaloes had a tendency towards longer length of lactation period than older ones. They found that the regression coefficient of length of lactation period on age of the buffaloe was -0.097 and the correlation coefficient between the two aspects was -0.322, both estimates were highly significant. The same authors concluded that age of the buffaloe did not affect the length of lactation period to a great extent. However, Afifi (1961), Mourad (1978) and Salem (1983) with Egyptian buffaloes showed a trend indicating the lengthening of the lactation period as the age of the buffalo advanced. Afifi (1961) reported that the regression coefficient of length of lactation period on age at calving was 0.01 and the correlation coefficient between the two variables was 0.003, both estimates were non-significant. Mourad (1978) found that the linear and quadratic regression were 2.66 and 0.01 day/month,respectively and that age of the buffalo affected length of lactation period significantly ($P < 0.01$), Salem (1983) reported that the regression coefficient of length of lactation period was 0.945 and highly significant ($P < 0.01$).

When age at calving was presented in terms of lactation number (parity), the average lactation length calculated from the findings of Afifi (1961) on a herd of Egyptian buffaloes was 288, 276, 274 and 300 days for the 1st, 2nd, 3rd and 4th lactation, respectively. These averages indicate that length of lactation period decreased from the 1st to the 3rd lactation and increased thereafter in the 4th lactation. Results reported by Soliman (1976) on other four herds of the same buffaloes showed a trend indicating that length of lactation period decreased with advance of lactation number up to the 8th lactation and increased thereafter up to the 10th lactation. The same auther added that the average length of the 10th lactation was significantly longer than that of any of the other preceding nine lactations. The trend observed by Soliman (1976) seems to be similar to that detected from the data of Afifi (1961), but the minimum length of lactation was reached in the 8th but not in the 3rd lactation as shown by the latter auther. Similarly, Mourad (1978) found that the average length of lactation period generally decreased as parity advanced from the 2nd till the 8th lactation and increased slightly in the 9th and 10th lactations. The same auther observed that lactation length of the 2nd parity was significantly longer than that of the other parities studied. In this respect, Salem (1983) reported that length of lactation period decreased with advance of lactation number from the 1st to the 7th lactation. Different trend was observed by Bedeir (1965) who found that length of lactation period increased from the 1st to the 2nd lactation and showed in general a slight decrease thereafter up to the 6th lactation. However, Ashmawy (1981) and El-Irian (1981) also, working on Egyptian buffaloes were not able to detect any definable trend for the effect of sequence of lactation on length of lactation period.

With Murrah buffaloes, Gurnani et al. (1976) noted that the longest lactation period occurred during the 1st lactation and that length of lactation period tended to decrease in the subsequent lactations. Also, Kumar and Bhat (1978a) reported that the lactation period was at its longest length in the first lactation and significantly decreased after the 4th lactation. Kohli and Malik (1960) with buffaloes of the same breed (Murrah buffaloes), found that the 1st lactation was the longest in comparison to the successive lactations. Basu and Ghai (1978b) noticed that the first lactation was the longest one, but they did not detect any specific trend for the effect of lactation number on length of lactation period. In this concern, different observations were noted on Murrah buffaloes. Bhatnagar et al. (1961) reported that animals completed the 2nd lactation had the longest lactation period while, those completed the 6th lactation had the shortest one. Sekhon and Gehlon (1966) noticed that the length of lactation reached its maximum at the 2nd lactation and its minimum at the 5th lactation. Jawarkar and Johar (1975) found a declining trend from the 2nd lactation which was the longest with advance of lactation number, but the 9th and 11th lactation showed a little deviation from that trend by having longer lactation period. However, Raut and Singh (1978) indicated that the lactation period of buffaloes was at its minimum length in the first lactation, increased in the 2nd and 3rd and started to decline in the 4th lactation.

Ashmawy (1981) stated that the different trends for parity effect on length of lactation period, observed by different investigators could be attributed to: (1) the different herds used which might be genetically different (2) the herds used had, on the average, different ages at first calving and different weights, (3) the differences in the numbers of lactations used and the varing numbers of observations in each lactation in these herds, (4) the different models of analysis adopted to investigate the factors affecting length of lactation period and/or (5) the various climatic and feeding conditions under which the different herds were reared. Also, differences in mangerial procedures could be added as another cause in this concern.

Findings of Ragab et al. (1953), Mourad (1978), and Salem (1983) revealed that age effects on length of lactation period, in some herds of Egyptian buffaloes, were highly significant, Similarly, Venkayya and Anantakrishnan (1957) found that the association between age of the buffalo and length of lactation period was significant in Murrah buffaloes. On the contrary, Afifi(1961) in Egypt, reported that length of lactation period was not significantly influenced by age of the she-buffaloe.

In the Egyptian buffaloes, parity effects on length of lactation period were found to be highly significant by Mourad (1978), El-Irian (1981) and Salem (1983). Also, Bedeir (1965) found significant effects for parity on length of lactation period. Soliman (1976) reported that lactation period varied significantly ($P < 0.05$) with parity from the 1st to the 10th lactation, but there were no significant differences between the 1st nine lactations in this respect. Ashmawy (1981) found that the effect of lactation number on lactation period was not significant.

In Murrah buffaloes, the effect of parity on lactation period was found to be significant by Bhatnagar *et al.* (1961), Jawarkar and Johar (1975), Basu and Ghai (1978b) and Kumar and Bhat (1978a) but non-significant by Gurnani *et al.* (1976).

The contribution of parity effects to the total variance of length of lactation period was found to be limited (0.4%) by Soliman (1976), small (3.91%), by Mourad (1978) and high (59.83%) by El-Irian (1981) all working on the Egyptian buffaloes.

B. ESTIMATING GENETIC CHANGE

Within a given population, the observed change in the performance of a particular trait due to any breeding programme and/or selection is composed of two components, the genetic change and the environmental change. Obtaining an estimate for the genetic component is of vital importance for the animal breeder. It enables him to check for the genetic progress (improvement) achieved and consequently for the efficiency of his breeding programme. The problem of separating both components from each other was recognized by Lerner (1950). The same author suggested ways for the separation of these two components. The same problem attracted the attention of different investigators (Lortscher, 1937; Van Velck and Henderson, 1961 and Smith, 1962) and several methods of estimating genetic changes have been devised. Many of these have been considered in recent reviews by Dickerson (1969) and Lindstrom (1969). For all these methods, the assumption that there is no accumulation of mutations which might cause bias or random errors was considered (Hill, 1972).

Methods of estimating genetic change in animals can be grouped into: planned methods and methods based on field records. The following presents the methods available in the literature.

1. Planned Methods

<u>Selection experiment in opposite directions</u>:

A measure of genetic change due to selection which is not confounded by environmental effects can be obtained by practicing selection in opposite directions in two contemporaneous lines at the same location. This technique of divergent selection has been used most often in mice (Roberts, 1965). However, no precise estimate of asymmetry of response is possible so that certain checks of results against predictions cannot be made. When the only objective of the experiment is to enable comparisons of alternative selection schemes for improving the same trait, the differences in response can be estimated without recourse to a control population (e.g. Falconer and Latyszewski, 1952; Bell *et al*., 1955), but the magnitudes of actual response from any particular scheme cannot be estimated accurately.

<u>Replication of the same set of genotypes in successive generation</u>:

Hill (1972) noted that it is possible to replicate the same set of genotypes in successive generation in some populations, so it can be used as a standard for comparison with a selected population. A change in the difference between the performance of the two populations when maintained under the same environment at the same time is then an estimate of the genetic change in the selected population. The accuracy of the estimate will be reduced if the supposed standard population undergoes genetic change itself, if it and the selected population react differently to environmental fluctuations or if few animals are measured.

Many ways in which replication of the same genotypes in successive generations can be applied. These methods are not completely distinct from each other but they overlap considerably.

a. Gamete storage. Gametes can be stored in cattle for a long period as deep-frozen semen (Hill, 1972). If every few years, depending on generation length, females are inseminated with this semen and their progeny reared alongside progeny of sires in current use, an estimate of one-half the genetic change in the population can be obtained (Dickerson, 1960, 1969). However, only the additive component of change is estimated without bias. If a population is becoming inbred during selection and the progeny reared from the long-term stored semen are less inbred, then an under-estimate of the change in genotypic value in the selected population would be obtained from the test comparison.

The females which are bred with stored semen should have a similar age distribution to those mated to contemporary bulls and should be chosen at random or matched for performance. The difference between the progeny performance of the old and contemporary bulls can be estimated within age-of-dam classes.

Hill (1972) reported that various semen storage plans are possible in cattle. Semen can be retained from a random sample of young bulls, but then the variance of the estimate of overall change includes part of the variance between bulls' breeding values; alternatively semen can be retained from bulls which have had an accurate progeny test so that their merit at the start of the programme in known accurately. If high-ranking bulls are used initially, their later use will not depress performance and thus increase testing costs, even if real responses are being made. However, since these bulls have been selected on the basis of their progeny test, their initial merit must be judged on the basis of records obtained following the selection or their progeny test will apparently regress (Dickerson, 1969). The semen storage method does not measure change in the population as a whole; the direct comparison is between bulls born in different years, and an implicit assumption is made that the population of cows is responding similarly. Thus, the estimate could be in-correct unless population is closed to outside breeding stock. A small bias can be introduced if selection of young bulls for future progeny testing improves with time, say by superior identification of good bull mothers. These errors will become smaller, at least for estimates of yearly change, as the period over which comparisons are made is lengthened for an increasing differential between cow and bull breeding values is unlikely.

b. Inbred lines. The maintenance of inbred lines which, generally, in the form of inter-crosses, can be used as controls (Bell et al., 1955; Rahnefeld et al., 1963). However, a few lines represent only a small sample of genotypes, as do the crosses among them, and the lines are special sample since they must have originally survived on intense inbreeding process. It is therefore possible that they will react in a unique way to environmental change. Highly inbred lines have not been obtained in large animal species, nor in some much smaller ones such as the Japanese quail (Sittmann et al., 1966). And unless the lines are almost isogenic, steps may have to be taken to minimize further drift or natural selection with them. The other potential hazard is the accidental loss of one are more of the lines, although it may be possible to correct the data accordingly with some reduction in precision.

c. <u>Control populations</u>. This method is an alternative to keeping inbred lines in which no genetic change should occur (Hill, 1972). A segregating population can be maintained in which attempts are made to minimize the genetic change from selection or random drift. Widespread use has been made of such segregating control populations commonly refered to as control populations in both experimental and applied breeding situations. Control population method was more used in laboratory animals and poultry than in cattle, sheep or pigs because of financial and organizational reseasons. A brief description of a control herd for dairy cattle have been given by Legates and Myers (1966). The population has been maintained alongside with one selected for fat yield but has only 6 bulls per generation with about 20 cows in lactation. There have been 183 complete lactations in the selection group and 178 complete lactation records in the control group and close mating was avoided. Both groups were managed as one herd. Weighted yearly differences in production between the selection and control groups were obtained by pooling the weighted intra-season comparison for a given year. The regressions of their weighted differences on years, reflect the yearly rate of divergence between the two groups. Hill (1972) reported that several sources of error in the estimation of genetic change using a control population have been identified as random genetic drift and directional change through natural selection in the control population, interaction between the environment and the genotypes of both control and selected populations and finally, the error resulting from estimating the mean of the control population through measuring few individuals. Errors from the last source can be minimized if sufficient facilities are available and it does not accumulate over generations. However, errors of the other sources may accumulate, and so should be considered more carefully when establishing a population.

In beef cattle, Freeden (1972) studied the genetic change of yearling weight by obtaining the difference between the selection and control groups in Brandon and Lacomb breeds. Legates (1973) estimated the actual genetic improvement after 20 years in milk and fat yields in Holstein cattle using the control and selected sire groups, that are handled as one unit. The weighted yearly differences in milk and fat yields between selection and control sire groups were obtained by pooling the two intra-season comparisons for a particular year. These yearly weighted differences were then regressed on year to ascertain the trend of change. The yearly change was 260 lb taking into account the potential impact of the increased rate of inbreeding in the control group. The same sires were used in the selection group as were used in the control group and the control group was maintained to minimize the genetic change. Hence, the average annual difference between the selection and control groups (260 lb) should approximate the genetic change.

d. Repeat mating design. This design have been proposed for poultry by Goodwin, Dickerson and Lamoreux (1955) as a method of establishing a kind of control or constant genotype in selection experiments. The method depends on the assumption that there is no age change in paternal influence on the performances of the progeny. In dairy cattle populations with artificial breeding, a dam rarely produces more than one daughter sired by the same sire. Therefore, the matings to be repeated, may be selected according to the performance of the progeny resulting from the 1st mating, and this selection would cause serious bias in the results (Syrstad, 1966). Giesbrecht and Kempthorne (1965) outlined an experimental design providing three modes of measuring genetic changes in poultry. All the three modes depend essentially on the use of matings which are repeated identically during two successive breeding seasons. The first mode measures the differences between the means of two groups of birds of different generations but reared in the same year. The second measures a combination of changes in genetic and joint maternal-year effects, and thus is of doubtful magnitude. The third measures the regression of response due to selection on year. The last mode has the disadvantage that the proper error is difficult to be estimated. The number of degrees of freedom available for this estimate is also very limited. Hill (1972) noted that, instead of repeated complete matings where it is difficult to remove maternal age effects, sires alone can be used in two or more consecutive years and compared with progeny of sires born the following year. A specific design have been suggested by Hickman and Freeman (1969) which was originally planned as an internal control in a small dairy cattle population. This design depends on the measurements of successive bull groups. Young unproven bulls enter the herd every year and are mated to cows of all ages for a period of 2 or 3 years with the first bull group being repeated at the end of the experiment. Cows are assigned to bull groups at random by using the same sire again to mate cows that produced a female calf and a sire from a new group of bulls to mate cows that produced a male calf. Thus numbers of full-sister progeny are maximized to enable genetic estimates from comparisons from repeat successive matings and untested matings. Progress from male and female selection can be measured independently. The authors pointed out that this design could be applicable to other species rather than cattle, despite possible maternal effects but assume that selection is continuously in one direction. To estimate the genetic progress, Haussmann and Fewson (1974) used the method applied be Everett et al. (1967) to a simulated population of cows, on two real populations. In this method the genetic progress was estimated by the aid of repeated matings of sires to samples of the population. The computed estimates were of little value because of the bias caused by the selection of sires. Haussmann and Fewson (1974) noted that this method seems to be appropriate for large quantities of data where adjustment for the influence of selection among sires is possible. They added that, in order to correct for age of dams, dams' performance and selection of sires, it is necessary to record the identification number of the dam of each cow and the number of daughters and their mean performance of each bull. The same authors discussed another method in which the bulls were repeated by mated to random samples of the population. They reported that, by applying this method, all the disturbing factors (selection of sires, differences in age of dams and dams' performance) could be avoided. This method could be carried out by subjecting the old bulls(previously progeny tested) to a second progeny test. That is, just like the test bulls, the old bulls are mate to a random sample of cows. In order for the second test to be reliable, it is best that old bulls be given new identification numbers so that those conducting the test do not know which bulls they are testing. If such a second progeny test is made, one then has two estimates of the breeding value of the bull that can be used to determine genetic progress. They concluded that a fairly high number of bulls with two progeny tests would be necessary if a precise estimate of genetic progress is desired.

2. Analysis of Field Records

The separation of genetic and environmental changes in milk yield was early attempted by Lortscher (1937) as cited by Syrstad (1966). The basic concept of this attempt is that the genotype of a particular cow is constant from year to another and accordingly, any change in the amount of its milk yield is of environmental origin. Averging age-corrected records of a group of cows in successive years measures the environmental changes directly and the genetic change may be obtained by subtraction from the phenotypic change. The weakness of this method lies on its sensitivity to errors in the age correction factors used (Rendel and Robertson, 1950). The same authors reported that, in some early studies in dairy cattle, comparisons were made within years, of age corrected lactation records, but the estimates of age effects are confounded with any genetic and environmental trend. Robertson and Rendel (1950) proposed a method for evaluating the difference between daughters of an artificially used sires and their naturally sired contemporaries. This method depends on contemporary comparison using the first records only, weighted according to the inverse of the variance of the difference between artificial insemination and natural service daughters within the herd. Van-Vleck and Handerson (1961) modified this method to make the comparison with a herd year-season of calving group, then effects of season-year and herd are removed from the difference. Except for sampling error, this comparison gives a measure of the difference in genetic merit between artificial insemination and natural service daughters.

The maximum likehood procedure as adapted by Henderson (1949) for dairy cattle was used to evaluate genetic change by different workers (Dillon, Yapp and Touchberry, 1955 and McDaniel, Plowman and Davis, 1961). In this method environmental change was estimated by measuring variation in dairy records which consist the single and the repeated records of the same cows as well the records of the contemporary paternal half-sib groups made over several years.

The genetic change is measured after the correction of the environmental effects (Arave, Laben and Mead, 1964). McDaniel et al. (1961) concluded that the maximum likelihood procedure has the advantage of utilizing all records and not being biased by selection. They added that, where the basic assumption are valid, the adjustment by the maximum likelihood procedure should make estimates of genetic changes more accurate in herd and population studies. Arave et al. (1964) estimated the total genetic gain in fat-corrected milk yield in a population of 11993 lactation records of Jersey cows over a 30-year period. They used two procedures being the maximum likelihood and the pooled intra-sire regression of progeny yield on generation number. They stated that the pooled intra-sire regression method of estimating genetic gain is far simpler computationally than the maximum likelihood method and may be useful in herds where pedigrees are fairly complete. Also, they noted that estimates of both methods agreed closely.

In a study undertaken by Burnside, Rennie and Bowman (1968) to estimate genetic and environmental trend of milk and fat yields as well as fat percent in the Holstein and Ayshire breeds maintained in the University of Guelph herd in the period of 1955 to 1965. The maximum likelihood procedure outlined by Henderson et al. (1959) was used to estimate environmental change in each breed for each trait. Equations were developed for the environmental effects peculiar to cows freshening in the years 1955 to 1965, for 16 years of birth for cows under study, and for the permanent producing ability of each cow. These equations were adjusted for the effects of year of birth and production of the cow, and solved for the yearly environmental effects. The annual environmental change for each of three production traits was then estimated by regressing the environmental constants on years. The total phenotypic change was estimated by computing the annual herd average production for each breed and for each trait and regressing these on years. Subtraction of the regression coefficient for environmental change from the regression coefficient for total phenotypic change provided an estimate of the annual genetic change, which was tested for significance by Student's test for the difference between two regression coefficients (Steel and Torrie, 1960). Those authors reported that the maximum likelihood constants for environmental change indicated an annual increase of 3.9 and 4.0 breed-age-class average points for milk and 2.2 and 2.3 breed-age-class average points for fat yield for the Holstein and Ayrshire breeds, respectively. In contrast, fat percent showed an equal strong negative environmental trend of -0.05 and -0.07% annually for the Holstein and

Ayrshire breeds. The annual genetic trend in the Holstein breed was insignificant, in contrast to significant positive estimates of 1.3 breed age-class average milk, 1.7 breed age-class average fat and 0.03% fat for the Ayrshire breed. The significant positive rate of genetic improvement for milk yield in the Ayrshire herd was attributed by those authors to more extensive use of artificial insemination sires with high breeding values for milk production.

Smith (1962) developed a method for measuring the genetic change which seems to be suitable for the use of the field records. It relies on that the progeny of sires used for several years provide some continuity of genotypes. The change in the performance of successive groups of progeny of individual sires (within sire change) is composed of the environmental change and half the genetic change in the population. The change in the population with time comprises environmental change plus the genetic change. The differences between the two estimates measures one half the genetic change. Therefore, the rate of genetic change (ΔG) may be estimated as follows: $\Delta G = 2\ (b_{PT} - b_{ST})$, where b_{PT} is the linear regression of population performance on time and b_{ST} is the pooled within sire regression of performance on time. This method requires that all matings are to be nonselected with regard to age and genetic merit. This requirement is not always fulfilled and there is probably a tendency to use older and better females as mates of olders sires of good progeny test records. Such selection may result in biased estimates for genetic change. This method also requires the spread of sires over time. This may be a cause which prevent the general use of this method in practice since there may not be sufficient sires, each spread over a sufficient period of time. This method has two advantages over other methods in that past as well as current changes can be measured and no additional facilities are required. Smith (1963) with pigs, removed the effect of selection among parents on the basis of their first set of progeny records through adjusting the initial records by theoretical regression factors. The genetic change is then estimated as a difference between the adjusted first progeny records and the records of the subsequent progeny groups. The author assumed that the affects of maternal age on progeny performance were small and have been ignored in the analysis.

Asker, Bedeir and El-Itriby (1966) estimated the genetic improvement in 305-day milk yield through selection by using records of 538 and 290 buffaloe cows and 54 and 50 buffaloe bulls, kept at Sakha and Sids experimental stations, respectively over a period of 20 years. The probable annual genetic improvement in any of the two herds of the study was calculated using data drawn from the records of the first 6 lactations. They applied the method used by Dickerson and Hazel (1944). Genetic improvement per generation in 305-day milk yield was found by those authors to be 225 and 17 pounds for buffaloes at Sakha and Sids, respectively, when calculated by the culling differential obtained through selection of dams of heifers (i.e. selection of dams); while 990 and 75 pounds for buffaloes at the two stations in the same order, when calculated by the culling differential obtained through selection of dams of bulls (i.e. selection of sires). The annual genetic gain in 305-day milk yield was 40.97 pounds at Sakha and 15.54 pounds at Sids. They also concluded that the genetic improvement per year as a percentage of the average 1st lactation milk yield was 1.8% at Sakha and ranged between 0.11 and 0.47% at Sids.

Syrsted (1966) with Norwagian Red breed of cattle, attempted to estimate the rate of genetic change in dairy yield through two approaches. In the first approach, selection differentials and generation intervals were estimated for the four paths along which genes are transmitted from one generation to the next. In the second approach , the method depending on the repeated use of sires developed by Smith (1962) was used after assuming that the mates of the younger and older sires are similar in genotypes.

Branton, Evans, Steele and Farthing (1967) with 772 first lactation records of daughters from 89 sires of a Holstein herd estimated the genetic progress. They obtained the within sire regression of the deviation of the daughter's record from her herd-mates' average on time. This measures one half the rate of genetic improvement made in the population.

Burnside and Legates (1967) obtained the year constants by the least squares method, and calculated the weighted regression of these constants on years. This regression provided an estimate of annual phenotypic trend. Data of the full sisters were analysed to obtain the least-square constants adjusted for sire and dam effects and corrected for selection. The weighted regression of these constants on years indicated the environmental trend. Comparison between the annual environmental trend with the annual phenotypic trend gives an estimate of the annual genetic trend. Also, the same authors adopted another method for obtaining an estimate for the genetic trend. They compared the overall trend (the phenotypic trend) with one-half the genetic plus the environmental trend. One-half-the genetic plus the environmental trend was obtained from records of paternal half-sisters adjusted for sire effects. The data was classified according to the age of the dam at the time of her daughter's birth to avoid confounding between age effects and the genetic trend. Separate estimates of one-half the genetic trend plus the environmental trend were obtained from daughters of 2-, 3- and 4-year old dams. Another type of bias to the obtained trends from paternal half-sisters if sires are selected for the future use on the basis of the performance of their first progeny groups. If considerable selection was practiced on the basis of sire's first progeny group, then daughters of sires with only one progeny group would tend to be inferror to the first progeny of sires with 2 or more progeny groups. Within each age-of-dam groups, only the progeny of sires which had daughters in more than one year are included. The annual genetic trend was found to be 45±16 kg for milk and 0.018±0.003 for fat percent when using the 1st method and 55±26 kg for milk and 0.016 for fat percent when using the 2nd method.

Harville and Henderson (1967) with milk and milk fat production records of the New York State, Holstein, artificially sired DHIA population, estimated the intra-herd environmental and genetic trends (changes). In this respect they used three methods to estimate the mean intra-herd linear environmental and genetic trends. The 1st method is basically that of Smith (1962). It required the estimation of the within-herd regression and the within-herd x sire subclass regression of the 1st lactation, 305-day, 2 X, M.E. milk or fat production on time. In the 2nd method they utilized the estimated within sire x dam subclass regression of 1st-lactation 305-day, 2X, M.E. milk or milk fat production on time to estimate the intra-herd environmental trend. The 3rd method was based on the use of contemporary comparison of the 1st-lactation milk or fat production of the mth cow, ik th hard x A.I. sire subclass, initiated in the jth year and the average of all other first lactation records initiated in the ijth herd-year-season subclass. All records were taken on the bases of 305-day, 2X, M.E. production. To arrive single estimates of intra-herd environmental and genetic trends, estimates of the 1st 2nd and 3rd methods were weighted according to the inverses of their estimated variances and pooled. They found that the total (phenotypic) intra-herd trend was 176±8 kg of milk and 6.4±0.3 kg of milk fat per year.

In beef cattle, Brinks, Clark and Rice (1971) investigated the genetic progress by measuring the difference between successive generations of animals whose generation number was known in relation to foundation animals in a closed herd. Stewart, Franke and Littell (1974) estimated the genetic trend in weaning weight of purebred beef cattle over a 15-year period by using the least squares method. They obtained year constants once by using a model including year, sex, age of calf and sire effects and another time by using a model including the same factors but without sire effects. The difference between specific year constant of these two models would be an estimate of half the genetic effect of that year. The estimate of the genetic trend for weaning weight was obtained by estimating the weighted regression of two times the difference between year constant on year.

Verde and Bodisco (1976) used the least squares procedure to estimate the genetic trend (change) in Brown Swiss cows. They analysed 282 milk records for the effects of year of calving, month of calving and age at first calving. The same records were analysed once more for the effects of the same factors in addition to sire effects. They obtained a negative change in the herd for milk yield. They attributed the negative trend due to the use of bulls number. Rate of environmental change was measured as the pooled regression of performance on time within generation number.

Hintz, Everett and Van Vleck (1978) obtained the unbiased predictors of the additive genetic value of cows and sires (i.e. genetic merit of the cows and transmitting ability of the sires) of Ayrshire, Guernsey, Holstein, Jersey and Brown Swiss cattle by the use of the best linear unbiased prediction (BLUP) procedure described by Henderson (1975) and Stanger et al. (1976). They used these predictors in estimating genetic trends (changes) in cows and sires. They found that the annual genetic trends in artificial insemination (A.I.) cow population were 36.1, 25.4, 26.1, 25.0 and 38.1 kg in Ayrshire, Guernsey, Holstein, Jersey and Brown Swiss hreeds. Also, the annual genetic trends in the transmitting ability of the AI sires was found to average 23.7, 14.6, 17.9, 18.3 and 34.7 kg for the 5 breeds in the same order. The same authors calculated the annual genetic trends in the non-A.I. cows as 36.1, 35.4, 31.0, 12.8 and 36.4 kg for the five breeds in the same order. They concluded that the genetic trends for cows populations were less than twice the contribution of sires to genetic trends indicating that estimating genetic trends in cow populations by doubling the trend of transmitting ability of sires is biased upwards.

El-Chafie (1981) used the best linear unbiased prediction (BLUP) method to estimate the genetic trend for 100-,200- and 300-day milk yield in two herds of buffaloes (the first is that of the Ministry of Agriculture located near Sakha and the second is that of Alexandria University located near Alexandria) and one herd of Friesian high grades (Friesian x native cattle) cows. He found that in 1st herd of buffaloes the genetic trend in sires exhibited a steady increase between the years 1960 and 1968 indicating an improvement in the sire genetic values occurring across the years for 100-, 200- and 300-day milk yield. In the second herd of buffaloes, little increase between the years 1952 and 1954, followed by a steady decline thereafter was observed in the sire values for 100- and 200-day milk yield. However, for 300-day milk yield, the decline was noticed between the years 1952 and 1962. With respect to the herd of the graded cows, significant fluctuations in the genetic trend were noticed by that author with respect to 100-, 200- and 300-day milk yield. He added that these fluctuations would be explained by the effect of crossbreeding which has increased the genetic variability among sires.

Milk records of Holstein Friesian cows from the fedral milk recording program from 1958 to 1978 were used by Schaeffer, Kerr and Burnside (1982) to estimate the transmitting abilities of dairy cows for milk and fat yields and fat percent. Procedures for the best linear unbiased prediction (BLUP) were followed. The genetic trends in herd averages within herd size categories were positive for milk yields and negative for fat percent.

Pedigree and first lactation 305-day milk yield records of a herd of purebred Shahiwal cattle were used by Zaheer Ahmed, Ahmed, Qureshi, Gill and Fahmy (1978) to estimate the genetic changes in the performance of milk yield through direct selection. They adopted the procedure suggested by Rendel and Robertson (1950). They found that the average 305-day milk yield of the 1st lactation was 2058 kg and that the annual genetic improvement in this trait under direct selection amounted to 1.23 kg or 0.7% of the herd average. The same authors added that selection of dams of heifers and selection of dam of bulls contributed 38.46 and 61.54% of the total genetic gains, respectively. The low estimate of the genetic progress achieved suggested that selection was ineffective to bring about the desirable changes. The genetic changes in age at first calving, first calving interval and first lactation length as a response to selection for milk yield computed by the same procedure were -0.18, -0.02 and -0.10% of the herd average per year, respectively.

Powell and Shainline (1979) studying the trend in genetic merit of dairy sires at initial proving, reported that genetic merit was increased over the five years of the study. They added that the regression of measure of merit on year averaged 19 kg of milk and 6 kg of fat.

C. GENETIC AND PHENOTYPIC PARAMETERS OF MILK PRODUCTION TRAITS

Estimates of genetic and phenotypic parameters, especially heritability, genetic and phenotypic correlation coefficients, are always exceedingly important for the animal breeder. They constitute the basic information needed for planing breeding programs to improve the genetic merits in a given herd for the traits under consideration.

1. Heritability

Heritability of a given trait is the fraction of the total phenotypic variance reflected by the genetic differences. It is narrowly defined as the ratio of the additive genetic variance to the total phenotypic variance. In other words, it expresses the proportion of the total phenotypic variance which is attributed to the average effects of genes. The magnitude of its estimate is helpful in deciding the type of mating that will permit the best and rapid improvement. It aids in determining the most appropriate scheme of selection to be followed. Also, it is used in formulating selection indices when selection is directed towards more than one trait. In addition, it is helpful in determining the least suitable number of offspring that should be used in progeny test for evaluating the breeding value of the breeding males.

Heritability estimates obtained by different investigators for milk production traits in buffaloes calculated by different methods under different sets of genetic and non-genetic conditions are presented in Table 1.

Table 1 - Heritability estimates of milk production traits in buffaloes found in the available literature

Trait and type	Heritability estimate	Method of estimation	Remarks	Authors
<u>Initial milk yield</u>				
Egyptian buffaloes	0.13	Intra-sire correlation		Asker and Bedeir (1961)
	0.11	Intra-sire regression of daughter on dam		Asker and Bedeir (1961)
Egyptian buffaloes	0.38±.12	Daughter-dam regression	based on 255 offspring	Asker <u>et al</u>. (1965)
" "	0.35±.13	Paternal half-sib correlation	based on 618 offspring	
	0.30±.05	Paternal half-sib correlation	based on 2874 lactation	Soliman (1976)
Murrah buffaloes	0.48±0.11	Paternal half-sib correlation	using 1926 half-sibs	Sosamma Ipe and Nagarcenkar (1978)
" "	0.49±0.11	Paternal half-sib correlation		"
Egyptian buffaloes	0.44±0.10	Paternal half-sib correlation	based on 2753 records	Ashmawy (1981)
	0.43±.13	Intra-class correlation among half-sib	Using 900 daughter	El-Chafie (1981)
" "	0.17	Paternal half-sib correlation	Using 371 daughter	"
" "	0.32	Paternal half-sib correlation		
<u>6-month milk yield</u>				
Murrah buffaloes	0.38±0.10	Paternal half-sib correlation	Using 1926 half-sibs	Sosamma Ipe and Nagarcenkar (1978)
" "	0.37±0.10			
Egyptian buffaloes	0.15	Paternal half-sib correlation	Using 900 daughters	El-Chafie (1981)
" "	0.46	Paternal half-sib correlation	Using 371 daughters	
<u>305-day milk yield</u>				
Egyptian buffaloes	0.39±.14	Paternal half-sib correlation	Based on 618 offspring	Asker <u>et al</u>. (1965)
" "	0.27±.14	Daughter-dam regression	based on 255 offspring	Asker <u>et al</u>. (1965)
" "	0.32±.33	Paternal half-sib correlation	based on 94 <u>1st</u> lactation	Mokhtar (1971)
" "	0.37±.45	Paternal half-sib correlation	based on 55 <u>2nd</u> lactation	
" "	0.26±.20	Daughter-dam regression	Using 104 <u>1st</u> lactation	
" "	0.78±.36	Daughter-dam regression	Using 64 <u>2nd</u> lactation	
Murrah buffaloes	0.27±.08	Paternal half-sib correlation	Using 1926 half-sibs	Sosamma Ipe and Nagarcenkar (1978)
Egyptian buffaloes	0.24	Paternal half-sib correlation	Using 900 daughters	El-Chafie (1981)
" "	0.78	Paternal half-sib correlation	Using 371 daughters	
" "	0.43±.13	Inter-class correlation among half-sibs	based on 2753 records	Ashmawy (1981)
<u>Total milk yield</u>				
Egyptian buffaloes	0.24	Correlation between half-sib	using 796 lactation	Asker <u>et al</u>. (1953)
" "	0.22	Daughter-dam regression	based on 41 pairs	Hilmy (1954)
Pakistan buffaloes	0.18	Correlation between half-sib	using 376 half-sibs	Ashfaq and Mason (1954)
Egyptian buffaloes	0.20	Correlation between half-sib	based on 1270 records	El-Itriby & Asker (1956)
Water buffaloes	0.16	Daughter-dam regression	using 413 pairs	Mahadevan (1960)
Egyptian buffaloes	0.43±.15	Paternal half-sib correlation	based on 618 offspring	Asker <u>et al</u>. (1965)
" "	0.27±.13	Daughter-dam regression	based on 255 offspring	
" "	0.32			El-Kimary (1966)
	0.47±0.15	Paternal half-sib correlation	based on 669 1st lactation and using 3 different method to calculated the mean squares among and within sires.	Ragab <u>et al</u>. (1970)
	0.62±0.20			
	0.55±0.22			
Egyptian buffaloes	0.84±0.06	Paternal half-sib correlation	Using 2874 records	Soliman (1976)
	0.45	Paternal half-sib correlation	Using 1406 records	Alim (1978)
	0.38±0.12	Paternal half-sib correlation	Using 2753 records	Ashmawy (1981)
<u>Lactation period</u>				
Egyptian buffaloes	0.11	Paternal half-sib correlation	Based on 796 lactation	Asker <u>et al</u>. (1953)
	0.21	Daughter-dam regression	Based on 41 pairs	Hilmy (1954)
	0.14	Paternal half-sib correlation	Using 1270 records	El-Itriby & Asker(1956)
Water buffaloes	0.06	Daughter-dam regression	Using 413 pairs	Mahadevan (1960)
Egyptian buffaloes	0.27±0.14	Daughter-dam regression	Based on 255 offspring	Asker <u>et al</u>. (1965)
	0.24±0.20	Paternal half-sib correlation	Based on 618 offspring	
	0.35±0.05	Paternal half-sib correlation	Based on 2874 records	Soliman (1976)
	0.42	Daughter-dam regression	Using 111 pairs	Alim (1978)
	0.42±0.13	Paternal half-sib correlation	Using 2753 records	Ashmawy (1981)

and Barrada (1973) with Egyptian buffaloes, indicated that the regression coefficient of 305-day milk yield on 4, 12 and 24 weeks part records were 4.66, 2.42 and 1.43, respectively. The same authors reported that the phenotypic correlation coefficients between 4, 12 and 24 weeks part records at one side and complete record were 0.607, 0.826 and 0.880, respectively, all estimates were highly significant. Results obtained by Soliman (1976) revealed that all possible phenotypic and genetic correlation coeffients among initial milk yield, total milk yield and length of lactation period were positive and highly significant ($P < 0.01$) with the exception of the phenotypic correlation between initial milk yield and lactation period, which equated to zero. High magnitude and significant genetic correlation among partial milk yields was reported by El-Chafie (1981) with Egyptian buffaloes. He found that the phenotypic correlation between 100- and 200-day milk yield, between 100- and 300-day milk yield and between 200- and 300-day milk yield were significant and above 0.8. Ashmawy (1981) in a study on Egyptian buffaloes, reported that the phenotypic correlation between the initial milk yield and both 305-day and total milk yield being 0.69 and 0.61, respectively were statistically highly significant ($P < 0.01$). The phenotypic correlation coefficients between 305-day milk yield at one hand and both total milk yield and lactation period were found by the same author to be statistically highly significant ($P < 0.01$), the estimates were .97 and .57, respectively. He added that a highly significant ($P < 0.01$) phenotypic correlation of 0.69 was obtained between total milk yield and lactation period. The same author, indicated that the genetic correlation between initial milk yield and both 305-day and total milk yield were 0.85 and 0.76, respectively, both estimates were highly significant ($P < 0.01$). The genetic correlation between 305-day and total milk yield was 0.99 and highly significant, however, a non-significant genetic correlation of 0.14 was found between initial milk yield and lactation period. He also reported highly significant correlation coefficients between lactation period and both 305-day and total milk yield being 0.65 and 0.76, respectively.

In Murrah buffaloes, Venkataratnan and Venkayya (1964) obtained significant correlation coefficient of 0.81 between milk yield and maximum initial milk yield. The multiple correlation of lactation yield with initial milk yield was highly significant (0.94). Iqbaluddin <u>et al</u>. (1970) with Murrah buffaloes, found significant correlation coefficients of 0.78, 0.71, 0.62 and 0.55 between milk yield of the first 5 months of each of the 1st 4 lactation at one side and that of their corresponding lactation yield. On the same breed, Sosamma Ipe and Nagarcenkar (1978) reported that the genetic correlation of part-records with 300-day records was of high magnitude and increased with the progressive length of lactation (0.65 for 1st 30-day and 0.99 for 1st 270-day). The proportionate increase was found by the same authors to be higher only up to 150-day period (r_G = 0.87). They noted that the phenotypic correlation coefficients also, showed the same trend exhibited by genetic correlation coefficients and added that the genetic correlation coefficients were observed to be slightly higher than the corresponding estimates of the phenotypic correlations.

III. MATERIALS AND METHODS

A. Data and Its Classes

Data of this investigation were taken from the milk production records collected since 1959 up till 1980 of a buffaloes herd located in the northern part of the Nile delta at Mehallet Moussa. This herd belongs to the Animal Production Research Institute, Ministry of Agriculture. Two classes of data were used. The first class comprised 888 normal lactation records of different lactation order (parity) produced by 190 buffaloe cows, which existed in the herd since 1959 and continued milk production till 1979. These data were considered as data of the base population and were used to investigate the non-genetic factors influencing milk production. The second class of data included the normal first lactation records of 1254 buffaloes, maintained in the herd during the period from 1959 to 1980. They were used in a trial to evaluate genetic improvement of milk production traits and to estimate some genetic parameters for these traits.

Lactation records of buffaloes producing for at least 24 weeks or 168 days were considered as normal records. Those for buffaloes producing less than that period and those affected by mastitis and other udder troubles and disorders (such as abortion) as well as those of doubtful information were refered to as abnormal records, were excluded from both classes of data. In setting up both groups of data for statistical analysis, separate information for each animal at each lactation including its pedigree, birth date, calving date, first 70-day milk production, 6-month milk production, 305-day milk production, lactation period, buffalo generation number and its sire generation number were used. Age at calving was estimated in months and length of lactation period in days. The absolute milk yield produced during normal lactations with lengths of 305 days or less were considered to be 305-day milk yield. Year of calving was divided according to climatic conditions into four seasons being autumn (September - November), winter (December - February) spring (March - May) and summer (June - August).

Generation number of each of the lactating buffaloes found in the herd of the study in 1959; i.e., buffaloes of the base population was assumed to be zero generation. For buffaloes born in the herd after 1960, generation number was calculated according to the following equation developed by Turner and Young (1969).

$$G_f = \frac{G_s + G_d + 2}{2}$$

where:

G_f is the generation of an offspring ;

G_s is the generation of its sire, and

G_d is the generation of its dam.

Generation number of the sires was estimated in the same way.

The distribution of 1st lactation records according to year of calving and generation number of the buffaloe and the distribution of 1st lactation records according to year of calving and generation number of the buffaloes' sire are presented in Appendices 1 and 2, respectively.

Traits subjected to investigation were : initial (first 70-day), 6-month and 305-day milk yield as well as length of lactation period.

8. Feeding and Management

Buffaloes were kept under regular systems of feeding and management adopted by the Animal Production Research Institute. Throughout the period from December to May, the animals were kept on the field of Egyptian clover to graze ad-libitum. Heavy milk producers (giving more than 18 kg/day) and those in the last two months of pregnancy were suplemented with extra ration of concentrates proportionate to their weight and production. During the other months of the year, animals were housed in open sheds for their protection from direct solar radiation and fed on a balanced ration of concentrates according to their weight and production. Hay of Egyptian clover or green sweet sorghum was offered only to heavy milk producers.

Lactating buffaloes were hand milked twice daily at 7 a.m. and 4 p.m. Milk production was recorded in pounds from 1959 to 1979 and in kilograms thereafter, Records obtained in pounds were multiplied by 0.4536 to be transferred in Kilograms. If the buffaloe did not go dry until 2months before calving , it was dried up by milking it once a day, then once every other day untin it went dry.

Bulls in that herd were selected for breeding purposes after being ranked for body conformation, lebido, semen characteristics and when available for the most probable producing ability of their dams and grand dams. Each selected bull was used for breeding for 5-6 years only and exchanged by another one. All heifers produced and lived in the herd till reaching 24 months of age were joined to the breeding stock. Only those showing abnormal defects, weakness or lower body weight than normal were excluded from the herd. Heifers after joining the breeding stock were kept in the herd till they produced the 2nd or 3rd lactation except if they proved infertile. Those showing low performance for milk production were excluded otherwise they were kept for the next lactation. The same procedure was repeated after each lactation. Bulls were assigned to breed the females at random. Females were usually naturally bred but artificial insemination was only practiced for disease control particularly when there was a propability of genital disease infection. Heifers were served for the first time when they reached 24 months, while buffaloes were usually served 2 months after parturition. Pregnancy was detected by rectal palpation 60 days after the last service. Buffaloes failed to conceive were rebred in the next heat period. Calves were left to suckle their dams for three days after birth and were bucket fed afterwards till weaning at 3.5 months of age. During the suckling period, calves were managed in individual solid wall pens, thereafter they were raised in groups in pens provided with yards of suitable space up to 6 months of age. The maximum age differences between calves in any groups did not exceed 2 months. At six months of age males were separated from females and housed in open sheds as adult animals.

G . Statistical Analysis

The statistical analysis of both the two classes of the data was carried out according to the least squares procedures described by Harvey (1960). This was done to avoid the unequality and disproportionality of the sub-class numbers of data. Tests of significance for the differences between means of different levels with-in each factor were performed according to Duncan's new multiple range test (1955).

Non-genetic factors:

Data of the base population, involving records taken on lactation records of the buffaloes existing in the herd in 1959 and maintained in the herd till 1979, were analysed for the study of the non-genetic factors influencing initial, 6-month and 305-day milk yield as well as length of lactation period. The following linear model was adopted.

$$Y_{ijkm} = \mu + r_i + s_j + t_k + b_1 (X_{1ijkm} - \bar{X}_1) + b_2 (X_{2ijkm} - \bar{X}_2) + e_{ijkm}$$

(Model 1)

where:

Y_{ijkm} is the observation of the mth record of the ijkth subclass ;

μ is the general mean, a common element to all records;

r_i is an effect due to the ith year of calving, i = 1, 2, ..., 18 where 1 = 1962, 2 = 1963, ...,18=1979;

s_j is an effect to the jth season of calving, j = 1, 2, 3, 4 where 1 = winter (December, January and February); 2 = spring (March, April and May), 3 = summer (June, July, and August) and 4 = autumn (September, October and November) ;

t_k is an effect due to the kth parity (lactation order); k = 1, 2, 3, ..., 10 where 10 = (10-15) ;

b_1 is the linear regression coefficient of the milk production trait on age of the buffaloe at calving in months;

X_{1ijkm} is the age of the buffaloe at calving in months for the corresponding Y_{ijkm} record;

$\bar{x}_1$ is the mean of the X_{1ijkm} ;

b_2 is the quadratic regression coefficient of the milk production trait on the square of age of the buffaloe at calving in months ;

X_{2ijkm} is the square of age of buffaloe at calving in months for the corresponding Y_{ijkm} record ;

$\bar{X}_2$ is the mean of the X_{2ijkm} and

e_{ijkm} is a random error particular to the $ijkm^{th}$ record with $e \sim N(0, \sigma^2)$.

It includes all the genetic and environmental effects not specified in the model of analysis.

Phenotypic and genetic improvement:

Data of all normal records of the 1st lactation i.e. the 1st parity of all animals maintained in the herd since 1959 up to 1980 were analysed for the study of the phenotypic and genetic improvement in different milk production traits of the study. These data were only used to let the effects of year of calving free from any confounding with age effects which may exist when including data of more than one lactation and because it comprised the largest number of records. Effects of age of buffaloes producing the 1st lactation was removed by the inclusion of regression on age of buffalo at 1st calving in the models of analysis. The assumption made, was that there was no interaction between age at 1st calving (the beginning of 1st lactation) and year of calving.

To evaluate the amount of phenotypic improvement, the following linear model was assumed for the statistical analysis of the data.

$$Y_{ijk} = U + r_i + s_j + b_1 (X_{1ijk} - \bar{X}_1) + e_{ijk} \qquad \text{(Model 2)}$$

Where:

Y_{ijk} is the observation of the k*th* record of the ij*th* sub-class;

e_{ijk} is a random error particular to the ijk*th* records with $e \sim N(o, \sigma^2)$. It includes all the genetic and environmental effects not specified in the model of analysis. and

the other symbols of the model were as those mentioned in Model 1.

The regression coefficient of means of years of calving on year number, obtained by the analysis based on this model, was calculated. The magnitude of that regression coefficient estimates the average phenotypic improvement per year which is equal to the summation of both genetic and environmental improvement per year. The average phenotypic improvement per generation was calculated by multiplying the magnitude of regression coefficient of the means of years of calving on year number by 6.2 years (the average generation interval in the herd of the study). The generation interval was estimated according to Asker and Ragab (1951). The difference between the mean of any year and that of any other particular successive year gives a good estimate for the phenotypic change that occurred during the interval between the 2 considered years.

In an attempt for calculating the genetic improvement per generation three methods were approached. In the first method data used in evaluating the phenotypic improvement (i.e. of the 1st lactation) were subjected to the statistical analysis by using the following model:

$$Y_{ijkm} = U + r_i + s_j + g_k + b_1 (X_{1ijkm} - \bar{X}_1) + e_{ijkm} \quad \text{(Model 3)}$$

Where:

Y_{ijkm} is the observation of the mth record of the ijkth subclass ;

g_k is the kth generation number of the buffaloe giving the ijkm th record and

the other symbols of the model were as those mentioned in model 1.

The regression coefficient of generation means on generation numbers of the lactating buffaloes can give an approximate estimate of the average genetic improvement per generation of the trait in question. Also, the difference between the trait mean of animals of any particular generation and that of animals of any subsequent one approximates the genetic improvement that happened from the former to the letter generation.

In the second method approached, the same data were analysed by assuming the following linear model:

$$Y_{ijkm} = U + r_i + s_j + gs_k + b_1 (X_{1ijkm} - \bar{X}_1) + e_{ijkm}$$

(Model 4)

Where :

gs_k is the generation number of the sire of the buffaloe giving the ijkm th record and

the other symbols of the model were as those mentioned in model 1.

The regression coefficient of the sire generation mean on the sire generation number approximate an estimate for one-half the average genetic change per sire generation of the trait under consideration. At the same time, the difference between the trait mean of animals whose sire belongs to a particular generation and that of those which sire belongs to any successive generation show an approximate value for half the genetic improvement that occurred between the two generations.

In the third method, the same data were analysed according to the following linear model:

$$Y_{ijk} = U + r_i + s_j + b_1 (X_{1ijk} - \bar{X}_1) + b_2 (x_{2ijk} - \bar{x}_2) + e_{ijk}$$

(Model 5)

Where:

Y_{ijk} is the kth observation of the ijth subclass ;

b_2 is the linear regression coefficient of the milk production traits on the generation number of buffaloe cow ;

x_{2ij} is the generation number of the buffaloe cow for the corresponding Y_{ijk} record and

$\bar{X}$ is the mean of X_{2ij}

The rest of symbols were as defined before.

The regression of the year means as derived from model 5 on years approximate the environmental trend while b_2 expresses the genetic trend per generation.

All factors included either in the model of evaluating the non-genetic factors influencing the studied milk production traits or those of evaluating the phenotypic and genetic improvements were assumed to be fixed except the error terms. Restrictions imposed on these models to obtain a unique solution for the least squares equations were :

$$\sum_i r_i = \sum_j s_j = \sum_k t_k = \sum_k g_k = \sum_k ga_k = 0.0$$

Genetic parameters:

Data of the normal records of the first lactation of all buffaloes mantained in the herd during the period of the study (1960-1980 inclusive) were first analysed according to model 2 to obtain the constants needed for correcting the data for the effects of year of calving, season of calving and age at 1st calving. Records of buffaloes with unknown pedigree were excluded from the data before the analysis was undertaken. The data were corrected by using the least squares constants obtained as described above and were subjected as one set to the least squares variance-covariance analysis according to the following model presented by Becker (1975).

$Y_{ij} = M + s_i + e_{ij}$ (Model 6)

Where :

Y_{ij} is the adjusted performance of the jth buffaloe born to the ith sire ;

U is a general mean which comprises effects that were common to all buffaloes in all the sire groups ;

s_i is an effect common to all performances of buffaloes born for the ith sire and

e_{ij} is the uncontrolled environmental and genetic deviations attributable to individuals within sire groups.

All effects in the model are assumed to be random normal and independent with expectations equal to zero. Component of variance were calculated according to the following formula

Source of variance	d.f.	S.S.	M.S.	Expected mean squares
Between sires	s-1	SS_s	MS_s	$\sigma^2_e + k\,\sigma^2_s$
Between buffaloes (progeny)/sires	n-s	SS_e	MS_e	σ^2_e

Where:

s is the number of sires ;

k is the coefficient of the mean number of buffaloes (progeny) per sire group ;

n is the total number of buffaloes (buffalo records) ;

MS_s is the between sire mean squares ;

MS_e is the between buffaloes (progeny) within sire mean squares ;

σ_s^2 is the sire component of variance estimated from the analysis of variance as $(MS_s - MS_e)/K$ and

σ_e^2 is between buffaloes (progeny) within sire component of variance.

Heritability estimate (h^2) was calculated according to the following formula:

$$h^2 = \frac{4\,\sigma_s^2}{\sigma_s^2 + \sigma_e^2}$$

The standard errors of heritability were estimated according to the following formula presented by Backer (1975).

$$S.E.\,(h^2) = 4\sqrt{\frac{2(n-1)\,(1-t)^2\,[1 + (k-1)t]^2}{k^2\,(n-s)\,(s-1)}}$$

Where:

S.E. (h^2) is the standard error of the heritability estimate.

t' is the intra-class correlation and equals $\sigma_s^2 / (\sigma_s^2 + \sigma_e^2)$ and n, k and s were defined previously.

Components of covariance between any two traits were obtained according to the following formula:

Source of variance	d.f.	SCP	MCP	Expected mean cross-product
Between sires	s-1	SCP_s	MCP_s	$Cov_e + k\ Cov_s$
Between buffaloes (progeny)/sires	n-s	SCP_e	MCP_e	Cov_e

Where:

MCP_s is the between sires mean cross product of the two traits ;

MCP_e is the between buffaloes (progeny) within sire mean cross product of the two traits ;

Cov_s is the between sires component of covariance of the two traits estimated as $(MCP_s - MCP_e)/k$ and

Cov_e is the between buffaloes (progeny) within sires component of covariance of the two traits.

The remaining symbols were as defined before.

The genetic correlation coefficient between any two different traits studied (r_G) was estimated using the following formula:

$$r_G = \frac{4\ Cov_s}{\sqrt{4\ \sigma^2_{s_1} \cdot 4\ \sigma^2_{s_2}}} = \frac{Cov_s}{\sqrt{\sigma^2_{s_1} \cdot \sigma^2_{s_2}}}$$

Where:

r_G is the genetic correlation coefficient between any 2 traits ;

$\sigma^2_{s_1}$ is the between sire component of variance of the 1st trait and

$\sigma^2_{s_2}$ is the between sire component of variance of the 2nd trait.

The remaining symbols were as defined before.

The standard errors of the genetic correlation coefficient were computed according to Robertson's approximation method (1959) as follows:

$$S.E.\ (r_G) = \frac{1 - r_G^2}{\sqrt{2}} \sqrt{\frac{S.E.\ (h_1^2)\ .\ S.E.\ (h_2^2)}{h_1^2\ .\ h_2^2}}$$

Where:

S.E. (h_1^2) is the standard error of heritability estimate of the 1st trait ;

S.E. (h_2^2) is the standard error of heritability estimate of the 2nd trait; ;

h^2_1 is the heritability estimate of the 1st trait and

h_2^2 is the heritability estimate of the 2nd trait.

The phenotypic correlation coefficients (r_p) between any two traits were calculated by employing the following formula:

$$r_p = \frac{Cov_e + Cov_s}{\sqrt{(\sigma^2_{s_1} + \sigma^2_{e_1})(\sigma^2_{s_2} + \sigma^2_{e_2})}}$$

Where:

r_p is the phenotypic correlation coefficient between and 2 traits.

$\sigma^2_{e_1}$ is the between buffaloes (progeny) within sire component of variance of the 1st trait.

$\sigma^2_{e_2}$ is the between buffaloes (progeny) within sire component of variance of the 2nd trait. and

The remaining symbols were as defined before.

The standard errors of the phenotypic correlation coefficients were estimated as :

$$S.E.\ (r_p) = \frac{1 - r_p^2}{\sqrt{n}}$$

Where:

S.E. (r_p) is the standard error of the phenotypic correlation coefficient and

n is the total number of buffaloes.

The remaining symbol was as defined before.

IV. RESULTS AND DISCUSSION

A. NON-GENETIC FACTORS INFLUENCING MILK PRODUCTION

1. Initial Milk Yield

The least squares mean of the initial milk yield taken on the basis of the 1st 70 days of lactation was 608.9±18.59 kg (Table 2). This mean is close to that obtained on the same basis by Mourad (1978) for three herds located at Mehallet Moussa, Sids and Gimmeza (540.8±7.79). Also, it is in the neighborhood of the mean estimated on the basis of the 1st 60 days of lactation by Soliman (1976) for buffaloes of Mehallet Moussa, Sids, Gimmeza and Giza Experimental Stations (485.6±5.3) and by Ashmawy (1981) for buffaloes of the same stations (471.82±3.28). Bedeir (1965) with buffaloes at Sakha and Sids as well as Salem (1983) with buffaloes of Mehallet Moussa considered milk production of the first 90 days of lactation as the initial milk yield. The mean initial milk yield was found to be 630.4± 8.65 kg by the former investigator and 653.47±8.84 kg by the latter one El-Itriby (1981) estimated the average milk yield of the first 3 months of lactation to be 376.70±8.48 kg for the 1st lactation and 570.75±6.27 kg for lactation from 2nd up to the 8th. El-Chafie (1981) calculated the average milk yield of

Table (2) : Least squares means, standard errors and Duncan's test for factors influencing initial milk yield (The 1st-70-days) of base population.

Classification	No.	$\bar{x}$ or b±S.E.	Classification	No.	$\bar{x}$ or b ±S.E.
Overall mean:			Season of calving		
	888	608.90±18.59			
Year of calving			Winter	231	612.46±19.55 a
			Spring	199	608.94±21.23 a
1962	20	343.74±39.85	Summer	179	622.09±21.22 a
1963	93	467.39±26.42	Autumn	279	592.09±19.90 a
1964	82	489.20±25.34	Parity		
1965	83	472.77±23.98			
1966	108	571.81±22.22	1st	177	190.21±27.32 a
1967	100	627.00±21.03	2nd	176	346.88±22.13 b
1968	101	667.08±20.70	3rd	172	492.81±19.94 c
1969	72	638.33±21.81	4th	117	577.06±21.16 d
1970	56	700.02±23.38	5th	76	628.31±24.15 e
1971	43	720.28±26.01	6th	55	699.93±28.39 f
1972	39	755.41±27.86	7th	39	750.43±33.93 f
1973	28	683.40±34.33	8th	26	738.77±41.52 f
1974	17	692.42±41.30	9th	20	766.26±48.42 f
1975	19	717.05±43.29	10th or more	30	898.29±54.48 g
1976	8	788.93±62.67	Linear regression		
1977	10	551.84±62.36	on age	888	10.66± 1.01
1978	6	558.61±72.31	Quadratic regression		
1979	3	519.81±107.46	on age	888	-0.03±0.005

Within each classification means having the same letter differ non-significantly from each other, otherwise they do ($P < 0.05$).

the 1st 100 days of lactation for buffaloes of 2 herds located at Alexandria and Mehallet Moussa to be 640.4± 17.92 kg and 462.1±4.82 kg, respectively.

Year of calving:

Results presented in Tables 2 and 5 reveal that initial milk yield vary with year of production and the differences were statistically highly significant ($P < 0.01$). These results agree well with those of Soliman (1976), Mourad (1978) and Ashmawy (1981). El-Iriam (1981) reported similar findings for the effect of year of calving on milk yield of the 1st 3 months of either the first lactation or subsequents up to the 8th. Also, El-Shafie (1981) noticed that the 1st 100-day milk yield of 2 herds raised in Alexandria and Mehallet Moussa varied significantly with year of calving.

Year-of-calving effects contributed 12.03% to the total variance in the initial milk yield (Table 5). This show that year of calving was a considerable source of variation in initial milk yield. Mourad (1978) and Ashmawy (1981) showed the same findings. They noted that differences in initial milk yield due to year-of-calving effects were responsible for 11.8 and 7.9% of the total variance, respectively. Also, El-Irian (1981) found that year-of-calving effects on milk yield of the 1st 3 months of lactation were considerable and accounted for 60.27 and 31.9% of the total variance in first lactation and in those from the 2nd to the 8th, respectively.

Season of calving:

Results of the analysis indicate that the average initial milk yield differed slightly with season of the year, (Table 5), the differences were non-significant and accounted for only 0.22% of the total variance. The least squares means showed that summer calvers produced the highest initial milk yield compared with calvers of the other three seasons. This observation agrees well with findings of El-Irian (1981) on milk yield of the 1st 3 months of lactation, but is not in agreement with findings of Soliman (1976), Mourad (1978) and Ashmawy (1981) who reported that the highest initial milk yield was obtained from buffaloes calving in winter. It also differs from the results of Asker and Bedeir (1961) who found that buffaloes calved during autumn produced the initial milk yield at its highest level when compared with those calving during any other season. In this respect, Ragab *et al*. (1973) found that buffaloes calved in autumn and winter started their lactations at a higher level of milk production than those calved in spring and summer.

In disagreement with result of this work, Soliman (1976), Mourad (1978), Ashmawy (1981) El-Irian (1981) and Salem (1983) reported that effects of season of calving on initial milk yield was statistically highly significant. Soliman (1976) found that these effects were responsible for 8.3% of the total variance of this trait, which seem to be important. El-Irian (1981) showed that season effects contributed 39.73 - 41.41% to the total variance of milk yield of the 1st 3 months which is more than obtained by Soliman (1976). However, Mourad (1978) and Ashmawy (1981) observed that the contribution of these effects to the total variance of initial milk yield was very limited (0.75 and 0.53%, respectively).

Effects of season of calving on initial milk yield as stated by Ashmawy (1981) may be due to type and amount of feed available and to variation in environmental temperature and humidity during the different seasons.

Parity:

Initial milk yield increased, on the average, from the 1st lactation up to the 7th, slightly decreased in the 8th, increased again up to the 10th (Table 2). These results show a general trend indicating the increase of initial milk yield with advance of parity up to the 10th. Accordingly, the peak of initial milk yield was reached in the 10th lactation. This is quite different than the results reported by different investigators working on Egyptian buffaloes. The initial milk yield attained its peak in the 7th lactation (Soliman, 1976 and Ashmawy, 1981), in the 5th lactation (Mourad, 1978) and in the 4th lactation (Salem, 1983). Ragab et al. (1973) indicated that milk yield during the ascending phase of lactation (initial milk yield) reached its maximum in the 5th lactation.

Results of the analysis gave an evidence that parity effects on initial milk yield were highly significant ($P < 0.01$) and accounted for 24.60% of the total variance. Coupling these findings with those obtained for the effects of the other factors included in the model of analysis (Table 5), it could be stated that parity was the most important factor influencing initial milk yield, Soliman (1976) and Ashmawy (1981) came to the same findings. They found that parity effects on initial milk yield were statistically highly significant ($P < 0.01$) and that most of the variance caused by the factors they studied was contributed by parity effect (33.1% by Soliman 1976, and 33.72% by Ashmawy, 1981). In this respect, Mourad (1978) and Salem (1983) proved that parity effects were constituted highly significant($p<0.0I$) source of variatio in initial milk yield. Mourad (1978) found that parity was responsible for only 5.57% of the total variance in initial milk yield of buffaloes studied. Also, El-Irian (1981) studied the effects of parity on milk yield of the first 3 months of lactation. He found that milk yield of this period varied significantly and the differences accounted for 31.96% of the total variance. Ashmawy (1981) atributed the effect of parity on initial milk yield to the increase in weight and size as age advanced causing increase of the ability of the animal to increasing its production and/or developing the secretory tissue in the udder with advance of the order of lactation until it reaches full development.

Age at calving:

The linear and quadratic regression coefficients of initial milk yield on age at calving for buffaloes of the present work were found to be 10.66±1.01 and -0.03±0.05 kg/month, respectively (Table 2). The analysis of variance proved that these estimates were highly significant ($P<0.01$) as shown in (Table 5). These findings reveal the dependence of the initial milk yield on age of the buffaloe at calving. This also was proved by Mourad (1978) and Salem (1983) in the Egyptian buffaloes. Mourad (1978) indicated that the linear and quadratic regression coefficients of initial milk yield on age(3.82 and -0.12 kg/month, respectively) were highly significant ($P<0.01$). Salem (1983) reported a highly significant ($P<0.01$) linear regression coefficient of initial milk yield on age at calving being 1.02 kg/month.

Estimates of both linear and quadratic regression coefficient of initial milk yield on age at calving revealed the curve-linearity effect of age on initial milk yield which was proved by most workers on Egyptian buffaloes (Bedeir, 1965; Ragab *et al*., 1973; Soliman, 1976; Mourad, 1978; El-Irian, 1983; Ashmawy, 1981 and Salem,1983).

2. Six Months Milk Yield

Milk yield of the first six months of lactation averaged 1115.43 ± 30.54 kg (Table 3). This estimate is lower than 741.56 ± 12.40 kg obtained by El-Irian (1981) when considering the 1st lactation. At the same time it is close to 1062.54 ± 7.40 kg obtained by the same author when considering lactations from the 2nd up to the 8th. Also, close to 1320.7 ± 37.46 kg was found by El-Chafie (1981) for the herd of Alexandria University. However, the present mean is higher than that reported on Mehallet Moussa buffalo (873.3 ± 9.34) by the same author. The two estimates of El-Chafie was calculated on the basis of the 1st 200-day milk yield.

Year of calving:

The average milk production of the 1st 6 months of lactation (not more than 174 days) changed from year to another during the period of the study (Table 3). Differences in 6-month milk yield due to year-of-calving effects were statistically highly significant ($P < 0.01$) and accounted for 10.88% of the total variance (Table 5). These findings are in consistency with those obtained in the present study when dealing with initial (1st-70-day)

Table (3) : Least squares means, standard errors and Duncan's test for factors influencing 6-month milk yield (not more 174-day) of base population.

Classification	No.	$\bar{x}$ or b ± S.E.	Classification	No.	$\bar{x}$ or b ± S.E.
Overall mean:	888	1115.43±30.54	**Season of calving**		
Year of calving:			Winter	231	1093.72±32.12a
1962	20	831.94±65.46	Spring	199	1137.03±34.87a
1963	93	989.93±43.40	Summer	179	1136.60±34.85a
1964	82	892.42±41.63	Autumn	279	1094.38±32.69a
1965	83	905.02±39.40	**Parity:**		
1966	108	1023.89±36.50			
1967	100	1136.04±34.55	1st	177	856.10±44.88a
1968	101	1178.78±34.01	2nd	176	927.84±36.36b
1969	72	1177.75±35.84	3rd	172	1026.69±32.76c
1970	56	1250.69±38.41	4th	117	1040.44±34.76c
1971	43	1297.22±42.74	5th	76	1063.89±39.68c
1972	39	1264.49±45.77	6th	55	1106.12±46.64cd
1973	28	1183.44±56.40	7th	39	1190.47±55.73d
1974	17	1217.04±67.86	8th	26	1216.85±68.21d
1975	19	1313.70±71.12	9th	20	1246.20±79.55d
1976	8	1100.95±102.95	10th or more	30	1479.73±89.49e
1977	10	1081.49±102.45			
1978	6	1027.07±118.79	**Linear regression on age**		2.28± 1.66
1979	3	1205.95±176.53			
			Quadratic regression on age		-0.02±0.01

Within each classification means having the same letter differ non-significantly from each other, otherwise they do ($P < 0.05$).

milk yield. In agreement with the present results, El-Chafie (1981) found a significant trend for the effect of year-of-calving on 200-day milk yield. Also, El-Iriam (1981) found that year-of-calving affects on the 1st 6-month milk yield of the 1st lactation were highly significant and at the same time contributed the highest to its total variance when compared with the other factors studied. However, the same author found that year of calving did not show any significant effect on the 1st 6-month of lactation when dealing with lactations from the 2nd to the 8th.

Season of calving:

The least squares means presented in Table 3 indicate that milk yield of the 1st six months of lactation varied with season of calving and that the maximum yield during this period was recorded by spring and summer calvers. These means also revealed that spring and summer calvers excelled autumn and winter calvers in this respect. Similarly, El-Chafie (1981) reported that summer calvers produced higher 200-day milk yield than winter calvers. In disagreement with these results, El-Erian (1981) found that winter calvers recorded the highest milk yield during the 1st 6-months of lactation and that winter and spring calvers produced more milk than summer and autumn calvers.

Effect of season of calving on milk yield of the 1st 6 months of lactation were not significant and accounted for only 0.32% of the total variance (Table 5). This observation lead to state that season of calving was a negligible non-significant source of variation in milk yield of the 1st 6 months of lactation for animals studied. This is similar to what reached in the present work dealing with initial milk yield. The present results are also in agreement with the low seasonal variation within herd in 200-day milk yield observed by El-Chafie (1981). In this respect, El-Irian (1981) found that season-of-calving effects were non-significant when dealing with the 1st lactation but highly significant and accounted for 21.5% of the total variance when considering lactations from 2nd up to the 8th.

Parity:

Milk yield of the 1st 6 months of lactation varied with parity and showed a trend indicating the increase of milk yield with advance of lactation number from the 1st to the 10th (Table 3). This trend was generally obtained in this work when dealing with the non-genetic effects influencing initial milk yield. El-Irian (1981) with Egyptian buffaloes observed that the average milk yield of the 1st 6 months of lactation increased from the 2nd and 5th lactations and fluctuated thereafter. However, Maymone (1942) with Italian buffaloes reported that the 6-month milk yield increased with advance of lactation sequence till its maximum was reached (at the 4th lactation) then declined thereafter.

Data enlisted in Table 5 showed that the effects of parity on milk yield of the 1st 6 months of lactation were highly significant ($P < 0.01$) and contributed to its total variance by 5.38%. In agreement with these results, El-Irian (1981) found that parity effects on milk yield of the same period was highly significant but accounted for a much higher percent-age of the total variance (66.1%). These findings are consistent with those obtained in this study analysing the data of initial milk yield which proved significance (Table 5).

Age at calving:

Results of the analysis presented in Tables 3 and 5 showed a non-significant estimate for the linear regression coefficient of 6-month milk yield on age of lactating buffaloes at calving. At the same time, they indicated that the quadratic regression coefficient of the same trait on age at calving was -0.02 kg/month and significant ($P < 0.05$). Estimates of both regression coefficients, although were not highly significant, yet they refer to the curvelinearity effects of age on 6-month milk yield as observed when dealing with initial milk yield in this work.

3. 305-day milk yield

The least squares mean of the 305-day milk yield of buffaloes of the present study was 1461.4± 53.9 kg (Table 4). This mean is higher than 1004.3 kg calculated for the 1st lactation by El-Tawil et al. (1976) in a herd of Egyptian buffaloes, but lower than 1552.7 kg calculated for the 2nd lactation by the same authors in the same study. El-Irian (1981) with Egyptian buffaloes, reported lower averages for 10-month (305-day) milk yield of the first lactation, they ranged between 1015 and 1098.96 kg, the same author in the same study found that the average of 10-month milk yield for lactations from the 2nd up to the 8th ranged between 1500.59 and 1503.53 kg, which lies in the neighborhood of the present estimate. The present estimate of the average 305-day milk yield is also less than those reported by Ashmawy (1981) and Salem (1982) for the Egyptian buffaloes (1998.69 and 1880.18 kg, respectively); that obtained by Roy Choudhury (1970) for the 1st lactation of the Italian buffaloes (1695 kg) and than those reported by Singh et al.(1967) on Murrah buffaloes considering 300-day milk yield for summer, rainy and winter seasons (1707.7, 1951.7 and 1760.8 kg, respectively). Also, Dassat et al. (1966)

Table (4) : Least squares means, standard errors and Duncan's test for the factors influencing 305-day milk yield of base population.

Classification	No.	$\bar{x}$ or b ±S.E.	Classification	No.	$\bar{x}$ or b ±S.E.
Overall mean:	888	1461.40±53.91	Season of calving:		
Year of calving:			Winter	231	1425.27±56.69a
1962	20	1084.74±115.54	Spring	199	1535.35±61.55b
1963	93	1307.87±76.60	Summer	179	1472.29±61.51ab
1964	82	1157.27±73.48	Autumn	279	1412.68±57.69a
1965	83	1212.16±69.54	Parity:		
1966	108	1286.89±64.42	1st	177	1388.77±79.21ab
1967	100	1417.05±60.99	2nd	176	1416.82±64.18a
1968	101	1473.31±60.03	3rd	172	1481.60±57.83ab
1969	72	1501.00±63.25	4th	117	1408.76±61.36b
1970	56	1596.62±67.79	5th	76	1381.74±70.02ab
1971	43	1749.12±75.43	6th	55	1411.42±82.30ab
1972	39	1716.42±80.79	7th	39	1481.96±98.37bd
1973	28	1558.68±99.54	8th	26	1491.13±120.40ad
1974	17	1602.89±119.76	9th	20	1446.99±140.40d
1975	19	1756.43±125.53	10th or more	30	1704.77±157.96ad
1976	8	1556.54±181.71			
1977	10	1441.65±180.83	Linear regression		
1978	6	1211.04±209.66	on age	888	7.04±2.93
1979	3	1675.49±311.58	Quadratic regression		
			on age	888	-0.03±0.01

Within each classification those means followed by the same letter do not differ significantly from each other, otherwise they do ($P < 0.05$).

Table (5): Least square analysis of variance of initial milk yield, 6-month milk yield and 305-day milk yield of base population.

Source of variation	d.f.	Initial milk yield		Six -month milk yield		305-day milk yield	
		M.S.	V %	M.S.	V %	M.S.	V %
Year of calving	17	176160.7897**	12.03	342541.3093**	10.88	595295.8481**	5.75
Season of calving	3	34356.3578	0.22	123354.5935	0.32	646228.5013**	1.28
Parity	9	485999.9867**	24.60	262341.5166**	5.38	192237.9881	0.22
Lin. Reg. on age	1	2226345.9630**		101603.7429		970673.0317*	
Quad. Reg. on age	1	643659.2158**		248279.5578*		714753.8388*	
Residual	856	19966.4572	63.15	53885.7696	83.42	167862.6792	92.75

* = $P < 0.05$

** = $P < 0.01$

V % = Percentage of components of variations.

gave a higher estimate for the average 270-day milk yield of Italian buffaloes (1699 kg). Agrawala (1962) with water buffaloes, in India, Singh and Desai (1962), with Bhadawari buffaloes and Dutt *et al*. (1965) with Murrah buffaloes estimated the average 305-day milk yield as 3016 lb (1368 kg), 2756.3 lb. (1250 kg) and 1436.2 kg, respectively which are not considerably different from the present average.

The average of the total lactation milk yield in the Egyptian buffaloes was estimated to be 3792.6 lb (1720.3 kg) by Ragab (1945), 1720 kg by Sidky (1951), 521 gallons (2363.2 kg), by Hilmy (1954), 2052 kg by Ragab *et al*. (1956), 3822 lb (1733.7 kg) by Afifi (1961), 488.4 gallons (2215.4 kg) by El-Kimary (1966), 2421 lb (1098.2 kg) for the 1st lactation and 2626.0 lb(1191.2 kg) for the 2nd lactation by Shakin *et al*. (1966), 390 gallons (1769.0 kg) by Alim (1967), 2980.9 lb (1352.1 kg) by Shalash *et al*. (1968), 1320-1760 kg by El-Itriby (1974), 1745 kg by Fahmy *et al*. (1975), 2151.1 kg by Soliman (1976), 1868.5 kg by Mourad (1978), 445.7 gallons (2021.7 kg) by Alim (1978), 2097.0 kg by Ashmawy (1981) and 2154.6 kg by Salem (1983). The same average was estimated for Murrah buffaloes as 2815.96 lb (1277.3 kg) by Kohli and Malik (1960), 2340 liters (kg) by Tomar and Tomar (1960) in Pakistan, 2923.3 lb (1326.0 kg) by Bhatnagar et al. (1961) 1580 liters (kg) by Arora and Gupta (1964), 4205.0 lb (1907.4 kg) by Sankunny (1964), 3508.4 and 3982.2 lb (1591.4 and 1806.3 kg) by Venkataratnan and Venkayya (1964a & b), 3106.8 lb (1409.2 kg) by Dutt et al. (1965), 2684 lb (1217.5 kg) for the 1st lactation and 3227.6 lb (1464.0 kg) by Sekhon and Gehlon (1966), 1850.4 kg by Singh and Singh (1967), 1983 kg for the 1st lactation and 2117 kg for all lactation by Polihronov (1969), 1495 kg by Gurnani and Nagarcenkar (1971), 1577 kg by Raizada et al. (1971), 1710 kg by Raut et al. (1974), 1921.3 kg by Lall (1975), 1491.1 & 1476 kg Gurnani et al. (1976 a & b), 1647.3 kg by Basu and Ghai (1978), 1867.4 kg by Kumar and Bhat (1978a) 1550 kg by Balachandran (1979) in Sri-lanka, 1388 to 1855 kg by Bhat (1979), 1387.9 kg by Chien (1979) and 1540.6 kg by Nagarcenkar (1979). Total milk yield was found to average between 1172 and 1756.8 kg for other different Indian breeds (Dave, 1938; Goswami and Nair, 1965; Raut, 1977 and Bhat, 1979). For the are the reflection of differences in lactation number and/or in the amount of records per each lactation.

<u>Year of calving</u>:

The 305-day milk yield of buffaloes of the present work varied with year of calving (Table 4), the differences were highly significant ($P < 0.01$) (Table 5). This is in fair agreement with results of Abdel-Aziz and Abdel-Ghany (1978), Abdel-Aziz and Hamed (1979) and Ashmawy (1981) on 305-day milk yield and with findings Alim (1967), Ragab *et al*. (1970), Soliman (1976), Mourad (1978), Abdel-Aziz and Abdel-Ghany (1978), Alim (1978), Abdel-Aziz and Hamed (1979), Ashmawy (1981) and El-Irian (1981) on total milk yield, all working on the Egyptian buffaloes. Similarly, El-Chafie (1981) with 2 herds of Egyptian buffaloes noticed that 300-day milk yield varied significantly with year of calving. Year of calving effects were also found to be a highly significant source of variation in milk yield of the Indian buffaloes (Singh and Dhillon, 1975, Kanaija and Balaine, 1975, Basu and Ghai, 1978a, Bhat and Patro, 1978 and Kumar and Bhat, 1978b). On the other hand, Mokhtar

(1971) in Egypt, reported that year of calving showed non-significant effects on milk yield of 1st lactation produced by daughters of his buffaloes.

In the present study, differences due to year of calving effects in 305-day milk yield accounted for 5.75% of the total variance (Table 5). Bearing in mind the highly significant effects of year of calving on initial, 6-month and 305 day milk yield as well as its sizable contribution to variances of these traits as shown in Table 5 it could be stated that year of calving was an important source of variation in milk yield of the different stages of lactation studied. In agreement with the present results on 305-day milk yield, El-Kimary (1966), Alim (1967 & 1978), Mourad (1978) and El-Irian (1981) showed that differences in year in total milk yield of Egyptian buffaloes were of pronounced magnitude. However, studies of Ashfaq and Mason (1954) on Pakistani buffaloes and those of Dassat et al. (1966) on Italian buffaloes claimed little effects for year of calving on total milk yield.

Season of calving:

Season means, given in table 4, reveal a trend indicating that spring calvers recorded the highest 305-day milk yield when compared with calvers of the other three seasons of the year. This is in consistency with findings of Soliman (1976) and Ashmawy (1981) who observed that buffaloes calved in spring showed the best performance for 305-day and/or total lactation milk yield. El-Tawil et al. (1976) and Mourad (1978) showed that calvers of months from March to August (spring and summer) produced more milk than those calved from September to February (autumn and spring). Salem (1983) showed that summer calvers were the best producers for either 305-day or total milk yield. His results were in accordance with Zaher(I944)who observed that summer calving was favourable for milk yield than winter calvings. However, Sidky (1952), Ragab et al. (1954) and Ragab and Sourour (1963) indicated that autumn and winter calvers produced more milk yield than spring and summer calvers. In this respect, Kamal (1956), Khishin et al. (1968) , Soliman (1976)and El-Irian (1981) gave evidence that winter calvers scored higher average milk yield than summer ones. Abdel-Aziz and Hamed (1979) reported that autumn calvers (Sept. - November) produced the lowest milk compared with those calving in the other seasons. El-Chafie (1981) found that summer (March-August) calvers had higher 300-day milk production than those calving during winter (September - February) season.

Seasonal differences in milk yield of the Egyptian buffaloes were attributed to differences in the availability of green fodder, weather conditions especially atmospheric temperature and managerial procedures (Ragab et al., 1954; Mokhtar, 1971 and Ashmawy, 1981). Kamal (1956) noted that a reduction in the milk yield was induced by high atmospheric temperatures. Afifi (1961) stated that the high milk production recorded by winter and spring calvers of his study may be due to the suitable conditions to which the animals were subjected during lactation such as plenty of Egyptian clover, mild weather and the unfavourable conditions for the spread of diseases and parasites. El- Tawil et al. (1976) stated that differences in dry matter content of the Egyptian clover between early and late cuts was of prime importance in the effect of season of calving on milk yield.

Results presented in table 5 indicate that differences in 305-day milk yield due to season of calving were highly significant ($P<0.01$) but accounted for only 1.28% of the total variance. Similarly, El-Kimary (1966), Soliman (1976), Mourad (1978), Abdel-Aziz and Hamed (1979) and Ashmawy (1981) observed that season of calving showed highly significant effects on milk yield of Egyptian buffaloes and were responsible for a small percentage (0.2-1.6%) of the total variance. El-Irian (1981) found that season of calving was a highly significant ($P<0.01$) source of variation in 10-month (305-day) milk yield when studying the lactations from the 2nd to the 8th. The significant effects of season of calving were also reported on milk yield of Pakistani buffaloes (Ashfaq and Mason, 1954), Murrah buffaloes (Goswami and Nair, 1965) and of Italiam buffaloes (RoyChoudhury, 1970 and Roy-Choudhury and Deshmukh, 1975). On the other hand, season of calving was found to be a non-significant source of variation in 305-day or total milk yield of the Egyptian buffaloes (Alim, 1967; Khishin et al., 1968; El-Tawil et al., 1976; Abdel-Aziz and Abdel-Ghany, 1978; Alim, 1978; El-Irian, 1981 with the 1st lactation only, and Salem, 1983) and of Murrah and other Indian buffaloes (Venkayya and Anantakrishnan, 1967; Venkataratnan and Vankayya, 1964, Singh and Singh, 1967; Gopalan et al., 1971; Raizada et al., 1971; Kanaujia and Balaine, 1975; Basu and Ghai, 1978a and Kumar and Bhat, 1978b).

The non-significant effects of season of calving on milk yield observed in most of the work on Egyptian buffaloes may attributed to the mild weather that prevails during months of the year and the reasonable standard feeding under which animals are maintained all over the year (Asker et al., 1958) or due to the fact that all herds studied were either commercial or experimental which are well fed or kept under favourable condition (Khishin et al., 1968).

Parity:

Results of parity effects showed that the 305-day milk yield increased from the 1st lactation up to the third, decreased from the 3rd to the 5th, increased again up to the 8th, decreased in the 9th and increased in the 10th lactation (Table 4). These observations indicate that the 305-day milk yield fluctuated with advance of lactation squence but showed in general, an ascending trend. In this respect, Ghazy (1953), Ragab <u>et al</u>. (1953), Hilmy (1954), Afifi (1961), Bedeir (1965), Soliman (1976), Mourad (1978) and Ashmawy (1981) with Egyptian buffaloes found that the 305-day or total milk yield increased with advance of parity till the mature yield was reached and declined thereafter. Singh and Desai (1962) and Sekhon and Gehlon (1966) with Indian buffaloes as well as Dassat <u>et al</u>. (1966) and Roy Choudhury and Deshmukh (1975) with Italian buffaloes showed the same trend. All these results reveal the curvelinearity of the effect of parity on milk yield of Egyptian, Indian and Italian buffaloes. The increase of milk yield with the advance of parity till reaching the peak of production was indicated to be a result of growth in size of the lactating female and the greater digestion capacity (Hilmy,1954).Soliman(1976)noted that the major reason of that increase is due to the advance of age which is accompanied by the development of physiological functions and growth of the udder capacity until the animals arrive the mature age and weight. Ashmawy (1981) attributed such increase in milk yield to the full development of the animal's body weight and size which is associated with the increase in the size and function of the mammary glands as well as digestive, circulatory and other body systems. The same author added that the amount of feed intake and feed utilization, therefore, is greatly increased and this is associated with increasing the efficiency of milk synthesis and secretion of the udder glandular tissues. The decrease of milk production with the advance of lactation sequence after reaching the maximum production was reported by Hilmy (1954) to be mainly due to senility. Ashmawy (1981) stated that, after reaching the mature body weight and size, the physiological activity of all body systems started to decrease and the secretory tissue of the udder is partially degenerated leading to a decrease in the amount of milk production.

The mature total or 305-day milk yield was reached at varying lactations, from the 2nd to the 6th in the Egyptian buffaloes (Ragab *et al.*, 1953; Hilmy, 1954; Afifi, 1961; Khishin *et al.*, 1968; Soliman, 1976; Mourad, 1978; Ashmawy, 1981; El-Irian, 1981 and Salem, 1983) from the 3rd to the 5th in the Indian buffaloes (Dave, 1938; Agarwala, 1962; Singh and Desai, 1962; Sekhan and Gehlon, 1966; Rao _et al_., 1970; Basu and Ghai, 1978a, and Kumar and Bhat, 1978b) and in the 6th lactation in Italian buffaloes (Roy Choudhury, 1970). Attaining the mature milk yield at different lactations by buffaloes of different herds of the same country or of different countries could possibily be due to differences in age at first calving, length of dry period and/or genetic differences among the different herds studied as noted by Ashmawy (1981). Differences in mangerial procedures followed in these herds could be added in this concern.

The least squares analysis of variance (Table 5) indicated that parity did not show any significant effect on the 305-day milk yield and was responsible for only 1.28% of the total variance. Similarly, Gurani _et al_. (1976) found that effects of parity on milk yield of Murrah buffaloes did not constitute a significant source of variation. On the contrary, Soliman (1976), Mourad (1978), Ashmawy (1981), El-Irian (1981) and Salem (1983) with Egyptian buffaloes, found that parity effect on 305-day or total milk yield were highly significant and accounted for a considerable percentage (10.6-71.4%) of its total variance. Similarly, Bhatnagar <u>et al</u>. (1961), Singh and Singh (1967), Raizada <u>et al</u>. (1978b), Basu and Ghai (1978a) and Kumar and Bhat (1978b) indicated that milk yield of Murrah and other Indian buffaloes was significantly affected by lactation sequence.

<u>Age at calving</u>:

The linear and quadratic estimates of 305-day milk yield were 7.04 and -0.03 kg/month, respectively (Table 4). These estimates revealed that the effect of age at calving on 305-day milk yield was expressed in a curvelinear pattern such as the pattern shown when dealing with initial and 6-month milk yield (Table 2 & 3). The same pattern was also reported by Ghazy (1953), Ragab <u>et al</u>. (1953), Hilmy (1954), Afifi (1961), Soliman (1976) and Mourad (1978). The analysis of variance presented in table 5 showed that both linear and quadratic regression coefficients were significant ($P < 0.05$). This means that the 305-day milk yield was significantly dependent on age at calving. The same findings were also reported in respect to total milk yield by Alim (1967) and Salem (1983) in the Egyptian buffaloes; Iqbalub-din *et al*. (1970) and Mathur and Roy Choudhury (1971) in Italian buffaloes and by Singh and Desai (1962) in Indian buffaloes. On the contrary, Mourad (1978) found that both linear and quadratic regression coefficients of total milk yield on age at calving were non-significant.

4. Lactation Period

Length of lactation period is one of the most important criteria for the prediction of productive efficiency of dairy animals. The overall mean of length of lactation period for the Egyptian buffaloes used in this work averaged 301.8 days (Table 6). This average, when compared with those indicated by different investigators is close to 301.0 and 304.2 days obtained by Bedeir (1965) and El-Irian (1981), respectively. It is longer than those reported by Ragab (1945), Afifi (1961), Shahin et al. (1966), Khishin et al. (1968), Mourad (1978) and Abdel-Aziz and Abdel-Ghany (1978) which ranged between 241 and 291.4 days. At the same time, it is shorter than those found by Khishin (1951), Ragab et al. (1953), Alim and Ahmed (1954), Hilmy (1954), Asker et al. (1954), El-Kimary (1966), Alim (1967), El-Itriby (1974), Soliman (1976), Alim (1978), Ashmawy (1981) and Salem (1983), which ranged between 311 and 365.9 days.

Considering Murrah and other Indian buffaloes, it could be stated that the present average of length of lactation period, is close to 300.4, 303, 303.8, 295.9 and 299.0 estimated by Rai (1966), Raut et al. (1974), Kanaujia and Balain (1975), Bhat (1979) and Nagarcenkar (1979), Table (6) : Least squares means, standard errors and Duncan's test for factors influencing lactation period of base population.

Classification	No.	$\bar{x}$ or b ±S.E.	Classification	No.	$\bar{x}$ or b±S.E.
Overall mean:	888	301.8±11.6	Season of calving:		
Year of calving:			Winter	231	309.0±12.2 a
1962	20	274.2±24.9	Spring	199	314.6±13.3 b
1963	93	285.3±16.5	Summer	179	285.8±13.3 ab
1964	82	302.1±15.7	Autumn	279	297.8±12.4 a
1965	83	306.5±15.0	Parity:		
1966	108	284.8±13.9	1st	177	340.7±17.1 a
1967	100	265.6±13.2	2nd	176	347.0±13.8 a
1968	101	264.8±13.0	3rd	172	332.6±12.5 a
1969	72	275.5±13.6	4th	117	314.3±13.2 a
1970	56	289.6±14.6	5th	76	311.1±15.1 a
1971	43	304.5±16.3	6th	55	308.9±17.8 a
1972	39	330.9±17.4	7th	39	285.9±21.2 a
1973	28	336.9±21.5	8th	26	277.7±26.0 a
1974	17	357.7±25.8	9th	20	239.4±30.3 a
1975	19	321.3±27.1	10th or more	30	260.6±34.1 a
1976	8	406.9±39.2			
1977	10	291.4±39.0	Linear regression on age	888	-1.001±0.632
1978	6	275.0±45.3			
1979	3	259.5±67.3	Quadratic regression on age	888	0.005±0.003

Within each classification means having the same latter differ non-significantly from each other, otherwise they do ($P < 0.05$).

respectively, but it longer than those reported by Kohi and Malik (1960), Singh and Desai (1962), Venkataratnan and Venkayya (1964), Goswami and Nair (1965) Gurnani and Singh (1974), Sharma and Singh (1974), Tawarkar and Joher (1975), Gurnani et al. (1976a & b), Basu and Ghai (1978a & b) and Kumar and Bhat (1978) which ranged between 267.4 and 293 days. It is also shorter than those calculated by Venkayya and Anantakrishnan (1957), Bhatnagar et al. (1961), Sankunny (1964), Lall (1975) and Raut and Singh (1978) which ranged from 312 to 331.2 days.

The average length of lactation period reached in this study is more than all the available means obtained for Italian buffaloes, 285.7 days by Defranciscis et al. (1969), 258.0 days by Roy Choudhury (1970), 258.4 days by Deshmukh and Roy Choudhury (1971) and 275 by Franciscis (1979).

Year of calving:

Least squares mean of lactation period differed with year of calving, the differences were highly significant ($P < 0.01$, Table 6 & 7). This is in agreement with the findings of Soliman(I976) ,Mourad(I978),Alim

(1978) and Ashmawy (1981) who reported highly significant effects for year of calving on length of lactation period in the Egyptian buffaloes. The same results were also reported by Kanaujia and Balaine (1975) in Italian buffaloes and by Jawarkar and Johar (1975) and Basu and Ghai (1978b) in Murrah buffaloes. However, Abdel-Aziz and Abdel-Ghany (1978) with Egyptian buffaloes and Kumar and Bhat (1978) with Murrah buffaloes found that year-of-calving effects on length of lactation period were not significant. The significant effects of year of calving on length of lactation period was ascribed in Italy to differential nutritional and management practices prevalent over different times by Kanaujia and Balaine (1975).

Results of the analysis of variance presented in Table 7 showed that year-of-calving effects contributed by a small amount of the total variance (3.38%). Similarly year-of-calving effects were found to account for a low percentage (0.40 - 2.96%) of the total variance in length of lactation period by Kanaujia and Balaine (1975), Soliman (1976), Mourad (1978) and Ashmawy (1981) working on Italian and Egyptian buffaloes. In this respect, El-Irian

Table (7) : Least square analysis of variance of lactation period of base population.

Source of variation	d.f.	M.S.	V %
Year of calving	17	19245.2847 **	3.38
Season of calving	3	29056.3441 *	1.25
Parity	9	9807.7815	0.40
Lin. Reg. on age	1	19632.2209	
Quad. Reg. on age	1	18644.6608	
Residual	856	7822.4705	94.97

* = $P < 0.05$

** = $P < 0.01$

V % = Percentage of components of variations

(1981) found that year of calving contributed 75.14 and 2.44% of the total variance in length of lactation period considering the 1st lactation and lactations from the 2nd up to the 8th, respectively. At the same time, Alim (1978) reported that year of calving effects constituted a pronounced source of variation in length of lactation period, it accounted for 6.77% of its total variance.

Season of calving:

Least squares means presented in table 6 show that spring calvers recorded that the longest lactation period compared with those of the other seasons of year. They also reveal that summer calvers had the shortest lactation length. In agreement with these results, Soliman (1976), Mourad (1978) and Ashmawy (1981) found that the maximum length of lactation period was attained by spring calvers, while, Khishin et al. (1968) stated that the shortest lactation period was recorded by summer calvers. In this respect, Sidky (1952) and Ragab et al. (1954) indicated that autumn and winter calvers showed longer lactation period than those calved in summer and spring. Results of Abdel-Aziz and Abdel-Ghany (1978) and Salem (1983) showed that the longest lactation was reached by winter calvers while the shortest by summer calvers. El-Irian (1981) indicated that buffaloes calved in autumn gave lactations with longer periods than those calved in the other seasons.

Effect of season of calving on length of lactation period were significant ($P<0.05$) but accounted for only 1.25% of the total variance (Table 7). In line with these findings, Soliman (1976), Mourad (1978), Alim (1978), Ashmawy (1981) and Salem (1983) with Egyptian buffaloes reported that the differences in length of lactation period due to season of calving were highly significant ($P<0.01$). Similarly, Bhatnagar et al. (1961), Goswami and Nair (1965), Gurnani et al. (1976a and b) and Basu and Ghai (1978b) with Murrah buffaloes and other Indian buffaloes, reported significant effects for season of calving on length of lactation period. On the contrary, Afifi (1961), Venkataratnan and Venkayya (1964b), Khishin et al. (1968), Sharma and Singh (1974), Kanauji and Balaine (1975), Abdel-Aziz and Abdel-Ghany

(1978) and Kumar and Bhat (1978a) found that season of calving did not show any significant effect on length of lactation period in buffaloes of different countries. Results of the present study showed that season-of-calving effects although significant, it constituted a minor source of variation (Table 7). This also was evidenced by Soliman (1976), Alim (1978), Mourad (1978), Ashmawy (1981) and El-Irian (1981) since they found that season effects were responsible for 1.39 - 4.61% of the total variance.

Parity:

Length of lactation period varied with parity, it increased from the 1st to the 2nd lactation and showed a general decrease thereafter with advance of parity or lactation number (Table 6). In agreement with these observations, Bedeir (1965) found that length of lactation period increased from the 1st to the 2nd lactation and showed, in general, a slight decrease thereafter up to the 6th lactation. Different trends for the effect of parity on length of lactation period were observed on the Egyptian buffaloes (Soliman, 1976; Mourad, 1978; Ashmawy, 1981 and Soliman, 1983), on Murrah buffaloes (Bhatnagar et al., 1961; Singh and Desai, 1961; Jawarkar and Johar, 1975 and Basu and Ghai, 1978b).

Observations of table 6 on buffaloes of this work indicated that the 1st and 2nd lactations tended to have longer length than those of the subsequent ones. This seems to be in agreement with results of Ragab et al. (1953) who showed that young buffaloes had a tendency toward longer length of lactation than older ones.

Differences in length of lactation period due to parity effects were non-significant (Table 7). This is in consistency with this findings of Ashmawy (1981) in Egyptian buffaloes and Gurnani et al. (1976) in Murrah buffaloes. On the contrary, significant parity effects were reported by Bedeir (1965), Soliman (1976), Mourad (1978), El-Irian (1981) and Salem (1983) in the Egyptian buffaloes and by Bahatnagar et al. (1961), Jawarkar and Johar (1975), Basu and Ghai (1978b) and Kumar and Bhat (1978a) in Murrah buffaloes.

Parity effects on length of lactation period in buffaloes of this study were very limited since it accounted only for 0.4% of the total variation. This is in agreement with findings of Soliman (1976) and Mourad (1978).

<u>Age at calving</u>:

The linear and quadratic regression coefficients were -1.001 and 0.005 day/month, respectively (Table 6). The analysis of variance showed that age at calving did not exert any significant effect on length of lactation period (Table 7). These results indicate that age at calving did not influence length of lactation period in buffaloes of this work. Afifi (1961) reported the same findings. He found that both linear regression of length of lactation period on age and the correlation coefficient were not significant. In this respect, findings of Ragab <u>et al</u>. (1953) concluded that age of the buffaloe did not affect length of lactation period to a great extent. However, results of Salem (1983)indicated the importance of age in this respect. He reported that the regression coefficient of length of lactation period was 0.945 and highly significant.

B. PHENOTYPIC AND GENETIC IMPROVEMENT

Data of normal first lactation records of buffaloes of the herd under study from 1962 to 1980 were analysed to evaluate the phenotypic and the genetic improvement in initial, 6-month and 305-day milk yields as well as in length of lactation period. First lactation records were only used to avoid the confounding which may exist between the effects of year of calving and those of age of buffaloes at different calvings and between effects of selection done after the 1st lactation and sequence of calving (Parity). Moreover first lactation records are free from the effects of uncontrolled environmental factors that may influence the successive lactations such as dry period, service period, calving interval,..... etc. As mentioned previously in materials and methods, the assumption that there was no interaction between age at 1st calving and year of calving was made.

1. Phenotypic Improvement

To evaluate the phenotypic improvement in milk production traits of the present study, the normal first lactation records were analysed by adopting a linear model including the effects of year of calving, season of calving and regression on age at first calving; the least squares analysis was used. Results of this analysis are presented in tables 8 and 9. The average amount of phenotypic improvement per year was estimated by obtaining the regression coefficient of year of calving means of the trait on year number. The same procedure was followed by Burnside and Legates (1967), but the weighted regression of the least squares constants of year of calving on year number was calculated to provide their estimates of annual phenotypic trends in milk yield and percent age of fat in Holstein Friesian cattle. The average phenotypic improvement per generation in this study was obtained by multiplying the average phenotypic improvement per year by 6.2 which is the average generation interval in the herd under study (estimated according to the method applied by Asker and Ragab, 1951).

The least squares yearly means for the studied traits reveal, in general, a steady progress from 1962 up to 1980 in initial, 6-month and 305-day milk yields, but showed fluctuations with no consistent trend in length of lactation period Table 8 and Figure 1. Differences among year of calving means adjusted for season of calving and age at first calving (by their inclusion in the model of analysis) were highly significant (Table 9). It is believed that the difference between the mean of any year of calving obtained in the present study and that of any other successive one gives a

Table (8) : Least squares means, standard error and Duncan's test for the factors influencing milk production traits of the 1st lactation.

Classification	No.	Initial milk yield (kg)	6-month milk yield (kg)	305-day milk yield	Lactation period
		x̄ or b ±S.E	x̄ or b ±S.E	x̄ or b ± S.E	x̄ or b ± S.E
Overall mean:	1254	337.34± 2.76	767.49± 5.81	1134.42±10.64	326.20± 3.04
Year of calving:					
1962	20	271.56±19.73	604.71±41.63	881.81±76.16	321.30±21.80
1963	93	315.43± 9.19	753.01±19.40	1137.26±35.50	332.27±10.16
1964	102	302.10± 8.73	690.71±18.43	1011.75±33.72	354.94± 9.65
1965	88	261.44± 9.53	595.33±20.12	935.49±36.81	354.77±10.33
1966	94	302.48± 9.19	715.94±19.39	1059.34±35.48	372.96±10.15
1967	120	305.34± 8.19	695.60±17.29	1089.01±31.64	365.60± 9.05
1968	78	313.23±10.00	715.29±21.11	1049.58±38.63	321.86±11.05
1969	61	315.49±11.26	741.78±23.76	1119.40±43.47	313.82±12.44
1970	61	333.98±11.29	740.90±23.83	1076.41±43.60	310.03±12.48
1971	68	365.58±10.73	830.24±22.64	1236.76±41.43	311.42±11.85
1972	58	347.16±11.52	800.40±24.32	1214.71±44.50	340.85±12.73
1973	40	304.77±13.96	704.23±29.46	1050.09±53.90	310.83±15.42
1974	75	398.19±10.22	872.16±21.58	1239.39±39.48	318.14±11.30
1975	43	394.79±13.43	900.99±28.34	1309.45±51.85	339.08±14.84
1976	81	342.23±10.07	787.55±21.26	1245.38±38.89	370.96±11.13
1977	39	338.54±14.08	780.58±29.71	1171.78±54.35	332.72±15.55
1978	45	402.49±13.21	854.62±27.87	1173.31±51.00	282.84±14.59
1979	59	371.29±11.49	850.83±24.24	1182.56±44.35	266.47±12.69
1980	29	423.45±16.36	947.37±34.53	1370.46±63.19	276.98±18.08
Season of calving:					
Winter	319	336.05± 5.11a	738.48±10.78a	1109.92±19.73ac	343.07± 5.65a
Spring	302	334.75± 5.32a	771.92±11.22b	1173.05±20.53b	331.09± 5.88ab
Summer	283	340.87± 5.47a	792.92±11.55b	1161.81±21.13ab	316.68± 6.05bc
Autumn	350	337.70± 4.92a	766.62±10.38ab	1092.90±19.00c	313.97± 5.44c
Regression on age at 1st calving:	1254	1.5933±0.3712	1.9719±0.7833	1.2773±1.4331	-0.5040±0.4101

Table (9) : Least squares analysis of variance for milk production traits of the first lactation.

Source of variation	d.f	Initial milk yield		6-month milk yield		305-day milk yield		Lactation period	
		MS	V %	MS	V %	MS	V %	MS	V %
Year of calving	18	104196.5053**	21.42	443941.8072**	20.45	739178.2449**	10.28	58714.6084**	10.10
Season of calving	3	1877.4754	0.00	142025.4739**	0.83	463407.8888**	0.91	55202.3397**	1.45
Regression on age at 1st calving	1	141699.7282**		217048.0744**		91066.3100		14178.9381	
Residual	1231	7689.4287	78.58	34246.1104	78.72	114639.8574	88.81	9387.8731	88.45

** $P < 0.01$

V% = percentage of components of variations.

good estimate for the phenotypic change that has occurred during the time interval between these 2 years. Differences between 1962 mean on one hand and those of the other successive years up to 1980 were in most cases, significant ($P < 0.05$ as Duncan's test showed. These differences appeared to increase as years passed from 1962 to 1980 for initial, 6-month and 305-day milk yield only (Figure 2).

Data of the present work revealed that the average phenotypic change per year was 6.637±1.093 kg in initial milk yield, 13.613±2.356 kg in 6-month milk yield, 16.999±3.387 kg in 305-day milk yield and -2.92±1.099 day in length of lactation period (Table 10). These were significant at 1% level of probability except that of annual change in length of lactation period which was significant at 5% level of probability only. The regression lines of yearly means on year number for the different traits studied were plotted in Figure 3 considering the average phenotypic change per generation, the estimates were 41.149, 84.401 and 105.394 kg for initial, 6-month and 305-day milk yields, respectively and -18.104 day for length of lactation period. The annual phenotypic change as a percentage of the herd average was found to be 1.967, 1.774, 1.498 and -0.895% for initial milk yield, 6-month milk yield, 305-day milk yield and length of lactation period, respectively (Table 10).

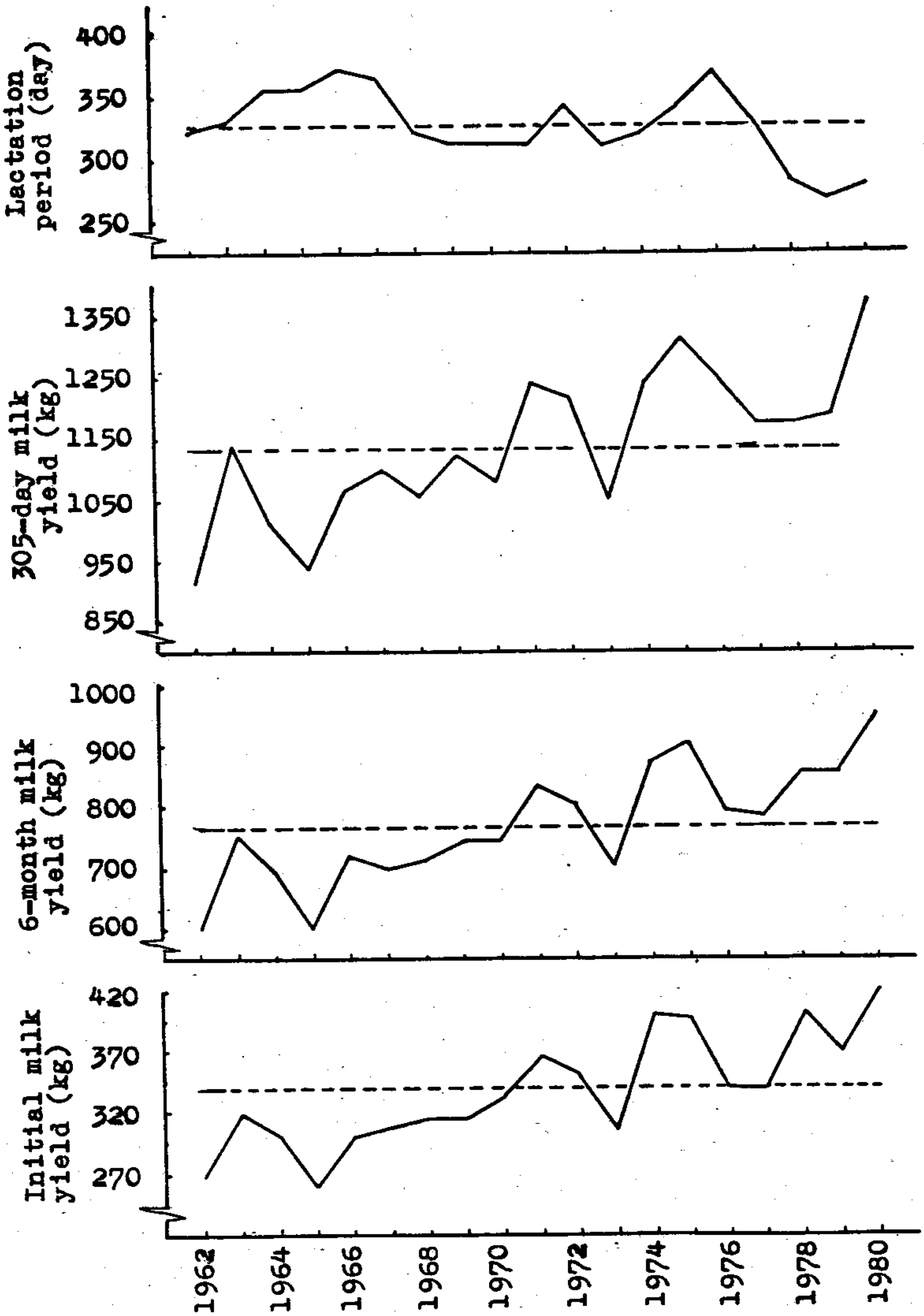

Fig. 1 : Yearly variation in least square means of production traits under study.

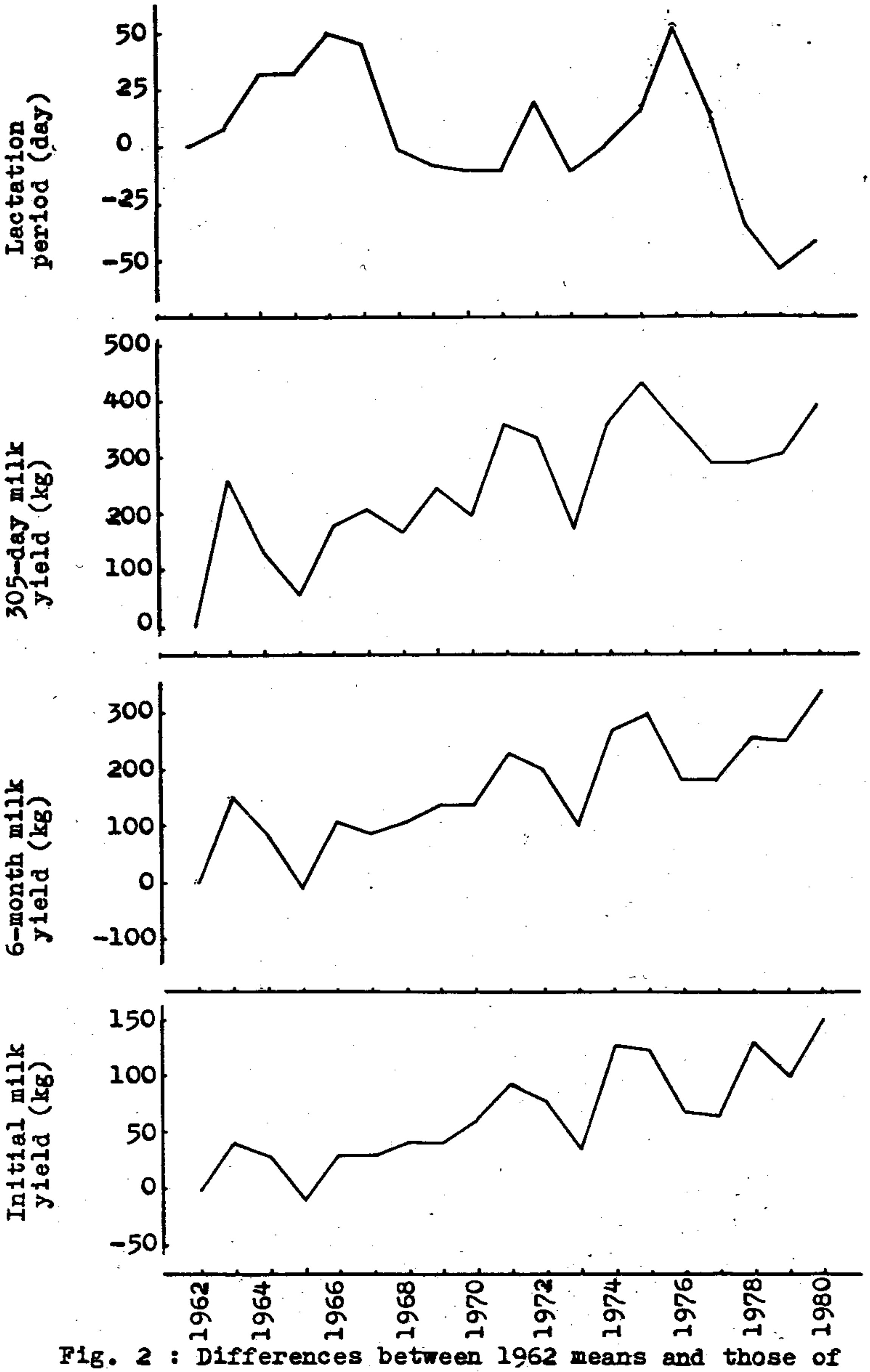

Fig. 2 : Differences between 1962 means and those of the successive years in milk production traits.

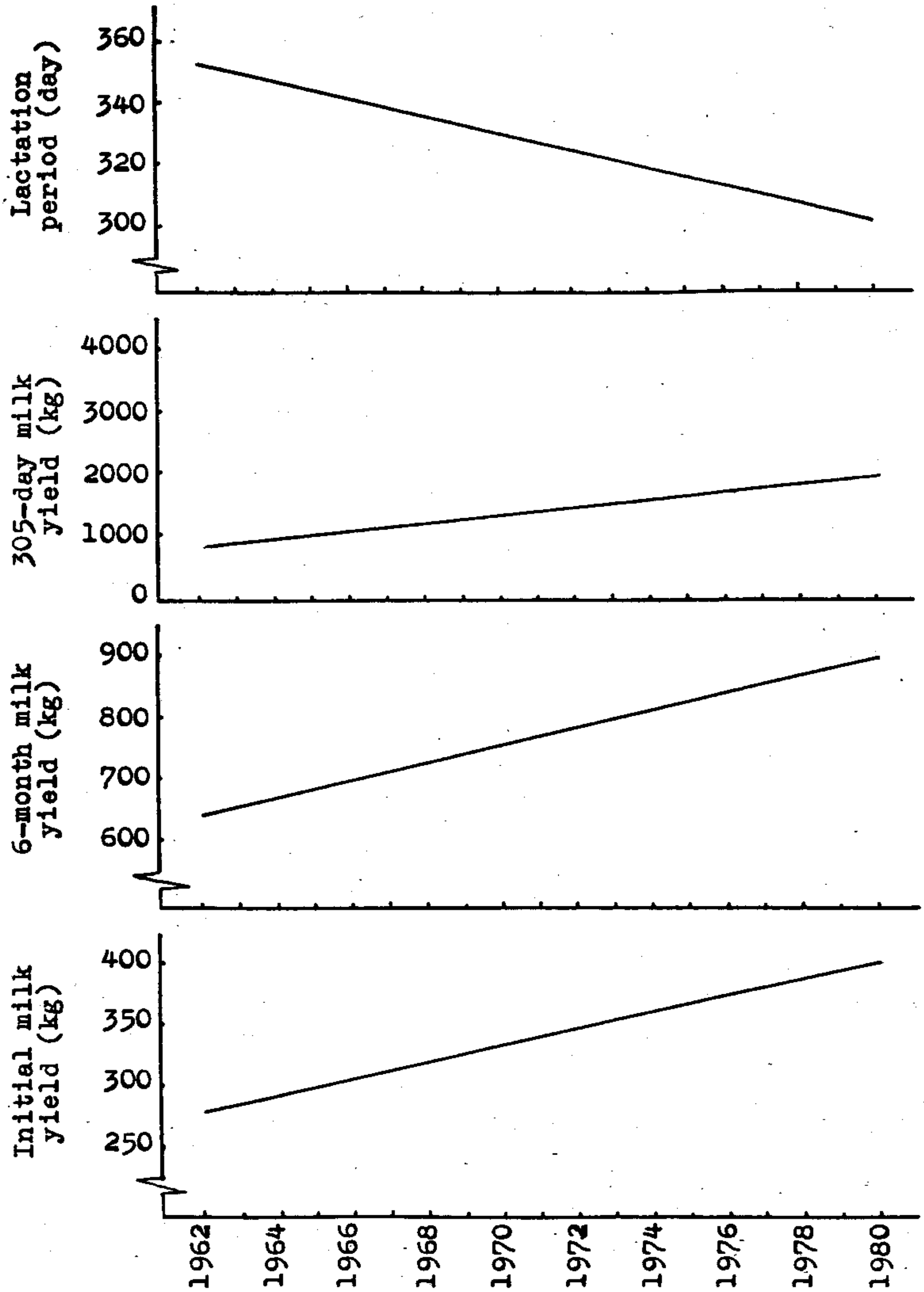

Fig. 3 : Regression of yearly means on year number ($^{b}\Delta G + \Delta E$) for all the production traits under study ($\hat{Y} = \mu + by_{x}(x - \bar{x})$)

Table (10) : Phenotypic improvement (change) in initial, 6-month and 305-day milk yield as well as in length of lactation period.

Trait	Overall mean $\bar{x} \pm$ S.E.	Average annual phenotypic improvement: Estimate ± S.E.	Average annual phenotypic improvement: As a % of the overall mean	Average improvement per generation
Initial milk yield (kg)	337.34±2.76	6.637±1.093 **	1.967 %	41.149 kg
6-month milk yield (kg)	767.49±5.81	13.613±2.356 **	1.774%	84.401 kg
305-day milk yield (kg)	1134.42±10.64	16.999±3.387 **	1.498 %	105.394 kg
Length of lactation period (days)	326.20±3.04	-2.920±1.099 *	-0.895 %	-18.104 days

* $P < 0.05$
** $P < 0.01$

All these findings indicate that phenotypic improvement in the three traits of milk yield was achieved during the period of the study, but the annual change in length of lactation showed a slightly negative phenotypic trend.

Similar to the present results, Dillon et al.(1955) reported a positive trend by using the maximum likehood procedure in milk production. They found that the regression of the average real producing ability on years in a herd of Holstein Friesians was 0.68±14.00 lb of fat corrected milk. Also, using the least squares procedure, Harville and Henderson (1967) with Holstein Friesian cattle, reported a positive phenotypic change (progress) of 176±8 kg in milk and 6.4±0.3 kg in milk fat per year. Burnside and Legates (1967) with 1st lactation records of Holstein Herd Improvement Regestry, from 1953 to 1961, showed positive phenotypic change. They estimated the weighted regression of the least squares constants of years of calving on year number (the annual phenotypic change) as 63±11 kg for milk yield and 0.007±0.001 for fat percentage.

The observed negative phenotypic change in the length of lactation period is unexpected because the same data indicated high positive phenotypic and genetic correlation coefficients between length of lactation period and 305-day milk yield which showed positive and highly significant ($P < 0.01$) phenotypic change. The estimate of the average phenotypic change in length of lactation period seems to be biased downwards and this seems to be due to that the data were recorded some time ago from 1962 and may have been biased by environmental effects now unknowed. Therefore it could not be explained.

2. Genetic Improvement

The measurement of genetic improvement from data unplanned for this purpose seems to lack accuracy and needs special precuations. In this study three methods were attempted to measure the genetic improvement clean from environmental deviations in initial, 6-month and 305-day milk yields as well as length of lactation period which may have occurred during the period of the study. Complete accuracy of estimate was not likely to be achieved. First, normal 1st lactation records were analysed for the effects of generation number of buffaloes that gave the records, year of calving, season of calving and regression of the records on age at 1st calving. The regression coefficient of generation means of each of the traits studied on generation number was calculated to obtain the average genetic improvement per generation. Second, The same data were reanalysed for the effects of the generation number of the sire of the lactating buffaloes and the other non-genetic factors involved in the 1st analysis. The regression coefficient of the sire generation means (the means of buffaloes born to sires of different generations) on sire generation number was estimated to approximate an estimate for one half the genetic improvement per generation. Third, the same data were analysed once more for the effects of year of calving, season of calving, regression on age at 1st calving and regression on generation number of the lactating buffaloe. The estimate of the regression of performance on the buffaloes' generation number was estimated to approximate the genetic improvement per generation. Results of the least squares analysis performed in the three methods are presented in tables 11 through 25. These results proved that the performance of all milk production traits varied with generation number of either the lactating buffaloes or their sires but without significance.

In method 1 and method 2, the difference between the mean of a particular generation and that of any of the successive generations approximates the amount of genetic improvement that occurred during the time interval between these 2 generations. The difference between the means of zero generation and the last one in methods 1 and 2, respectively was

Table (11) : Least squares means, standard errors and Duncan's test for the factors influencing initial milk yield (first 70-day) of first lactation.

Classification	No.	$\bar{x}$ or b ±S.E.(kg)	Classification	No.	$\bar{x}$ or b ± S.E. (kg)
Overall mean:	1254	341.05± 4.75	**Season of calving:**		
Year of calving:			Winter	319	339.95± 6.60a
1962	20	272.51±23.35	Spring	302	338.36± 6.47a
1963	93	320.18±13.61	Summer	283	344.81± 6.66a
1964	102	314.95±11.48	Autumn	350	341.08± 6.20a
1965	88	274.90±12.04	**Generation number of buffaloe**		
1966	94	319.15±11.70	0	177	339.59±11.59ab
1967	120	321.28±10.74	1	503	323.04± 6.09a
1968	78	325.08±11.69	2	334	343.68± 5.95b
1969	61	326.39±12.70	3	220	345.43± 8.59ab
1970	61	337.76±12.63	4	20	353.52±21.37ab
1971	68	368.87±11.99	**Regression on age at 1st**		
1972	58	349.44±12.75	**calving**	1254	1.44± 0.42
1973	40	307.05±14.78			
1974	75	396.65±11.44			
1975	43	392.71±14.45			
1976	81	337.58±11.21			
1977	39	334.21±14.99			
1978	45	397.37±14.49			
1979	59	365.82±12.96			
1980	29	418.07±17.57			

Table (12) : Least squares means, standard errors and Duncan's test for the factors influencing 6-month milk yield (not more than 174-day) of first lactation.

Classification	No.	$\bar{x}$ or b ± S.E.(kg)	Classification	No.	$\bar{x}$ or b ± S.E. (kg)
Overall mean	1254	779.13±10.01	Season of calving:		
Year of calving:			Winter	319	750.78±13.93 a
1962	20	588.40±49.28	Spring	302	782.89±13.65 b
1963	93	749.05±28.73	Summer	283	805.25±14.06 b
1964	102	710.95±24.22	Autumn	350	777.62±13.08 ab
1965	88	617.50±25.42	Generation number of buffaloe:		
1966	94	748.26±24.68	0	177	793.52±24.45 a
1967	120	727.53±22.67	1	503	743.56±12.86 a
1968	78	742.84±24.68	2	334	772.94±12.55 a
1969	61	767.36±26.80	3	220	771.07±18.12 a
1970	61	755.21±26.66	4	20	814.58±45.11 a
1971	68	845.07±25.30	Regression on age at 1st calving:	1254	1.36± 0.88
1972	58	814.30±26.90			
1973	40	716.85±31.19			
1974	75	879.92±24.15			
1975	43	908.44±30.50			
1976	81	789.36±23.66			
1977	39	784.14±31.64			
1978	45	856.91±30.57			
1979	59	851.94±27.35			
1980	29	949.54±37.08			

Table (13) : Least squares means, standard errors and Duncan's test for the factors influencing 305-day milk yield of first lactation.

Classification	No.	$\bar{x}$ or b ± S.E. (kg)	Classification	No.	$\bar{x}$ or b ± S.E. (kg)
Overall mean	1254	1151.81±18.33	Season of calving:		
Year of calving:			Winter	319	1128.14±25.51ac
1962	20	835.26±90.21	Spring	302	1189.21±24.99 b
1963	93	1114.10±52.60	Summer	285	1180.54±25.73ab
1964	102	1032.87±44.33	Autumn	350	1109.36±23.94 c
1965	88	960.16±46.53	Generation number of buffaloe:		
1966	94	1103.05±45.18	0	177	1194.49±44.77 a
1967	120	1132.97±41.50	1	503	1102.69±23.55 a
1968	78	1089.47±45.18	2	334	1140.01±22.97 a
1969	61	1156.13±49.06	3	220	1124.32±33.18 a
1970	61	1097.29±48.81	4	20	1197.55±82.58 a
1971	68	1260.46±46.32	Regression on age at 1st		
1972	58	1238.06±49.25	calving	1254	0.03± 1.61
1973	40	1070.82±57.09			
1974	75	1255.92±44.21			
1975	43	1326.14±55.83			
1976	81	1255.40±43.32			
1977	39	1185.42±57.92			
1978	45	1188.32±55.96			
1979	59	1196.15±50.08			
1980	29	1386.46±67.88			

Table (14) : Least squares means, standard errors and Duncan's test for the factors influencing lactation period of first lactation.

Classification	No.	$\bar{x}$ or b ± S.E.(day)	Classification	No.	$\bar{x}$ or b ± S.E.(day)
Overall mean	1254	328.06± 5.25	Season of calving:		
Year of calving:			Winter	319	344.99± 7.31a
1962	20	329.26±25.84	Spring	302	332.98± 7.16ab
1963	93	337.33±15.06	Summer	283	318.38± 7.37bc
1964	102	354.48±12.70	Autumn	350	315.89± 6.86c
1965	88	353.85±13.33	Generation number of buffaloe		
1966	94	369.62±12.94	0	177	320.56±12.82a
1967	120	362.06±11.89	1	503	332.05± 6.74a
1968	78	318.00±12.94	2	334	330.67± 6.58a
1969	61	310.53±14.05	3	220	314.64± 9.50a
1970	61	307.38±13.98	4	20	342.39±23.65a
1971	68	309.90±13.27	Regression on age at 1st		
1972	58	339.44±14.11	calving:	1254	-0.35± 0.46
1973	40	311.15±16.35			
1974	75	321.29±12.66			
1975	43	341.92±15.99			
1976	81	377.03±12.41			
1977	39	337.66±16.59			
1978	45	291.32±16.03			
1979	59	274.79±14.34			
1980	29	289.14±19.44			

1962	20	279.37±12.42	Spring	302	335.55± 6.84a
1963	93	323.12±12.33	Summer	283	340.66± 7.05a
1964	102	309.63±12.03	Autumn	350	337.76± 6.60a
1965	88	269.13±12.61	Generation number of sire		
1966	94	310.06±12.33	0	752	329.70± 5.25a
1967	120	312.98±11.57	1	334	349.29± 5.77b
1968	78	316.40±12.17	2	125	343.66±10.76ab
1969	61	317.55±13.05	3	43	326.80±15.54ab
1970	61	331.71±12.78	Regression on age at 1st calving		
1971	68	363.41±12.09		1254	1.60± 0.37
1972	58	343.68±12.72			
1973	40	302.33±15.14			
1974	75	390.67±11.67			
1975	43	386.75±14.04			
1976	81	335.00±10.63			
1977	39	331.12±14.37			
1978	45	397.42±13.73			
1979	59	367.17±12.54			
1980	29	422.38±16.99			

Table (17) : Least squares means, standard errors and Duncan's test for the factors influencing 6-month (not more than 174-day) of first lactation.

Classification	No.	$\bar{x}$ or b ± S.E.	Classification	No.	$\bar{x}$ or b ± S.E.
Overall mean	1254	763.13±11.02	Season of calving:		
Year of calving:			Winter	319	733.64±14.47a
1962	20	604.90±45.27	Spring	302	768.00±14.46b
1963	93	753.22±26.05	Summer	283	788.38±14.89b
1964	102	690.79±25.43	Autumn	350	762.53±13.95ab
1965	88	595.49±26.64	Generation number of sire:		
1966	94	716.08±26.05	0	752	763.02±11.08a
1967	120	695.83±24.45	1	334	785.53±12.19a
1968	78	710.31±25.71	2	125	749.18±22.74a
1969	61	735.91±27.57	3	43	754.81±32.84a
1970	61	730.03±27.02	Regression on age at 1st calving:	1254	1.95± 0.79
1971	68	820.78±25.55			
1972	58	789.26±26.89			
1973	40	693.35±32.00			
1974	75	855.92±24.66			
1975	43	888.03±29.67			
1976	81	775.12±22.47			
1977	39	772.18±30.38			
1978	45	857.82±29.02			
1979	59	858.89±26.50			
1980	29	955.66±35.90			

Table (18) : Least squares means, standard errors and Duncan's test for the factors influencing 305-day milk yield of first lactation.

Classification	No.	$\bar{x}$ or b ± S.E.	Classification	No.	$\bar{x}$ or b ± S.E.
Overall mean	1254	1143.20±20.18	**Season of calving:**		
Year of calving:			Winter	319	1118.84±26.50ac
1962	20	902.70±82.90	Spring	302	1181.53±26.48b
1963	93	1157.63±47.71	Summer	283	1170.56±27.28ab
1964	102	1032.36±46.57	Autumn	350	1101.89±25.55c
1965	88	955.91±48.78	**Generation number of sire:**		
1966	94	1079.76±47.71	0	752	1122.55±20.30a
1967	120	1109.29±44.78	1	334	1150.91±22.33a
1968	78	1063.44±47.09	2	125	1130.73±41.65a
1969	61	1131.96±50.49	3	43	1168.62±60.15a
1970	61	1083.22±49.48	**Regression on age at 1st**		
1971	68	1244.03±46.76	**calving**	1254	1.36± 1.44
1972	58	1219.70±49.24			
1973	40	1059.59±58.60			
1974	75	1238.85±45.17			
1975	43	1306.99±54.33			
1976	81	1239.96±41.15			
1977	39	1168.81±55.63			
1978	45	1175.64±53.15			
1979	59	1186.05±48.53			
1980	29	1368.00±65.75			

Table (19): Least squares means, standard errors and Duncan's test for the factors influencing lactation period of first lactation.

Classification	No.	$\bar{x}$ or b ± S.E.	Classification	No.	$\bar{x}$ or b ± S.E.
Overall mean	1254	330.2± 5.8	Season of calving:		
Year of calving:			Winter	319	347.5± 7.6a
1962	20	326.0±23.7	Spring	302	334.7± 7.6ab
1963	93	336.9±13.6	Summer	285	320.8± 7.8bc
1964	102	359.7±13.3	Autumn	350	318.0± 7.3c
1965	88	359.4±14.0	Generation number of sire:		
1966	94	377.6±13.6	0	752	325.5± 5.8a
1967	120	370.2±12.8	1	334	324.4± 6.4a
1968	78	326.7±13.5	2	125	326.0±11.9a
1969	61	318.8±14.4	3	43	345.0±17.2a
1970	61	315.4±14.2	Regression on age at 1st		
1971	68	316.7±13.4	calving	1254	-0.47± 0.41
1972	58	346.1±14.1			
1973	40	312.2±16.8			
1974	75	323.8±12.9			
1975	43	343.6±15.5			
1976	81	374.0±11.8			
1977	39	336.0±15.9			
1978	45	284.9±15.2			
1979	59	267.7±13.9			
1980	29	274.9±18.8			

Table (20) : Least squares analysis of variance of milk production traits studied of first lactation.

Source of variation	d.f.	Initial milk yield		6-month milk yield		305-day milk yield		Lactation period	
		M.S.	V%	M.S.	V%	M.S.	V%	MS	V%
Year of calving	18	49860.3034 **	11.07	247882.4555 **	9.22	432283.8233 **	4.33	44034.8519 **	5.61
Season of calving	3	1598.9358	-	144239.4752 **	0.97	456889.3903 **	0.96	55768.2894 **	1.54
Generation number of the sire	3	17483.5099	0.95	39275.2674	0.11	42549.6628	0.50	4581.5031	0.40
Regression on age at 1st calving	1	142081.3974 **		211039.9097 **		102696.2379		12356.2215	
Residual	1228	7665.5017	87.98	34233.8242	89.70	114815.9735	95.21	9399.6150	92.4

** $P < 0.01$
V% = Percentage of components of variations.

Table (21) : Least squares means, standard errors and Duncan's test for the factors influencing initial milk yield (first 70-day) of first lactation.

Classification	No.	$\bar{x}$ or b ± S.E.(kg)	Classification	No.	$\bar{x}$ or b ± S.E.(kg)
<u>Overall mean:</u>	1254	336.57± 2.85	<u>Season of calving:</u>		
<u>Year of calving:</u>			Winter	319	335.48± 5.14a
1962	20	280.48±21.45	Spring	302	334.00± 5.36a
1963	93	322.59±11.42	Summer	283	339.95± 5.54a
1964	102	306.67± 9.74	Autumn	350	336.84± 4.99a
1965	88	265.78±10.38	<u>Regression on generation</u>		
1966	94	305.46± 9.61	<u>number of buffaloe</u>		
1967	120	307.84± 8.53		1254	5.59± 5.29
1968	74	314.10±10.04	<u>Regression on age at 1st</u>		
1969	61	316.38±11.29	<u>calving:</u>	1254	1.73± 0.39
1970	61	333.54±11.30			
1971	68	364.18±10.81			
1972	58	345.14±11.68			
1973	40	303.12±14.05			
1974	75	394.77±10.72			
1975	43	390.98±13.90			
1976	81	337.06±11.20			
1977	39	332.87±15.06			
1978	45	395.06±14.97			
1979	59	363.43±13.68			
1980	29	415.37±18.06			

Table (22) : Least squares means, standard errors and Duncan's test for the factors influencing 6-month milk yield (not more than 174-day) of first lactation.

Classification	No.	$\bar{x}$ or b ± S.E. (kg)	Classification	No.	$\bar{x}$ or b ± S.E. (kg)
<u>Overall mean:</u>	1254	766.96± 6.02	<u>Season of calving:</u>		
<u>Year of calving:</u>			Winter	319	738.09±10.85a
1962	20	610.77±45.30	Spring	302	771.41±11.33b
1963	93	757.87±24.11	Summer	283	792.30±11.70b
1964	102	693.81±20.57	Autumn	350	766.04±10.53a
1965	88	598.28±21.92	<u>Regression on generation</u>		
1966	94	717.96±20.30	<u>number of buffaloe</u>		
1967	120	697.30±18.01		1254	3.80±11.18
1968	78	715.88±21.19	<u>Regression on age at 1st</u>		
1969	61	742.38±23.83	<u>calving:</u>	1254	2.06± 0.83
1970	61	740.60±23.86			
1971	68	829.29±22.82			
1972	58	799.03±24.66			
1973	40	703.12±29.65			
1974	75	869.83±22.64			
1975	43	898.40±29.35			
1976	81	784.03±23.64			
1977	39	776.73±31.80			
1978	45	849.56±31.60			
1979	59	845.49±28.88			
1980	29	941.88±38.13			

Table (23) : Least squares Means, standard errors and Duncan's test for the factors influencing 305-day milk yield of first lactation.

Classification	No.	$\bar{x}$ or b ± S.E. (kg)	Classification	No.	$\bar{x}$ or b ± S.E. (kg)
<u>Overall mean:</u>	1254	1134.98±11.01	<u>Season of calving:</u>		
<u>Year of calving:</u>			Winter	319	1110.34±19.85a[illegible]
1962	20	875.30±82.88	Spring	302	1173.59±20.72b
1963	93	1132.04±44.11	Summer	283	1162.48±21.40a[illegible]
1964	102	1008.42±37.63	Autumn	350	1093.52±19.26c
1965	88	932.32±40.10	<u>Regression on generation</u>		
1966	94	1057.16±37.14	<u>number of buffaloe</u>		
1967	120	1087.18±32.95		1254	-4.08±20.45
1968	74	1048.94±38.77	<u>Regression on age at 1st</u>		
1969	61	1118.75±43.60	<u>calving</u>	1254	1.18± 1.52
1970	61	1076.73±43.65			
1971	68	1237.79±41.76			
1972	58	1216.18±45.12			
1973	40	1051.29±54.26			
1974	75	1241.88±41.43			
1975	43	1312.23±53.71			
1976	81	1249.15±43.25			
1977	39	1175.91±58.19			
1978	45	1178.73±57.81			
1979	59	1188.29±52.85			
1980	29	1376.36±69.77			

Table (24) : Least squares means, standard errors and Duncan's test for the factors influencing lactation period of first lactation.

Classification	No.	$\bar{x}$ or b ± S.E.(day)	Classification	No.	$\bar{x}$ or b ± S.E.(day)
Overall mean:	1254	326.47± 3.15	Season of calving:		
Year of calving:			Winter	319	343.27±5.68a
1962	20	318.17±23.72	Spring	302	331.35±5.93ab
1963	93	329.76±12.62	Summer	283	317.00±6.12bc
1964	102	353.34±10.77	Autumn	350	314.27±5.51c
1965	88	353.24±11.48	Regression on generation number of buffaloe:		
1966	94	371.92±10.63		1254	-1.96±5.85
1967	120	364.72± 9.43	Regression on age at 1st calving:	1254	-0.55±0.43
1968	74	321.55±11.10			
1969	61	313.51±12.48			
1970	61	310.19±12.49			
1971	68	311.91±11.95			
1972	58	341.55±12.91			
1973	40	311.41±15.53			
1974	75	319.34±11.85			
1975	43	340.41±15.37			
1976	81	372.77±12.38			
1977	39	334.71±16.65			
1978	45	285.45±16.54			
1979	59	269.22±15.12			
1980	29	279.81±19.96			

Table (25) : Least squares analysis of variance of milk production traits studied of first lactation.

Source of variation	d.f.	Initial milk yield		6-month milk yield		305-day milk yield		Lactation Period	
		MS	V%	MS	V%	MS	V%	MS	V%
Year of calving	18	53528.1280**	8.82	257667.9760**	9.48	484361.6313**	4.92	47194.8262**	6.04
Season of calving	3	1726.2932	0.00	140555.5986**	0.94	463901.4889**	0.96	54675.8265**	1.50
Regression on generation number of buffaloe	1	8583.7284		3960.5411		4569.2218		1054.9507	
Regression on age at 1st calving	1	149040.4697**		212445.9257*		69272.3846		15167.4110	
Residual	1230	7688.7016	91.18	34270.7328	89.58	14729.3457	94.12	9394.6478	92.46

* $P < 0.05$
** $P < 0.01$
V% = Percentage of component of variance

13.93 and -2.90 kg for initial milk yield, 21.06 and -8.21 kg for 6-month milk yield, 3.06 and 46.97 kg for 305-day milk yield and 21.83 and 19.50 days for length of lactation period. These results indicate that the average genetic merit was increased for all milk production traits studied when regressing generation means on generation number of the lactating buffaloe (method 1), but only for 305-day milk yield and length of lactation period when regressing sire generation means on sire generation number (method 2). In New York DHIA Holstein herds, Van Vleck and Handerson (1961) found that the genetic merit has increased from 1951 to 1959 by 399 lb of milk in naturally sired daughters and by 515 lb in artificially sired daughters. These estimates showed higher genetic improvement than those reached in the present work. Burnside and Legates (1967) reported that older sires tend to be mated to older females and under such conditions, the new group of mates represent less total genetic change in the population.

The regression coefficients of the buffaloes' generation means on their generation number, of the sire generation means on sire generation number and of the individual performance on the buffaloes' generation number as well as the average of genetic improvement calculated in the three methods of analysis are listed in tables 26, 27 and 28.

Results of method 1 revealed the occurrence of limited genetic improvement in initial, 6-month and 305-day milk yields as well as in length of lactation period, being significant ($P < 0.01$) only for initial milk yield. The average genetic improvement per generation was 5.0 kg, 7.0 kg , 2.8 kg and 2.6 days for the 4 traits in the same order (Table 26). The application of methods 2 showed small negative genetic change per generation in initial and 6-month milk yields and low positive genetic change (improvement) per generation in both 305-day milk yield and length of lactation period. The regression coefficients of sire generation means on sire generation number were -1.428 kg/generation, -6.088 kg/generation, 11.80 kg/generation and 6.022 days/generation for the 4 traits, respectively, all estimates were non-significant (Table 27). Method 3 proved a positive, non-significant and small genetic improvement per generation on the average initial and 6-month milk yield (5.6 and 3.8 kg, respectively). However, it indicated a slight negative non-significant genetic change of -4.1 kg in 305-day milk yield and -2.0 days in length of lactation period (Table 28).

The magnitudes of the obtained genetic improvement (change) in each of the studied traits varied from one method to the other, inspite of the use of the same data. This is expected because these methods are based on different

Table (26) : Average genetic improvement per generation in milk production traits (Method 1).

Milk production traits	Overall mean $\bar{x} \pm$ S.E.	Regression coefficient on generation number of the lactation buffaloes Estimate ± S.E.	Average genetic improvement per generation	
			In units of measurements	As a percent from the over-all mean
Initial milk yield	341.05± 4.75 kg	5.028± 2.92 kg **	5.0 kg	1.47 %
6-month milk yield	779.13±10.01 kg	6.970± 8.85 kg N.S	7.0 kg	0.89 %
305-day milk yield	1151.81±18.33 kg	2.778±15.44 kg N.S	2.8 kg	0.24 %
Length of lactation period	328.06± 5.25 days	2.628± 3.63 days N.S	2.6 days	0.80 %

N.S. = Not significant

** = $P < 0.01$

Table (27): Average genetic improvement per generation in milk production traits (Method 2).

Milk production traits	Overall mean $\bar{x} \pm$ S.E.	Regression coefficient of sire generation means on sire generation number Estimate ± S.E.	Average genetic improvement per generation	
			In units of measurement	as a percent for overall mean
Initial milk yield	337.36± 5.21 kg	-1.428± 4.96 kg N.S	-2.8 kg	-0.83 %
6-month milk yield	763.13±11.02 kg	-6.088±7.60 kg N.S.	-12.2 kg	-1.60 %
305-day milk yield	1143.20±20.18 kg	11.808± 7.67 kg N.S	23.6 kg	2.06 %
Length of lactation period	330.2± 5.8 days	6.022± 3.34 days N.S.	12.0 days	3.63 %

Table (28) : Average genetic improvement per generation in milk production traits (Method 3).

Milk production traits	Overall mean $\bar{x} \pm$ S.E.	Regression coefficient of individual records on generation number of the buffaloes	Average genetic improvement per generation	
			In units of measurement	as a percent from the overall mean
Initial milk yield	336.57 ± 2.85 kg	5.59 ± 5.29 kg N.S	5.6 kg	1.66 %
6-month milk yield	766.96 ± 6.02 kg	3.80 ± 11.18 kg N.S	3.8 kg	0.50 %
305-day milk yield	1134.98 ± 11.01 kg	-4.08 ± 20.45 kg N.S	-4.1 kg	-0.36 %
Length of lactation period	326.47 ± 3.15 days	-1.96 ± 5.85 days N.S	-2.0 days	-0.61 %

techniques and one of them needed more steps of calculations than the others, thus any error if happens would be inflatten.

Estimation of negative genetic improvement (change) obtained for initial and 6-month milk yields when using method 2 and for both 305-day milk yield and length of lactation period when using method 3 were very low and can be neglected. Therefore, it could be stated that the present results showed a general slight positive genetic improvement per generation in milk production traits studied. The positive estimates of annual genetic change per generation ranged between 5.0 and 5.6 kg for initial milk yield, between 3.8 and 7.0 kg for 6-month milk yield, between 2.8 and 23.6 kg for 305-day milk yield and between 2.6 and 12.0 days for length of lactation period. The negative estimate of genetic change may be due to the great influence of the environmental conditions from year to year. Verd and Bodisco (1976) with dairy cattle attributed the negative estimate of the genetic trend to the use of bulls of genetic value lower than the sires of foundation females in the herd.

Genetic improvement was previously estimated for milk yield of the Egyptian buffaloes. Alim (1953) reported that the genetic improvement per year amounted to 2 pounds. Asker *et al.* (1966) found that the average genetic gain per year in

305-day milk yield of the 1st lactation in the herd of Sids was 3.49 lb when calculated by the culling differential and 15.54 lb when using the superiority of dams of heifers. The same authors calculated the corresponding estimates in the herd of Sakha as 40.97 and 42.87 lb.

In agreement with the general results obtained herein, Dillon et al. (1955) reported that the average real producing ability in a herd of dairy cattle changed very little since it was founded. They added that environmental changes from year to year can greatly influence a cow production. This seems to hold true for the present data, since year means obtained which represent the environmental changes in the 3 methods used were considerable (Table 11 through 25). This is deemed to be one of the causes of the low estimates obtained in the present work. Similar to the present results, Haussmann and Fewson (1974) noted that the computed estimates for genetic improvement were of little value in 2 herds of dairy cattle. Also, Zaheer et al. (1978) with a Sahiwal herd in Pakistan found that the annual genetic improvement in milk yield under direct selection was low (1.23 kg). They reported that this low estimate suggested that selection was ineffective. They attributed that to that selection was primarily done on type and conformation with some consideration on milk yield and that type and conformation had very low correlation with lactation milk yield. They added that young bulls were also selected on the basis of their conformation and milk yield of their dams. Hilmy (1954) with Egyptian native cattle estimated the annual genetic gain in the 1st lactation milk yield as 18 lb. Arave et al. (1964) with 11993 lactation records of 3900 Jersey cows in 12 herds over a 30-year period found that the average annual genetic change expressed as the linear regression of fat corrected milk yield of records adjusted for yearling environmental effects ranged from -51 to 145 lb. However, estimates of the present study could not be matched with estimates of some other workers on purebred herds of dairy cattle because of their relatively low magnitudes. Branton et al. (1967) with Louisiana Holstein herd, the annual genetic improvement in milk yield during the period 1930-1965 was 50.9 kg of milk. Burnside and Legates (1967) provided an estimate for annual genetic trend of 45 kg for milk yield using 34380 1st lactation Holstein herd Improvement Regestry records taken from 335 herds during the period 1953-1961. Harville and Henderson (1967) with New York State Holstein artificially sired DHIA populations estimated the intra-herd genetic trend as 47 kg of milk per year. Draganescu et al. (1977) with 3 herds of Romanian Brown Swiss indicated that the amount of genetic gain in milk yield was 18.3, 10.7 and 18.3 kg. Syrsted (1966) with Norwegian dairy cattle found that the genetic

Estimates of genetic trend in milk yield per year obtained by Burnside and Legates (1967) represented 0.75 and 0.92% of the average milk yield in the Holstein population studied. Legates (1973) with herds of North Carolina Institutional Breeding Association indicated that the predicted annual rates of genetic improvement of 1.6% of the mean could be attained.

The relative similarity of the genetic improvement in direction and amount obtained by the application of method 1 for the 4 milk production traits under study would give the chance to perform early selection by using the initial milk yield as a criterion for better genetic improvement in 305-day milk yield. This statement could be confirmed by the high genetic correlation coefficient between initial milk yield and 305-day milk yield (Table 33).

Results of the present work, in general showed low non-significant genetic improvement in milk production traits during the period of study. This might has happened because bulls were selected for breeding purposes after being ranked for body conformation, lebido and semen characteristics and when available for the most probable producing ability of their dams and grand dams. This type of selection seems to be inefficient because the association between body conformation, being the main criterion, and milk production traits is poor.

In addition selection of bulls, based on the most probable producing ability of their dams and/or grand dams, although rarely done, it did not give the chance for accurate evaluation of their genetic merit. Also, the relative small size of the herd, may have retarded the genetic change (the average number buffaloes that calved per year was 65.9 with a range of 20-120). According to that small size, all heifers produced in the herd and lived till reaching about 24 months of age were joined to the breeding stock except those showing abnormal defects, weekness or lower body weight than normal. Thus on chance for artificial selection for heifers with pronounced pressure was available. Specht and McCilliard (1960) have indicated that by increasing the herd size from 25 to 200 cows, the expected genetic gain with progeny testing is approximately doubled. A factor, which can be added in this concern may have biased downwards the estimate of genetic improvement, is the inaccuracy in classifying cows according to generation number. For example the female offspring of zero generation sire and dam would properly be classified as generation one animal. If this cow were mated back to her sire or another one from zero generation, the female offspring resulting from that mating would be more correctly classified a 1.5 generation animal rather than a second generation as was the case.

C. GENETIC AND PHENOTYPIC PARAMETERS OF MILK PRODUCTION TRAITS

Heritability estimates for milk production traits as well as the genetic and phenotypic correlation coefficients among them are of essential importance in predicting the genetic improvement that could be achieved through selection. Estimates of these parameters were estimated for initial, 6-month and 305-day milk yields and lactation period of the first lactation. Effects of year of calving, season of calving and age of the buffaloe cow at first calving were considered to be the non-genetic factors influencing these traits. Constants and analysis of variance of the effects of these factors on the traits under investigation (Tables 29 and 30) were obtained by the least squares technique. The effects of year and season of calving were significant at 1% level of probability for nearly all traits. The regression coefficient of the phenotypic value on age at 1st calving was significant at the same level only for initial milk yield. Data after being corrected for the non-genetic factors, were used in estimating heritability, genetic and phenotypic correlation by their subjection as one set to the least squares variance-covariance paternal half-sib analysis. Estimates of these parameters were based on 1st lactation records of 1065 daughters born to 78 sires, each sire was represented by records of at least 3 daughters (the number of daughters per sire ranged between 3 and 68). The distribution of the number of daughters per sire for the data used is presented in Table 31.

Table(29): Least squares constants, standard errors and Duncan's test for the factors influencing milk production traits of first lactation.

Classification	No.	Initial milk yield Con.or b ±SE (kg)	6-month milk yield Con.or b ±SE (kg)	305-day milk yield Con.or b ±SE (kg)	Lactation period Con. or b ±SE (day)
Overall mean:	1066	338.52± 3.00	770.29± 6.21	1140.59±11.37	327.81± 3.26
Year of calving:					
1963	29	-36.73±16.40	-63.87±33.96	-61.26±61.34	3.90±17.85
1964	71	-44.16±10.77	-104.29±22.31	-177.67±40.71	22.32±11.72
1965	61	-83.90±11.57	-188.87±23.95	-226.97±43.71	33.84±12.59
1966	83	-35.04±10.18	-44.94±21.07	-67.93±38.46	47.59±11.07
1967	105	-37.40± 9.38	-76.71±19.42	-49.73±35.44	44.34±10.21
1968	74	-29.32±10.62	-55.06±21.99	-86.34±40.14	-0.85±11.56
1969	62	-24.16±11.36	-29.27±23.51	-25.15±42.91	-14.56±12.36
1970	60	-8.05±11.47	-36.15±23.74	-66.44±43.32	-15.49±12.48
1971	67	25.21±10.94	57.81±22.65	97.54±41.34	-14.15±11.91
1972	56	7.61±11.89	27.74±24.61	69.53±44.91	12.69±12.93
1973	40	-36.17±13.89	-71.39±28.77	-94.97±52.50	-15.93±15.12
1974	75	65.40±10.39	109.19±21.51	104.90±39.26	-8.86±11.31
1975	43	53.91±13.39	129.36±27.73	163.13±50.60	12.92±14.57
1976	78	-0.24±10.45	6.53±21.61	90.10±39.43	43.80±11.36
1977	37	-0.31±14.40	10.20±29.81	25.95±54.40	1.67±15.67
1978	44	67.39±13.34	86.34±27.61	38.57±50.39	-42.55±14.51
1979	55	32.04±11.93	80.66±24.71	40.78±45.10	-63.31±12.99
1980	26	83.30±17.10	162.71±34.66	222.94±61.94	-47.36±18.54
Season of calving:					
Winter	285	-4.32± 4.83	-36.35± 9.99	-35.58±18.24	15.78± 5.25
Spring	257	-0.10± 5.02	9.16±10.39	47.41±18.96	6.50± 5.46
Summer	220	4.27± 5.33	27.32±11.04	32.71±20.15	-6.60± 5.80
Autumn	304	0.15± 4.74	-0.14± 9.81	-44.53±17.91	-15.67± 5.16
Lin. Reg. on age	1066	1.19± 0.50	0.39± 1.04	-0.82± 1.89	-0.72± 0.54

Table 30 : Least squares analysis of variance for milk production traits of first lactation.

Source of variation	d.f.	Initial milk yield M.S.	Initial milk yield V %	6-month milk yield M.S.	6-month milk yield V %	305-day milk yield M.S.	305-day milk yield V %	Lactation period M.S.	Lactation period V%
Year of calving	17	108399.4892**	17.57	431739.6166**	16.23	705520.1798**	7.95	59752.3226**	8.12
Season of calving	3	2898.4095	0.00	176274.2248**	1.31	558912.2846**	1.36	52084.2740**	1.56
Reg. on age at 1st calving	1	46521.8603**		5119.0926		22297.4377		17177.0194	
Residual	1044	8224.7084	82.43	35258.4061	82.46	117432.9523	90.69	9739.3386	90.32

** P 0.01

V % = Percentage of component of variance.

Table(31): Frequency distribution for number of daughters per sire in the data used in estimating genetic and phenotypic parameters.

No. of daughters/ sires	Frequency	No. of daughters/ sire	Frequency	No. of daughters sires	Fre-quency
3	8	9	3	14	1
4	12	10	6	15	1
5	9	11	2	16	0
6	5	12	2	17	1
7	3	13	2	18 and more	20
8	3				

First lactation records were used since it is believed that their use would help in obtaining accurate estimate for the genetic properties of the herd studied. This is because some causes of environmental variation do not play their full role in the 1st lactation such as dry period, calving interval, service period, parity, ... etc., as they do in the subsequent lactations. In addition, this is done to avoid the decrease in the genetic variability which may occur in later lactations caused by selection based on the 1st lactation performance.

1. Heritability

Table 32 shows the results of estimating heritability and its standard error for milk production traits studied using data of the first lactation.

Table 32 : Heritability estimates of initial, 6-month and 305-day milk yields as well as lactation period for the 1st lactation in buffaloes.

Trait	Estimate	Standard error
Initial milk yield	0.021	0.052
6-month milk yield	0.070	0.059
305-day milk yield	0.111	0.065
Lactation period	0.039	0.055

The heritability estimate of initial milk yield (milk yield of the first 70 days of lactation) in the first lactation was 0.021±0.052. This estimate is very low compared to the estimates previously reported by different investigators on Egyptian and Indian buffaloes for the same trait using either the intra-sire dam daughter correlation, intra-sire dam regression or paternal half-sib correlation. For the Egyptian buffaloes, heritability was estimated for initial milk yield as 0.11 and 0.13 by Asker and Bedeir (1961), 0.35±0.13 and 0.38±0.12 by Asker et al. (1965), 0.30±0.05 by Soliman (1976) and 0.43±0.13 by Ashmawy (1981). El-Chafie (1981) reported that the estimate of heritability of milk yield of the 1st 100 days of lactation was 0.17 and 0.32 in two herds of Egyptian buffaloes. In Murrah buffaloes, heritability for initial milk yield was estimated as 0.40 by Kushwaha et al. (1972) and as 0.48 by Sossamma Ipa and Nagarcenkar (1978). All these reviewed estimates indicate that heritability of initial milk yield tend to be of moderate to high either for the Egyptian or Indian buffaloes. The very low estimate obtained for initial milk yield, may probably indicate that the major part of variance in the present data for this trait was of non-genetic origin.

The estimate of heritability of initial milk yield, when accurately estimated, could be used in a preliminary evaluation of the breeding value of a buffaloe and also to get an early assessment of the breeding value of the sires.

The estimate of heritability of 6-month milk yield (milk yield of the 1st 6-months of lactation) in the 1st lactation was found to be 0.070±0.059 in the present study (Table 32). Sosamma Ipe and Nagarcenkar (1978) reported higher estimates for the same trait in Murrah buffaloes being 0.37 and 0.38. El-Chafie (1981) with Egyptian buffaloes estimated heritability for milk yield of the 1st 200 days of lactation as 0.15 and 0.46 in 2 different herds.

Heritability estimate obtained for 305-day milk yield in the first lactation was 0.111±0.06 which, is somewhat low. It is less than those estimated by Asker et al. (1965) in buffaloes of Egypt using the paternal half-sibs analysis and the daughter dam regression (0.39±0.14 and 0.27±0.14, respectively). Also, it is less than those calculated by Mokhtar (1971) for the 1st and 2nd lactation in a herd of Egyptian buffaloes by using the method of half-sib analysis (0.318±0.083 and 0.366± 0.113, respectively) and the daughter-dam regression method (0.263 ± 0.199 and 0.783 ± 0.358, respectively). Ashmawy (1981) also with Egyptian buffaloes estimated the heritability of 305-day milk yield of the half-sib analysis as 0.43 ± 0.13 which is considerably higher than the estimate reached in the present work. Sosamma Ipe and Nagarcenkar (1978) with which is lower than 0.11, 0.21, 0.14, 0.27, 0.24, 0.35, 0.42 and 0.42 reported for the same trait in Egyptian buffaloes by Asker et al. (1953), Hilmy (1954), El-Itriby and Asker (1956), Asker et al. (1965), Soliman (1976), Alim (1978) and Ashmawy (1981). Also, it is less than the low estimate (0.06) given by Mahadevan (1960) for length of lactation in water buffaloes in India. Jawarkar and Johar (1975) with Murrah buffaloes calculated a higher estimate for heritability of lactation period being 0.16. The present estimate may indicate the presence of low genetic variability for lactation length in the buffaloes studied.

From table 32 it appears that heritability calculated for initial milk yield and lactation period were less efficient than those estimated for 6-month milk yield and 305-day milk yield. This is because the former estimates have higher standard errors than the latters and we know that the efficiency of the parameter is inversely correlated with the variance of its estimate.

Results of the present work showed that heritability estimate of initial milk yield (0.021) was lower than that of 6-month milk yield (0.070) which is also lower than that of 305-day milk yield (0.111). This trend could not be interpretted because of the low estimates in general and the high standard error of some of them. A reverse trend was observed by Ashmawy (1981) who stated that heritability estimates of initial and 305-day milk yield (being 0.43 & 0.43) were higher than heritability estimate of total milk yield (.38), He attributed this trend to the increasing effects of the non-genetic factors towards the end of lactation. The same author added that it may therefore be by profitable to select buffaloes on the basis of part lactation record rather than on the basis of the whole lactation record.

Estimates of heritability of milk production traits calculated in the present study were low compared to the most estimates reviewed in the literature on Egyptian, Indian, Italian and Pakistani buffaloes which are of moderate or high magnitude. This may indicate lower genetic variability and/or more environmental variability in buffaloes of this study. This could be partly due to that the correction for the effect of year of calving which would have accounted for a part of the differences among sires since sires and years are partly confounded. So, the adjustment in the data used would have resulted in a change in the relative magnitude of components of variation involved in the estimation. Moreover, it could also be due to that some other environmental effects, not considered in the model of the analysis, may have existed in the within sire component of variance. Also, managerial procedures may have forced in some way the means of daughters of different sires to resemble each other more than normal as suggested by Mokhtar (1971).

Results of the present work and those of the reviewed literature showed divergence in the estimates of heritability of the same trait. This is expected, since heritability of a particular trait is actually a property of that trait in a certain population under certain environmental conditions and during a definite period of time and some or all of these vary from one report to another. Differences in nature and samples of data, in distributions and numbers of records and finally in methods of measuring the estimate may be added as other causes for such divergence in the magnitude of heritability estimates.

2. Phenotypic correlation coefficients

The phenotypic correlation coefficients between initial milk yield and each of 6-month and 305-day milk yields were of high magnitudes (0.834±0.089 and 0.670±0.017, respectively) and statistically highly significant at 1% level (Table 33). The same pattern was also observed when considering the phenotypic correlation coefficient between 6-month milk yield and 305-day milk yield, its estimate was 0.852±0.008 (Table 33). These results offered an indication that the increase of initial milk yield was always associated with an increase in each of 6-month milk yield and 305-day milk yield. They also proved that the increase of 6-month milk yield was associated with considerable increase in 305-day

Table 33 : Phenotypic and genetic correlation coefficients between initial milk yield,6-month milk yield,305-day milk yield and lactation period for the first lactation in buffaloes.

Traits	Initial milk yield estimate ± S.E.	6-month milk yield estimate ± S.E.	305-day milk yield estimate ± S.E.	Lactation period estimate ± S.E.
Initial milk yield		0.834±0.09**	0.670±0.017**	0.249±0.029*
6-month milk yield	0.472±0.793		0.852±0.008**	0.372±0.026**
305-day milk yield	0.566±0.579	0.99±0.004		0.652±0.018**
Lactation period	1.097±0.269	1.434±0.938	1.461±0.729	

Phenotypic correlations are above the diagonal and genetic correlation below

** P 0.01

* P 0.05

milk yield. Accordingly, it could be suggested that it is possible to combine a high initial or 6-month milk yield with a high 305-day milk yield. Bedeir (1965) reported the same conclusion for the phenotypic relationship between initial milk yield and 305-day milk yield.

In agreement with the present results, Asker *et al.* (1965) and Ashmawy (1981) working on Egyptian buffaloes found that the phenotypic correlation coefficient between initial milk yield and 305-day milk yield were of high magnitude and highly significant ($P < 0.01$), the estimates were 0.738 ± 0.037 and 0.69 ± 0.016. Similarly, El-Chafie (1981) estimated the phenotypic correlation between 100-day (initial) milk yield and 300-day milk yield as 0.804 and 0.914 in 2 herds of Egyptian buffaloes and the estimates were highly significant. Asker and Bedeir (1961) with a herd of Egyptian buffaloes found that the phenotypic correlation coefficient between initial milk yield and 305-day milk yield was significant but of lower magnitude than those obtained in the present work and the work of Asker *et al.* (1965) and Ashmawy (1981). Similarly, Afifi and Barrada (1973), Soliman (1976) and Ashmawy (1981) with Egyptian buffaloes found that the phenotypic correlation coefficient between initial and total lactation milk yield was of sizable magnitude and highly significant. Their estimates were 0.826, 0.52 ± 0.013 and 0.61 ± 0.17, respectively. Asker and Bedeir (1961) estimated the same correlati(

coefficient as 0.36 in Egyptian buffaloes. Kuswaha et al. (1972) with Murrah buffaloes found a strong phenotypic association between initial and total milk yield.

Findings of the present study with respect to the phenotypic correlation coefficient between initial milk yield and 6-month milk yield and between 6-month milk yield and 305-day milk yield are in consistence with results of El-Chafie (1981). He found that the phenotypic correlation coefficient between 100-day (initial) milk yield and 200-day milk yield was 0.892 in a herd of Egyptian buffaloes and 0.938 in another herd and that between 200-day milk yield and 300-day milk yield was 0.874 and 0.985 in the 2 herds, all these estimates were highly significant. Also, Afifi and Barrada (1973) reported that the phenotypic correlation coefficient between 24-week (6-month) milk yield and total milk yield was 0.880 and highly significant ($P < 0.01$). Similarly, Iqbaluddin et al. (1970) with Murrah buffaloes estimated the phenotypic correlation coefficient between 5-month milk yield and total milk yield was of high magnitude, its value was 0.78, 0.71, 0.62 and 0.55 in the 1st, 2nd, 3rd and 4th lactations, respectively.

The high positive and significant phenotypic correlation coefficients among the part records of lactation yields studied in this work indicate that initial milk yield could be effectively used as a good indicator for both 6-month and 305-day milk yield, it accounted for 69.56 and 44.89% of their total variance. Also, 6-month milk yield could be used as a good predictive value to 305-day milk yield, it accounted for 72.59% of its variance. In agreement with these statements, Ashmawy (1981) concluded that initial milk yield was a reliable criterion for evaluating milk production ability of the buffaloe cow.

The strong positive and highly significant correlation coefficients that were found among initial, 6-month and 305-day milk yields shown in Table 33, suggest that selection for superior initial milk yield when combined with selection for superior 6-month milk yield would result in a considerable improvement in 305-day milk yield and consequently in total milk yield. This is because it has been found by Ashmawy (1981) that 305-day milk yield was strongly and positively correlated with total milk yield, the phenotypic correlation coefficient between the two traits was 0.97 ± 0.005 and highly significant ($P < 0.01$). As a result of the high positive phenotypic association that existed among 100-,200- and 300-day milk yields (all were above 0.8), El-Chafie(1981) concluded that the superior sires for 100-day milk yield will be also superior for 200- and 300-day milk yields and their daughters will be superior for the three traits.

From table 33, it is obvious that each of initial milk yield, 6-month milk yield and 305-day milk yield was positively correlated with lactation period. The phenotypic correlation coefficients between these connections were 0.249±0.029, 0.372±0.026 and 0.652±0.018, respectively, all these estimates were highly significant ($P < 0.01$, table 33). These results showed that the strongest association was between 305-day milk yield and lactation period and that the poor association existed between initial milk yield and lactation period. However, the association between 6-month milk yield and lactation period was of moderate magnitude. These results lead to state that selection for increased 6-month milk yield when combined with selection for increased 305-day milk yield would result in an increase in length of lactation period which was found by different investigators to be strongly, positively and significantly correlated with total milk yield. The phenotypic correlation coefficient between lactation period and total milk yield was estimated in Murrah buffaloes as 0.78 by Venkataratnan and Venkayya (1964), 0.56-0.96 by Jawarkar and Johar (1975), 0.68 by Basu and Ghai (1978) and in Egyptian buffaloes as 0.859±0.021 by Asker et al.(1965) 0.71±0.009 by Soliman (1976), 0.75 by Alim (1978) and 0.69± 0.011 by Ashmawy (1981).

Asker et al. (1965) reported an estimate for the phenotypic correlation coefficient between initial milk yield and length of lactation period of 0.414±0.037 which is somewhat higher than that obtained in the present work for the same relationship. On the other hand, Soliman (1976) and Ashmawy (1981) reported lower estimates being 0.00±0.019 and 0.05±0.021, respectively. The present estimate of the phenotypic correlation coefficient between 305-day milk yield and lactation period (0.652), estimated here, is more than 0.57±0.018 obtained by Ashmawy (1981) for the same correlation in buffaloes.

3. Genetic correlation coefficients

Genetic correlation coefficients among milk production traits are of essential importance in buffaloe breeding as in dairy cattle breeding. They give the chance to be aquainted with the direction and magnitude of genetic change in any of these traits as an expected correlated response for selection of any of the other traits. This is because the genetic correlation coefficient between any two traits represents the association between the additive effects caused by the genes controlling the two traits.

The genetic correlation coefficients among initial milk yield, 6-month milk yield, 305-day milk yield and length of lactation period in all possible combinations and their standard errors are listed in table 33. Estimates of genetic correlation coefficients between initial milk yield on one side and both 6-month and 305-day milk yields were 0.472±0.793 and 0.566±0.579, respectively. Also the genetic correlation coefficient between 6-month milk yield and 305-day milk yield was 0.995±0.004. These estimates, although the standard error of the 1st two of them was relatively high, indicated the presence of general positive genetic association among the traits studied in all possible connections as expected. The genetic association between 6-month milk yield and 305-day milk yield was of very high magnitude (0.995) and its estimate seems to be of the most promising value because of its relatively very low standard error (Table 33). The positive genetic association observed among these traits holds true with the findings and conclusions reached in this work when dealing with the phenotypic association among them. Accordingly, these findings may be helpful in carrying out indirect selection for earlier part records of milk yield. Also, the present estimates of genetic correlation ceofficients among initial, 6-month and 305-day milk yields, if trusted, might indicate that selection when directed towards initial milk yield and combined with selection for the increase of 6-month milk yield will result in a pronounced improvement in 305-day milk yield. Consequently, we expect a parallel improvement in total milk yield which was found by Ashmawy (1981) to be strongly and significantly phenotypically and genetically associated with 305-day milk in the Egyptian buffaloes. The estimates obtained for the phenotypic and genetic correlation coefficients between 2 traits were 0.97±0.005 and 0.99±0.004, respectively.

In a study on Egyptian buffaloes, Bedeir (1965) estimated the genetic correlation coefficient between initial and 305-day milk yield on the basis of half-sib correlation as 0.792±0.111 using the pooled data of 2 herds of Egyptian buffaloes. The same author, also, calculated the same coefficient between the same 2 traits, using the daughter-dam-regression, as 0.885±0.069 and concluded that her results indicated that genes responsible for initial milk yield influence to a great extent 305-day milk yield at the same time. Similarly, Soliman (1976) reported that total milk yield of the buffaloes seems to be highly genetically positively correlated with initial milk yield, the genetic correlation coefficient between these two traits was 0.52±0.013 and being highly significant. Ashmawy (1981) showed the same trend, he reported that the genetic correlation coefficient between the two traits was 0.85±0.061 being highly significant. In addition, El-Chafie (1981) with 2 herds of Egyptian buffaloes found that the genetic correlation coefficients among 100-, 200- and 300-day milk yields in all possible connections were always positive and of high values in most cases. His estimates in the two herds, respectively, were 0.849 and

0.762 between 100- and 200- day milk yields, 0.560 and 0.120 between 100- and 300-day milk yields and 0.610 and 0.441 between 200- and 300-day milk yields. These estimates support his conclusion indicating that superior sires for 100-day milk yield will be also superior for 200- and 300-day milk yield and their daughters will be superior for the above mentioned traits. With Murrah buffaloes, Sosamma Ipe and Nagarcenkar (1978) showed that 30-day, 150-day and 270-day part records of milk yield were strongly genetically positively correlated with 300-day milk yield, the estimates of the genetic correlation coefficients of these connections were of high magnitudes (0.65, 0.87 and 0.99, respectively). The same authors noted that these estimates were observed to increase with the progress of length of lactation. Results of Soliman (1976) and Ashmawy (1981) indicated the presence of positive genetic relationship between initial and total milk yields, the coefficients of genetic correlation between these 2 traits were 0.65 ± 0.053 and 0.76 ± 0.695, respectively and being highly significant ($P < 0.01$). All these results (of different investigators) in addition to those obtained in the present study with respect to both the genetic and phenotypic association when combined with those of the phenotypic association reported by different investigators as described before in the previous section, confirms the presence of pronounced positive phenotypic and genetic association among the different part records of lactation milk yield and both 305-day and/or total milk yield.

in buffaloes. They also indicate that selection for part records of milk yield is expected to cause a sizable improvement in lactation milk yield.

Estimates of the genetic correlation coefficients between initial, 6-month and 305-day milk yield on one hand and length of lactation period on the other were calculated as I.097±0.269, I.434±0.939 and I.46I±0.729, respectively (Table 33). Although these estimates were greater than unity, it could be stated that there was a high positive genetic association between length of lactation period and each of initial, 6-month and 305-day milk yields. The same trend was indicated in the previous section when dealing with the phenotypic correlation coefficients among the same traits. Estimates of genetic correlation coefficients showing magnitudes of unity or more may be due to the probable non-suitable environmental conditions that did not give the chance for the genes controlling these traits to exhibit their true effects. Sampling errors can be added as another cause for obtaining such coefficients. The estimate of the correlation coefficient between initial milk yield and length of lactation period seems to be the most dependable one among the considered 3 connections because of its relative low standard error. These findings may lead to state that selection when directed towards superior initial milk yield is expected to be associated with increasing length of lactation period and consequently increasing tota lactation milk yield. Total milk yield has been found to be strongly, positively and significantly correlated with length of lactation period by Asker et al. (1965), Soliman (1976) and Ashmawy (1981) in Egyptian buffaloes. The genetic correlation coefficient between length of lactation period and total milk was estimated by those authors as 0.674±0.191, 0.76±0.095 and 0.63±0.045, respectively.

In agreement with the present results, Asker et al. (1965) and Soliman (1976) the genetic correlation coefficient between initial milk yield and length of lactation period in Egyptian buffaloes as 0.463±0.222 and 0.54±0.093, respectivel. Also, Ashmawy (1981) reported a high significant positive genetic correlation coefficient of 0.65±0.127 between 305-day milk yield and length of lactation. However, the latter author reported a non-significant genetic correlation coefficient of 0.14±0.216 between initial milk yield and length of lactation period.

Results of the present work on the genetic correlation coefficients among the studied milk production traits gave a satisfactory indication for the existence of the pleotropic action of the genes controlling these traits.