Study on
Genetic And Phenotypic Parameters Of Some Economic Characters Of Deoni Herd at Hyderabad (A. P.)

A Thesis

Submitted to the Faculty of
Veterinary Science & Animal Husbandry,
Nagpur University,
In Partial Fulfilment of the Requirements
For the Degree of
Master of Science (Animal Husbandry)

By

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B. V. Sc. & A. H.

BIHAR VETERINARY COLLEGE,

PATNA

November, 1965

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I certify that this Thesis has been prepared under my supervision by Shri M. A. Quadeer, a candidate for the degree of M. Sc. (A.H.) with Animal Genetics and Breeding as major subject, and that it incorporates the results of his independent study.

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CHAPTER - I.

INTRODUCTION

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INTRODUCTION

Quinquennially taken the Ninth Livestock Census, which is a latest one, reveals a distribution of adult stock among males and females of cattle and buffaloes to be 133 : 100 and 31 : 100 respectively (Chaudhri & Giri 1964). The cause of this difference lies in the better care and management of the useful members of both the species. Between bullock and he-buffalo, the former is much valued for draught purposes due to its comparative lightness, active nature, suitability for sustained heavy work and ability for sweating. Between cow and she-buffalo the latter is much valued as milch animal due to the low yield of the former. The existing breeding policy with the objective of 'cow for bullock and buffalo for milk' is the outcome of an erroneous belief that milk and draught qualities are incompatible. Thus in the hope of achieving two primary objectives i.e. draught and milk, we are maintaining two species-the direct cause of overstocking resulting in acute imbalance between the number of livestock and feed and fodder resources of the country.

It is to be noted that the Indian farming would remain bullock based for decades to come. It is due to the impracticability of mechanization of agriculture in India mainly because of the facts : (i) tractors increase the productivity "per unit of labour" but not "per unit of land" and on the contrary we are having ample and cheap animal and human resources, (ii) they require large and compact land for efficient utilisation whereas the holdings of Indian farmer are meagre and scattered, (iii) keeping a tractor is a costly affair for an average Indian farmer, (iv) resulting huge

unemployment of villagers and (v) bullocks would be required to be fed without work or killed. So we have to maintain bullocks and for bullocks we have to keep cows.

Hence, the reasonable solution would be to use males and females of the same species for both the purposes — increasing the milking potentialities of dual purpose cattle.

BREED UNDER STUDY

Deoni cattle belong to dual purpose breed (Karthe 1957 and Rahman 1958). Study of its performance has been undertaken to explore the possibilities of its improvement.

Deoni breed resembles Gir breed (Ware 1942 and Randhawa 1956) and has in addition blood of other breed like Dangi as has been reported by Dasgupta (1945), Joshi & Phillips (1953), Kulkarni (1953), Karthe (1957) and Kaura (1957). Rahman (1958) giving a detailed account of its origin traced the history as back as 200 years and stated that herds of Gir and Kankrej animals consisting of few hundreds with required land as grazing areas were distributed among some cultivators, Deshmukhs and Jagirdars, of the Marathwada region of ex-Hyderabad State for the supply of fixed number of bullocks of proved merits to the State Army Department for artillery, bullock cart etc. As the superior strains of these cattle were collected and used to be sold at "Deoni" village market in taluka Udgir, they were known after that name as "Deoni" animals.

The breed is prevailingly found in the north-western and western portions of ex-Hyderabad State [Oliver (1938), Dasgupta (1945), Joshi & Phillips (1953), Kulkarni (1953), Karthe (1957), Kaura (1957), Randhawa (1958) and Rahman (1958)].

The 'Deoni cattle belt' covers the interior villages of Udgir, Nilanga, Ahmedpur, Latur and Ausa Talukas of Osmanabad district, Deglour and Mukhed talukas of Nanded district, Ambajogia taluka of Bhir district and Gangakhed taluka of Parbhani district of Maharastra State; Bhalki and Santrampur Aured talukas of Bidar district of Mysore State and Zahirabad taluka of Medak district of Andhra Pradesh (Joshi 1963). Thus the breeding tract has its distribution in three States : Andhra Pradesh, Maharashtra and Mysore and the first two States are maintaining the cattle of this breed in Government Farms also e.g., Cattle Breeding & Dairy Farm Rajendranagar, Hyderabad in Andhra Pradesh; Cattle Breeding Farm Hingoli and Cattle Breeding Farm Udgir in Maharashtra State. It is to be noted that this breed has not spread beyond its native home.

The approximate area covered by the breed lies between 17°30' and 18°55' north and 76°30' and 77°55' east. The whole area is hilly with an average altitude of 1,600 to 2,350 feet above sea level. There are shallow valleys and plateaus where the soil varies from clay loam to black cotton soil. The entire area is more or less arid with rainfall average of 25" to 30". The main crops are Jowar, Bajra, Wheat, Groundnut and Cotton.

Rahman (1958) described this breed as medium to heavy sized animals resembling Gir in physical structure to a large extent. Coat colour varies from spotted black to patchy black and white with occasionally few red markings. The head is big and prominent. Horns are small thick and crescentic shaped. Eyes are very prominent with a sleepy appearance. Ears are pendulous, moderately long and end in a point with

small modified notch on the lower side of the inner border of concha. The neck is of medium length and fairly muscular. The animals possess moderately long dewlap, well developed prominent hump, broad and wide brisket, long trunk proportionate to the body, moderately hanging sheath and limbs straight and proportionate. Though slow at work they are preferred for heavy and medium fast work of long duration. A typical mature male measures 60" in height at withers and weighs 1,150 lbs. and mature female has the height of 52" at withers and a weight of 650 lbs. (Joshi & Phillips 1953).

The genotype of the individual is a ceiling for the phenotype in the sense that when once with best environment the potentialities possessed by the genotype are achieved further improvement requires change in genotype. Satisfying the environmental factors that a present day cow is lacking there is an increasing necessity of making cow genetically superior which is achieved only through scientific breeding. The problem of improvement through breeding basically resolves itself into the problem of establishing an organised herd due to the following reasons.

(i) Proper environment that is needed for the expression of the genetic make-up of the individual can be made available in organised herd.

(ii) Organised herd also serves as a laboratory for new findings relating to animal breeding which may be later on extended for field operation.

(iii) The most important benefit of its is that it facilitates in maintaining accurate records which are absolute necessity for the intelligent evaluation of the individual.

By the help of records it is possible to calculate accurately the various economic traits. The proper statistical

treatment to the records would reveal the position of the population under study as regards its milking capacity and breeding efficiency. Maintenance of records of pedigree and family would help in selection while records of progeny make possible running of progeny testing.

SCOPE OF STUDY :

In the present study with the help of records of Deoni cattle maintained at Cattle Breeding & Dairy Farm Rajendranagar, Hyderabad (A.P), the following study has been made :-

I. MEANS, STANDARD ERRORS AND COEFFICIENTS OF VARIATION OF THE FOLLOWING TRAITS :-

Gestation period, Birth weight, Age at first service, Services per conception, Age at first calving, Weight at first calving, Post-partum interval to first service, Dry period, Lactation length, Calving interval and Lactation yield.

Service period

II. EFFECT OF SEASON AND MONTH OF CALVING ON THE FOLLOWING TRAITS:-

Gestation period, Birth weight (not season), Age at first calving (of birth), Services per conception, Post-partum interval to first service, Service period, Dry period, Lactation length, Calving interval and Lactation yield.

III. GENETIC AND PHENOTYPIC CORRELATIONS:

1. Body weight at calving x Birth weight of calf
2. Gestation period x " " "
3. Preceding dry period x " " "
4. Weight at birth x Age at first calving
5. Age at first service x " " "
6. Weight at birth x " " "

7.	Age at first calving	x	Weight at first calving
8.	Service period	x	Lactation period
9.	Age at first calving	x	First lactation period
10.	Service period	x	Dry period
11.	Age at first calving	x	First dry period
12.	" " "	x	First calving interval
13.	Age at first service	x	" " "
14.	Weight at freshening	x	Lactation yield
15.	Weight at first calving	x	First lactation yield
16.	Service period	x	Same lactation yield
17.	" "	x	Subsequent lactation yield
18.	Age at first calving	x	First lactation yield
19.	" " "	x	Second lactation yield
20.	" " "	x	Third lactation yield
21.	" " "	x	Fourth lactation yield
22.	" " "	x	First three lactation yields
23.	" " "	x	First four lactation yields
24.	Age at first service	x	First lactation yield
25.	Lactation period	x	Lactation yield
26.	Dry period	x	Subsequent lactation yield
27.	First calving Interval	x	First lactation yield.

IV. HERITABILITY ESTIMATES OF THE FOLLOWING TRAITS:

Gestation period, Birth weight, Age at first service, Services per conception, Weight at first calving, Age at first calving, Post-partum interval to first service, Service period, Lactation length, Dry period, Calving interval and Lactation yield.

V. REPEATABILITY ESTIMATE OF THE FOLLOWING TRAITS:

Gestation period, Birth weight, Services per conception, Post-partum interval to first service, Service period, Lactation

length, Dry period, Calving interval and lactation yield.

OBJECTIVE OF THE STUDY :

Biometrical studies of the data accumulated in the course of the breeding of sizeable herd serve useful purpose in formulating and planning breeding programme on scientific lines for the improvement of livestock. These studies may comprise working out of phenotypic parameters like averages, standard errors, coefficients of variation and correlations and genetic parameters like heritability, repeatability and correlations. These parameters act as a knob in focussing potential structure of a dairy herd as far as their economic traits are concerned.

Due to the huge amount of data and disimilar nature of variations for a particular character, it becomes impossible to get a concise idea of it unless and until statistical approach is made to calculate averages, standard deviations and standard errors. Calculation of coefficients of variation would make it possible to compare the magnitude of variation between different traits.

The economic characters are metric in nature and their inheritance does not follow exactly law of Mendelian transmission. The phenotypic expression of these traits is controlled by polygenes and they are very much influenced by the environment to which an animal is subjected. It is important then to determine the extent to which observed variations in a trait are the result of differences in genetic constitution of the individuals. Heritability and repeatability are the two genetic parameters for measuring genetic variations

in the metric trait. The heritability may be defined in broad as well as in narrow sense (Lush 1945). Heritability in broad sense is quotient of total hereditary variation and total phenotypic variation. The defination in narrow sense means fraction of the total variance in the trait as a result of additive effect of genes. The magnitude of heritability would range between 0 to 1 as it is a ratio of two variances. By knowing the heritability estimates of lactation yield, lactation length, calving interval, dry period, service period etc. it would be possible to know how far the total phenotypic variance in a particular trait is controlled by heredity and what should be the breeding technique to improve it i.e., mass, pedigree and family selection etc. Further it would be possible to know if a particular character is non heritable when h^2 turns out to be zero, then only way of improving it would be the provision of best environment.

Repeatability is the degree to which an individual tends to produce the same amount of quantitative expression from one observation to other of the trait. Since it is a quotient of total hereditary variance plus permanent environmental effects and total phenotypic variance it varies from 0 to 1 and indicates the contribution of permanent environmental effects in the total variance. By averaging the life time observations of the individual the random temporary variations would cancel each other and the average would constitute the genotypic and permanent environmental contributions. Repeatability also gives the idea of hereditary and permanent environmental contributions.

Thus repeatability is helpful in knowing the individuals merit for a particular character on first few observations only thereby making room for early culling.

Phenotypic correlations would give the degree of association between two characters. Genetic correlation is the result of pelietropic genes or linkage. Phenotypic and genetic association of lactation yield or other economic characters with any character which is under the control of the breeder would be one way of improving the individual. Hence in the present study an attempt has also been made to correlate characters among each other to explore the possibilities of improving lactation yield and other economic traits.

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CHAPTER - II

REVIEW OF THE LITERATURE

CHAPTER - II

REVIEW OF THE LITERATURE

(I) GESTATION PERIOD

The knowledge of the length of gestation is of importance to the breeder in order to arrange special feeding schedule known as "flushing" in the late stage of pregnancy. Understanding of hereditary and environmental factors effecting this period would be helpful in reducing it thereby shortening the calving interval.

Averages :

There seems to be no information available on the duration of pregnancy of Deoni breed. Usually gestation period ranges between 276 to 295 days in different breeds of cattle.

Effect of sire of the calf.

It has been reported by several workers that sire of the calf influenced the gestation period of cows to a great extent. Knott (1932), Rife et al (1943), Donadonna & Valorani (1946), Rife (1948), Alexander (1950) Jafar et al (1950), Ragab & Asker (1951), Lazarus & Rangaswamy (1952), Brakel et al (1952), Wheat & Riggs (1952), Channon et al (1956), Kohli & Sari (1957) and Dansoury & Bayoumi - all of them found a significant effect of sire of the calf on the length of the time the latter passed in "utero". But Jordao & Veiga (1939), Briquet & Abreu (1948) and Burris & Blunn (1952) could not establish this fact.

Effect of dam

The effect of dam on gestation length has also been found significant in cattle (Knapp et al 1940; Jafar et al

1950 and Dennsoury & Bayoumi 1962). However, Lasarus & Ananta Krishnan (1952) found that there was not significant variation in the length of gestation period between individual cows of the same breed.

Heritability

Singh et al (1960) reported the heritability in Tharparkar cattle of the magnitude 0.002 ± 0.084, 0.002 ± 0.069 and 0.320 ± 0.33 by intra sire regression of daughter on dam, intra sire correlation and paternal half sib correlation respectively.

Repeatability :

Knapp et al (1940) reported an intra breed repeatability of about 0.20 for gestation period while Jordao & Veiga (1939) have shown that repeatability of gestation period for cows was small. Ragab & Asker (1951) reported a repeatability of 0.340 and opined that gestation period could be reduced through selection in Egyptian cattle.

Effect of sex of the calf.

The influence of the sex of the calf upon the duration of gestation is a question of considerable controversy. Fitch et al (1924), Copeland (1930), Knott (1932) Knoop & Hayden (1934), Jordao & Veiga (1938), Livesay & Dee (1945) Veiga et al (1947), Long et al (1948), Ward & Castle (1948), Braunde & Walker (1949), Jafar et al (1950), Jordao et al (1951), Lombardt (1951), Ragab & Asker (1951), Burris & Blunn (1952) and Dennsoury & Bayoumi (1962) have all found that bull calves were carried a day or two longer than the heifer calves. A difference of about 5 days in the gestation period between male

and female calves has been reported by Dement (1945) in various breeds and Dinkhauser et al (1944) in Black Pied cattle. Chenem et al (1955) observed a significant effect of sex on the length of gestation period but contrary to the findings of other workers they reported that female calves were carried 1.5 days longer than male calves. As against these findings, Wing (1899), McCandlish (1922), White (1934), Weaver et al (1947), Ragab & Asker (1951) and VanGreen & Joubert (1961) found that sex of the calf had no influence on the length of gestation.

On Indian breeds, Littlewood (1937) in Ongole, Red Sindhi and Kangayam, Dave (1941) in Red Sindhi, Kumaran (1947), Choudhry & Sinha (1951) in Tharparkar, Lazarus & Ananta Krishnan (1952) in Red Sindhi and Gir, Kohli & Suri (1957a) in Hariana, Singh & Roy (1961) in Red Sindhi and Goswami et al (1963) in Hariana cattle, indicated definite variation in the gestation period due to the effect of sex of the calf and on the other hand Briquet & Abreu (1948) in Kankrej, Villares & Abreu (1948) in Gir and Nellore and Singh et al (1958a) in Tharparkar failed to confirm that males calves were carried significantly longer than female calves.

Effect of sequence of calving:-

The calving sequence or age of cows has been reported by workers [Knott (1932), Knapp & Hayden (1934), Dinkhauser et al (1944), Herman & Spalding (1947), Chenem et al (1955), Kohli & Suri (1957a), Van Green & Joubert (1961) and Goswami et al (1963)] to influence the gestation period significantly while McCandlish (1922), Copeland (1930), Knapp et al (1940), Weaver et al (1947), Breunde & Walker (1949), Jafar et al (1950), Ragab & Asker (1951), Lenhardt (1951), Burris & Blunn

(1952), Lazarus & Ananta Krishnan (1952), Singh et al (1956a) Singh & Ray (1961) and Donnesoury & Bayoumi (1962) observed no such influence.

Effect of season of calving :-

Conflicting findings are reported in literature on the effect of month of calving on the duration of pregnancy in cattle. McCandlish (1922), Copeland (1930), Knapp et al (1940) Jakubec (1941), Dinkhauser et al (1944), Ward & Castle (1948), Jafar et al (1950) and Burris & Blunn (1952) found that the season of calving had no influence on the gestation period whereas Ineichen (1946), Herman & Spalding (1947), Long et al (1948), Alexander (1950), Ragab & Asker (1951), Lamberdt (1951), Brakel et al (1952), Chanem et al (1955), Van Graan & Joubert (1961) and Donnesoury & Bayoumi (1962) reported that cows calving during the winter had the longest gestation and those calving during summer had the shortest.

In Indian cattle, the findings of Briquet & Abreu (1948) in Kankrej, Lazarus & Ananta Krishnan (1952) in Red Sindhi and Gir cows, Singh et al (1956a) in Tharparkar, Singh & Ray (1961) in Red Sindhi and Goswami et al (1963) in Hariana cows showed no significant influence of the month of freshening on the gestation period. Chaudhry & Sinha (1961) in Tharparkar, Kohli & Suri (1957a) in Hariana and Prabhu (1961) from pooled data over Indian breeds recorded significant variation in the duration of gestation period depending upon the month of freshening.

(2) BIRTH WEIGHT

The birth weight of a new born calf denotes its skeletal structure on which the development of future animal depends. Further it helps in judging its health and also of dam. If the birth weight of calf is inherited and found to be related to any of the important economic traits, it will constitute the first and earliest possible measure of selection.

Averages:-

TABLE (1)

Author	Year	Breed (Farm)	n	X ± S.E. (lbs.)
Joshi	1963	Deoni (Rajendra nagar)	165	49.33 ± 0.36
		(Hingoli)	109	41.1 ± 0.71
		(Forbreed)	274	46.06 ± 0.43

Effect of sire of the calf:-

Abreu (1949) in Nellore breed, Asker & Ragab (1952) in Egyptian cattle and Ananta Krishnan & Lazarus (1953) in Red Sindhi and Gir reported a significant influence of sire upon the birth weight of calves but Eckles (1919) in Ayrshire, Holstein and Jersey calves, Burris & Blunn (1952) in beef cattle and Kohli & Suri (1957b) in Hariana reported in against.

Effect of dam of the calf

Abreu (1949) reported that there was a significant influence of dam upon the birth weight of Nellore breed of calves.

Heritability estimates

TABLE (2)

Author	Year	Breed	D.F.	h^2 ± S.E.	Remarks.
Knapp & Nordskog	1946	Beef cattle		0.23	Pat. half sib correlation.
				0.34	Regression
Dawson, et al	1947	Shorthorn		0.269	Pat. half sib correlation
				0.110	Pat. half sib corrected for sex, age of dam.
Tyler et al	1947	Holstein Friesian		0.32	Maternal half sib
Bradford & Clark					
Clark	1950			0.23	
Knapp & Clark	1950			0.42	
Gregory et al	1950	Beef cattle		0.45	
				1.0	By smaller D.F.
Asker & Regab	1952			0.417	Pat. half sib.
Burris & Blunn	1952	Beef cattle		0.22	
Dawson et al	1955			0.50	
Harwood	1955			0.44	
Koch & Clark	1955			0.35	
Romoni &	1955		109	0.22	Regression
Shelly & Clark	1955			0.35	
Shelly et al	1955	Beef cattle		0.72	
Koch & Clark	1956			0.42	
Singh & Desai	1959	Hariana		0.135 ± 0.145	Pat half sib
Batra & Desai	1962	Sahiwal	402	0.2345 ± 0.152	Corrected for age of dam and sex of calf.

Repeatability estimates:

TABLE (3)

Author	Year	Breed	D.F.	R ± S.E.	Remarks.
Tyler et al	1947	Holstein Friesian		0.10	
Gregory et al	1950	Beef cattle		0.114 to 0.244	
				-0.31	
Asker & Regab	1952	Egyptain cattle		0.048	
Botkin & Whetly	1953	Hereford		0.43 to 0.51	
Koch & Clark	1955	Beef cattle		0.26	
Singh & Dutt	1961	Sahiwal		0.1139	
Batra & Desai	1962	Sahiwal	397	0.369 ± 0.059	

Effect of sex of the calf :-

Eckles (1919), McCandlish (1922), Fitch et al (1924), Morison (1936), Littlewood (1937), Knapp et al (1940), Dave (1941), Rhoad et al (1945), Knapp & Nodskog (1946), Dawson et al (1947), Tyler et al (1947), Veige et al (1948), Braunde & Walker (1949), Gregory et al (1950), Lazarus & Ranganswamy (1950), Dave (1950), Chaudhry & Sinha (1951), Sharma et al (1951), Asker & Regab (1952), Ananta Krishnan & Lazarus (1953), Jobert & Bonsma (1957), Kohli & Suri (1957b), Singh & Desai (1959), Singh & Dutt (1961) and Batra & Desai (1962) have all reported that male calves were significantly heavier than female calves. However, Villegas (1939) studying Nellore and Red Sindhi calves did not agree with them.

Effect of sequence of calving :-

Birth weight was significantly affected by the age or calving sequence of dam (Eckles (1919), McCandlish (1922),

Fitch et al (1924), Krasnov & Pak (1937), Knapp et al (1947), Venge (1948), Braunde & Walker (1949), Asker & Ragab (1952), Burris & Blunn (1952), Anantn Krishnan & Lazarus (1953) and Batra & Desai (1962)_7 but Tyler et al (1947), Jordao et al (1951) and Kohli & Suri (1957b) reported to the contrary.

Effect of month of calving :-

Month of calving was proved to be of no effect on birth weight of cattle _7Uman Yu (1933), Knapp et al (1940), Dinkhauser et al (1944), Tyler et al (1947), Braunde & Walker (1947), Abreu (1949), Asker & Ragab (1952), Burris & Blunn (1952), Anantn Krishnan & Lazarus (1953) and Kohli & Suri (1957b)_7.

Effect of weight of dam at freshening :-

The weight of the dam influenced the birth weight of calf as has been reported by some workers. Eckles (1919), McCandlish (1922), Krasnov & Pak (1937), Munoz & Rigor (1940), Knapp et al (1940) and Batra & Desai (1962) have got a positive association between the weight of the dam and birth weight of calf. Uman Yu (1933), Tyler et al (1947), Gregory et al (1950) and Anantn Krishnan & Lazarus (1953) have reported positive and significant effect.

Effect of gestation length:

Most of the workers have found that there was a correlation between the gestation period and birth weight of calves. Eckles (1919), Mc Candlish (1922), Fitch et al (1924), Krasnov & Pak (1937) and Singh and Dutt (1961) found a slight association (not significant) whereas Dawson et al (1947) and Kohli & Suri (1957b) observed a positive, significant and low association but marked association reported by Wing (1899), Henson (1922) Chapman (1931), Uman Yu

(1933), Little wood (1937), Knapp et al (1940), Jafar et al (1950), Jordao et al (1951), Regab & Asker (1951), Brakel et al (1952) and Anantn Krishnan & Lazarus (1953).

Effect of dry period :-

Owen Yu (1933) in Red German and Krüsenecky & Kudlicka (1944) in Moravian, Bohemain and Silisian breeds found a positive correlation between the length of preceding dry period and birth weight of calf. However, Anantn Krishnan & Lazarus (1953) on Red Sindhi and Gir could not confirm this.

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(3) AGE AT FIRST CALVING

From economic point of view age at first calving is of considerable importance as in early calvers the cost of rearing the heifers to productive stage is much reduced. Further early calving would result in the reduction of generation interval thereby augmenting the process of progeny testing, increasing the rate of genetic gain and allowing early selection of female stock on the basis of their own performance. Early calvers gave more calves than late calvers (Johansson 1950). Hartmann (1953) found that fertility and life time production were highest in cows which had their first calving at an early age and it did not effect the body size and growth of the animal.

Averages

TABLE (4)

Author	Year	Breed (Farm)	n	$\bar{X} \pm$ S.E. (days)
Joshi	1963	Deoni		
		(Udgir)	12	1648.5 ± 57.21
		(Hingoli)	24	1430.66 ± 54.008
		(Rajendranagar)	49	1504.59 ± 34.55
		(For breed)	85	1504.0 ± 25.80

Heritability estimates

TABLE (5)

Author	Year	Breed (Farm)	D.F.	$h^2 \pm$ S.E.	Remarks
Mahadevan	1951	-	-	0.10 to 0.15	Regression of daughter on dam.
Stonaker	1953	Red Sindhi	90	0.39	" "
Singh	1957	Tharparkar (Patna)	139	-0.361 ± 0.099	Intra sire regression of daughter on dam.

Table (5) Contd.

			139	-0.305 ± 0.063	Intra sire correlation
			139	0.046±0.086	Paternal half sib
Amble et al	1958a	Red Sindhi (Hosur)	192	-0.09±0.17	Intra sire regression
		Red Sindhi (Banglore)	134	0.16± 0.29	"
		Kangayam (Hosur)	281	-0.06±0.16	"
		Gir (Banglore)	29	-1.24±0.58	"
		Kankreg (Anand)	41	0.66±0.24	"
		Therparkar (Patna)	215	0.48±0.16	"
Singh	1959	Hariana		0.3403	Intra sire regression
				0.5916	Paternal half sib
Ahmed	1961	Hariana (Izatnagar)	146	0.375±0.074	Intra sire regression
Batra	1961	Sahiwal	160	0.5043±0.1938	Paternal half sib
Kohli et al	1961a	Hariana (Hissar)	199	-0.31±0.16	Intra sire regression
Singh & Desai	1961a	Hariana	241	0.3403±0.1216	"
				0.3412±0.1960	Paternal half sib
				0.404	"
Prasad	1962	Therparkar		0.08	
Singh	1964	Hariana	149	0.3540± 0.2696	Paternal half sib
			49	-0.095±0.234	Intra sire regression of daughter on dam
			49	-0.1212±0.272	Intra sire correlation

Effect of season of birth :-

Dennaoury & Bayoumi (1962) studied the effect of month of birth on their age at first calving in Sudanese cattle using the data on 184 heifers and found that variations in age at first calving as affected by month and season of birth were not significant.

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(4) SERVICES PER CONCEPTION.

There are large number of causes which make the cow failure to conceive on the first service or insemination and provide a need of one or more subsequent services for the successful conception. A greater conception rate expressed in terms of percentage of successful services or a lesser number of services per conception would obviously mean a better reproductive efficiency. Conception rate or services per conception is one of the direct factors controlling service period and indirectly determining the length of calving interval. Hence a study of this trait with regard to its nature of inheritance and factors controlling it would be much valuable for keeping the service period, dry period and calving interval at 'optimum' levels thereby getting a maximum possible life time production - a primary achievement of the breeder and dairymen.

Averages :-

No published information is available on the number of services required per conception of Deoni cows.

Effect of sequence of calving

Lasely & Bogart (1943) reported that the number of services needed per conception was affected by the age of cow. Younger cows required more services per conception. Krishna Rao (1951) observed in Normal Neal herd of California University that reproductive efficiency measured in terms of services per conception was low in heifers and it improved up to third lactation. Davis & Benjamin (1953) observed that first calf heifers required more services per conception and then there was a decrease in the number of services per conception till the fourth calving. Ragab et al (1956) observed in Egyptian cattle that the first calf heifers

required more services per conception than those for cows in later lactation and the number decreased till the third calving, thereafter it increased again. But the works by Baker & Quaissenberry (1944), Venkayya & Ananta Krishnan (1958) and Singh (1961) did not agree to it.

Effect of season of calving

Erb et al (1940) reported highest conception rate in May and lowest in August. Sheath & Staples (1941) observed that conception rate was affected by season and was highest in winter and lowest in summer. Wilson (1946) and Lewis (1948) observed seasonal variation in conception rate. Kumaran (1949) observed seasonal variation in the rate of conception of Tharparkar, Sahiwal and Amrit Mahal cows on the basis of services required per conception. Schindler (1954) observed highest conception rate during the period March-May and lowest in the month of September. Ehlers et al (1956) observed highest conception rate from March to September. Fryer et al (1958) obtained highest conception rate in Fall. Kale (1963) noted the services per conception requirement in Sahiwal cattle was usually lowest for the months of January, February and April (1.8, 1.8, 1.6 and 1.9 respectively) with exceptions for July and October. A highly significant seasonal variation in conception rate was observed by Singh et al (1964) in Hariana cattle. Significant variations in average conception rate between seasons with highest in winter and lowest in summer were observed by Sinha (1964).

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

Heritability

Various workers reported this trait to be nonheritable and variations in it were mostly due to managemental practices. Dunbar & Henderson (1950) studied the fertility of cow for A.I. as measured by 60-90 days non-returns to first service and obtained an estimate of 0.004 for heritability. Legates (1954) studying genetic variation in services per conception and calving interval in dairy cattle calculated the heritability of services per conception as 0.026. Singh (1961) in Tharparkar cattle obtained the heritability of services per conception by paternal half sib correlation method to be -0.048 and 0.147 on the basis of services per conception for single first pregnancy and for first three pregnancies respectively.

Repeatability

Berge (1942) reported repeatability of 0.22 ± 0.08 for conception rate on the reproduction records of a Norwegian herd for a period of 50 years. Legates (1954) obtained intra-cow repeatability of zero for services per conception. Dunbar & Henderson (1950) obtained repeatability estimate of 0.024. The repeatability of the number of services per conception was found to be 0.002 for Egyptian cattle by Ragab et al (1956). Singh (1961) estimated the repeatability of 0.099 for services per conception and supporting the non-genetic variation nature of services per conception explained the high values of repeatability obtained by Berge (1942) to be due to the influence of time trend in herd managemental practices over the long period.

(5) POST-PARTUM INTERVAL TO FIRST SERVICE

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

Averages

Study of literature indicated that no information on the average interval between calving and subsequent heat for Deoni cows is available.

Effect of sequence of calving :-

Herman & Edmondson (1950) reported that age of the cow and stage of lactation were found to be the factors influencing the interval. Hafez (1952) stated that older animals seemed to manifest early post-partum oestrous than young cows. Kohli & Suri (1957) reported a significant effect of age on the interval from parturation to first oestrous and also found a significant difference in calving sequence with respect to this character. The first calf heifers had a high interval and afterwards with the increase in number of lactations there was a definite trend towards a shorter interval upto fifth lactation and then an increase was obtained in succeeding lactations. Singh (1964) obtained first post partum interval to first service to be the longest than the rest of the intervals.

Effect of season of calving:-

Kohli & Suri (1957) studied the effect of month of calving on the duration and found that the interval was higher for the months April and May and lesser for September. The effect of month and season was significant. However, Herman & Edmondson (1950) reported that there was no relationship between season of the year and the interval.

Heritability and repeatability estimates :-

TABLE (6)

Author	Year	Breed	D.F.	h^2 ± S.E.	R ± S.E.	
Olds & Seath	1955	Dairy cattle		0.27	0.293	
Cerman	1955	"		zero	0.15	herd one
				zero	0.27	herd second.

(6) POST PARTUM INTERVAL TO CONCEPTION

Post-partum interval to conception constitutes on part of the two components of calving interval and is subjected to much variations (Asdell 1946 and VanDemark & Salisbury 1950) in contrast to the other part - the gestation length. Actually the crux of the problem of breeding efficiency measured in terms of calving intervals lies in reducing the service period to 'optimum level' by the knowledge of its heritability, repeatability and environmental factors effecting it.

Averages :-

Information is lacking on average service period of Deoni breed.

Effect of sequence of calving

Sanders (1927) indicated that the first calf Ayrshire heifers had a longer service period than the subsequent ones. Sikka (1931) observed in Sahiwal cows that as the age advanced the length of service period fell slightly. In both cattle and buffaloes the length of service period fell definitely from the first to second lactation but it showed a tendency to rise afterwards (Rageb et al 1956). Prasad (1958) got a significant variation between service periods of different lactations in Tharparkar cattle. Venkayya & Ananta Krishnan (1958) stated that there was a fall in the service period of Red Sindhi cows from first to second calving but it rose again in the third calving and the differences in the lengths of service periods from first to six calvings were not significant statistically. Batra (1961) in Sahiwal cows obtained the longest first-service period and it decreased from first to second and then remained more or less constant upto fifth lactation. Kohli & Acharya (1961) in Hariana

cows observed that the service period did not differ significantly for different lactations but was maximum for the first and minimum for fifth.

Effect of season of calving :-

Prasad (1958) observed that there was no influence of season of calving on the length of service period in Tharparkar herd at Patna. But Malik et al (1960) and Kohli & Suri (1960 b) reported a significant effect of season of calving on service period in Sahiwal and Hariana cows respectively. Singh & Dutt (1963) supported the findings of Malik et al (1960) to the extent that Sahiwal cows calving during summer had the longest service period and those calving in atumn had the shortest and by observing not significant effect of season of calving confirmed the findings of Prasad (1958).

Heritability estimates :

TABLE (7)

Author	Year	Breed	D.F.	h^2 + S.E.	Remarks.
Prasad	1958	Tharparkar		-0.12	Intra sire regression
				-0.016	Paternal half sib correlation
Batra	1961	Sahiwal		-0.178	
Kohli et al	1961(b)	Hariana		0.10 ± 0.17	

Repeatability estimates:

TABLE (8)

Author	Year	Breed	D.F.	R + S.E.	Remarks
Berge	1942	Red Polled Osterland cows.		0.013	
Regab et al	1956	Egyptian cattle		0.05	
Batra	1961	Sahiwal	715	0.2405	Intra-cow correlation

(7) DRY PERIOD

As a consequence of conception leading to normal pregnancy, parturation and lactation there is a lot of exhaustion on the part of cow and as such she needs a period of rest in order to replenish the energy lost. Further in well managed herds the dry cows are supposed or expected to carry their younge and hence the same dry period would be a sort of preparation period to undergo next turn of exhaustion. This exphasises the fact that cows must be given a period of rest and to avoid all sorts of negligence of feeding and menagement which may be existing during this period.

This period being unproductive component of calving interval, care should be exercised to keep it at 'optimum' level. The knowledge of its variability and the degree to which it is influenced by genetic and environmental factors is of utmost importance for the breeder to keep it at reasonable level.

Averages

Karthe (1936) reported an average dry period of 121 days in farm bred (2 records averaged) and 113 days in purchased (5 records averaged) Deoni cows maintained at Cattle Breeding Farm Hingoli (M.S.)

Effect of sequence of calving :-

Sanders (1927), Lonka (1946) and Jha & Biswas (1964) found that the first dry period was shorter than any of the later ones but Sikka (1931) in Sahiwal cows found an upward trend with the increase of age. On the contrary Bhatnagar & Choudhry (1960-61) in Malvi cows and Patra (1961) in Sahiwal cows observed that the dry period decreased with the increase in lactation number or age.

Effect of season of calving :-

Joseph & Dave (1931) in Montgomery cows observed that the length of dry period was not affected by season of calving

Repeatability of

Author	Ye
Johansson & Hansson	19
Johansson	19
"	
"	
Hilmy	
El-Itriby & Asker	
Betre	
Singh & Desai	

Venkiah (1964) found that variations due calving on subsequent dry period were cant at 1% level.

riod :

claimed that the length of dry period was length of service period in Sahiwal cows. orted a correlation coefficient of .427 eriod and dry period.

first calving

ppears to be no relationship between age at first gth of dry period (Asker et al 1959). Danasoury & in Sudanese cattle obtained a correlation 0.35 and regression coefficients of 0.293 and age at first calving and first dry period and these cally not significant.

estimates:

TABLE (9)

Year	Breed	D.F.	$h^2 \pm$ S.E.	Remarks
1956	Egyptian cattle		0.02	
1961	Sahiwal		0.1169	

while Venkataratnam & Venkiah (1964) found that variations due to effect of season of calving on subsequent dry period were statistically significant at 1% level.

Effect of service period :

Sikka (1931) claimed that the length of dry period was not affected by the length of service period in Sahiwal cows. Pajalic (1952) reported a correlation coefficient of .427 between service period and dry period.

Effect of age at first calving

There appears to be no relationship between age at first calving and length of dry period (Asker et al 1959). Danasoury & Bayoumi (1962) in Sudanese cattle obtained a correlation coefficient of 0.35 and regression coefficients of 0.293 and 0.117 between age at first calving and first dry period and these were statistically not significant.

Heritability estimates:

TABLE (9)

Author	Year	Breed	D.F.	$h^2 \pm$ S.E.	Remarks
El-Itriby & Asker	1956	Egyptian cattle		0.02	
Batra	1961	Sahiwal		0.1169	

Repeatability estimates

TABLE (10)

Author	Year	Breed	D.F.	R± S.E.	Remarks
Johansson & Hansson	1940	Swedish white and Red Cattle		0.22	
Johansson	1949	" "		0.18	
"	"	" "		0.20	
"	"	Swedish Polled cattle		0.28	
Hilmy	1954	Egyptian cattle		0.177	
El-Itriby & Asker	1956	Egyptian cattle	457	0.052	
		European cattle	179	0.131	
		Cross bred	400	0.173	
Batra	1961	Sahiwal		0.1584	
Singh & Dessi	1962a	Hariana	335	-0.138	

(6) LACTATION PERIOD

Being a productive component of calving interval it is much desired by the breeder but too long and too short lactation periods deserve no encouragement. Lengthening the lactation period would result in long inter calving period and as such the total production of milk and the calf crop in the life span of a cow would be reduced. On the other hand, short lactation periods would fetch low yield per lactation and resulting short inter calving periods would be harmful to the health of the cow. On the basis of sound reasoning (gestation period of 280 days and post-partum interval to conception of 85 days - a liberal allowance for the cow to come into oestrous after calving and for recovery of uterine mucosa so as to avoid possible infection consequent to service) the 'optimum' length of inter calving period should be one year. Keeping the optimum length of dry period 60 days (a desirable length suggested by most of the workers for maximum yield in the subsequent lactation) the lactation length turns out to be 305 days which is otherwise known as 'standard lactation length'. Through the knowledge of genetic and environmental factors affecting lactation period, breeder must try to achieve the 'standard lactation length'.

Averages

TABLE (11)

Author	Year	Breed (Farm)	Stage of lactation	n	$\bar{x} \pm$ S.E. (Days)
1	2	3	4	5	6
Kartha	1938	Deoni (Hingoli)	Purchased	5	363
		(Hingoli)	Homebred	2	263
Rahman	1956	Deoni			300
Joshi	1963	Deoni (C.B.F. Udgir)	1	35	373.8

Table 11 contd.

1	2	3	4	5	6
			2	34	329.8
			3	30	330.7
			4	24	318.0
			5	21	315.3
			6	16	299.5
			Overall	160	332.9 ± 8.1
		(C.B.F. Hingoli)	1	26	295.9
			2	29	292.3
			3	28	272.4
			4	25	271.8
			5	22	270.0
			6	16	264.5
			7	11	307.9
			8	8	266.1
			9	5	306.6
			10	1	224.0
			Overall	171	281.7 ± 10.87
		(C.B.& D.F. Rajendra-nagar)	1	50	350.2
			2	38	320.5
			3	34	306.5
			4	21	301.6
			5	10	248.4
			6	7	276.8
			7	3	269.0
			8	2	395.0
			9	1	320.0
			10	1	359.0
			Overall	167	319.4 ± 6.2

Table 11 contd.

1	2	3	4	5	6
		Deoni (Udgir+Hingoli +Rajendranagar)	1	111	344.9
			2	101	315.5
			3	92	306.2
			4	70	296.6
			5	53	283.9
			6	39	281.0
			7	14	299.5
			8	10	291.9
			9	6	308.8
			10	2	295.5
			Overall	498	300.5 ± 5.24

Effect of sequence of calving :

Singh & Desai (1961) analysed lactation records of Hariana cattle and reported that the lactation period decreased from the first to the third lactation. The age in terms of lactations was found to effect the lactation period in Sahiwal cows significantly at 0.01% level (Singh & Dutt 1963). Joshi (1963) studying the lactation records of Deoni cows at three farms Udgir, Hingoli and Rajendranagar noted that the lactation period from first to sixth lactation resumed a decline. Singh (1964) observed a decreasing trend in size of lactation in case of Hariana herd at Pusa and an increase of lactation length from second to third lactation and then fall in case of Hariana and Shahabadi at Dumraon but no systematic trend of increase or decrease in size of lactation in Shahabadi herd at Seraikella.

Effect of season of calving :

Teiland (1959) in cows kept at Konigshutte, Tomar & Mittal (1960) in Hariana cows, Blau (1961) in German Simmental cattle and

Dutt & Singh (1961) in Hariana cows, all these workers found that month or season of calving significantly affected the lactation period. Disagreeing to these findings, Joseph & Deve (1931) in Montgomery, Sikka (1931) in Sahiwal, Venkayya & Ananta Krishnan (1956) in Red Sindhi, Singh et al (1962) in Tharparkar and Desai & Dharmendra (1964) in Hariana cows observed no significant effect of season and month of calving on the lactation period.

Effect of service period

TABLE (12)

Author	Year	Breed	D.F.	Correlation	Remarks
Sikka	1931	Indian Cattle		0.524**	
Kartha	1934			0.7*	
Pejalic	1962	Montafenherd	183	0.895	
Ragab et al	1956	Egyptian cattle		0.601**	

Effect of age at first calving

TABLE (13)

Author	Year	Breed	D.F.	Correlation	Remarks
1	2	3	4	4 5	6
Venkayya & Ananta Krishnan	1956	Red Sindhi	216	0.49*	Phenotypic
		Cir	80	0.79*	"
		Ayrshire x Sindhi	241	0.16*	"
Batra	1961	Sahiwal		0.0831	"
				0.6996	genetic
Singh & Chaudhry	1961	Sahiwal		0.19	Phenotypic
		Tharparkar		0.08	"
Donaseury & Bayoumi	1962	Sudanese cows	187	0.08	"
				0.203*	"
Singh	1964	Hariana	134	0.7136	genetic

Heritability estimates

TABLE (14)

Author	Year	Breed	D.F.	h^2 ± S.E.	Remarks
ICAR Team	1957	Tharparkar (Patna)	86	0.08	Regression of daughter on dam
Amble et al	1958a		182	0.04	" "
	1960		304	0.13	" "
Batra	1961	Sahiwal	186	0.374±0.1534	Paternal half sib correlation
Kohli et al	1961(a)	Hariana	140	-0.22	Regression of daughter on dam
Mahadevan & Marples	1961	Uganda cattle		0.1	
Singh & Desai	1961c	Hariana	190	0.3215	Intrasire regression
		"	190	0.828	Paternal half sib correlation
		"	322	0.104	" "
Prasad	1962	Tharparkar		0.09	
Singh	1964	Hariana		0.5860±0.144	Intrasire regression of daughter dam
				0.4380±0.242	Intrasire correlation
				0.3844± 0.184	Paternal half sib correlation

Repeatability estimates

TABLE (15)

Author	Year	Breed	D.F.	R ± S.E.	Remarks
Alim & Ahmed	1954	Kenana herd	517	0.160	
Hilmy	1954	Egyptian cattle	-	0.575	
El-Itriby & Asker	1956	Egyptian native cattle	478	0.258	
		European cattle	176	0.186	
		Crossbred	411	0.190	
Amble et al	1958(a)		921	0.33	
"	1960		1231	0.31	
Mahadevan	1960			0.24	
Batra	1961	Sahiwal	767	0.2507	Intraherd basis
Mahadevan & Marples	1961	Nganda cattle	-	0.42	
Singh & Desai	1961	Hariana	594	0.2766	
Alim	1962	Butana cattle Sudan		0.415 ± 0.043	
Singh	1964	Hariana	335	0.3614 ± 0.049	Intra cow correlation

(9) CALVING INTERVAL

The total amount of yield a cow gives in her life time is covered by lactation yield, longevity and rate of reproduction. The rate of reproduction remains under the direct control of inter calving period. Hence for maximum total lactation yield and economic cattle breeding the importance of short inter-calving periods needs no much emphasis.

Averages

TABLE (16)

Author	Year	Breed (Farm)	Stage of lactation	n	$\bar{X} \pm S.E.$ (days)
1	2	3	4	5	6
Rahman	1958	Deoni	Well managed herd		13-14 months
			Ordinary managed		18-24 "
Joshi	1963	Deoni			
		(C.B.F. Udgir)	1	31	517
			2	32	525.6
			3	24	510.8
			4	21	487.1
			5	17	441.4
			Overall	125	502.8 ± 12.9
		(C.B.F. Hingoli)	1	21	482.1
			2	20	474.4
			3	21	411.09
			4	18	423.6
			5	13	426.0
			6	13	443.4
			7	8	474.7

1	2	3	4	5	6
			8	5	372.0
			9	1	448.0
			Overall	120	441.008 ± 12.4
		(C.B.& D.F. Rajendra-nagar)	1	41	531.07
			2	34	503.06
			3	21	452.04
			4	10	455.7
			5	8	469.8
			6	4	399.0
			7	2	410.5
			8	2	444.0
			Overall	122	491.9 ± 11.8
		(Udgir + Hingoli + Rajendranagar)	1	93	515.3
			2	86	504.8
			3	66	460.4
			4	49	457.4
			5	38	442.1
			6	17	433.0
			7	10	461.9
			8	7	392.5
			9	1	448.0
			Overall	367	479.9 ± 6.7

Effect of sequence of calving :-

Watson (1929) suggested that the optimum calving interval in Indian cattle varied directly with milking capacity and inversely with age up to maturity. Brown et al (1954) and Singh (1958) reported significant effect of sequence of calving on the calving interval.

Bhatnagar & Chaudhry (1960-61) found in Malvi cows that calving interval tended to decrease with increasing age of the animal. The inter calving period in Deoni breed resumed a decline as the age advanced (Joshi 1963).

Effect of season of calving

Singh (1958) failed to get any significant effect of season of calving on calving interval in Tharparkar cows. On the contrary Singh et al (1958[b]) got statistically significant effect of season of calving on inter calving period in Hariana cattle. The animals that calved in the month of May and June had the longest inter calving period (514 ± 10.67 days). Those calving from December to April had the next highest inter calving period of 488 ± 6.97 days. The inter calving period for the cows having calved from July to November was 464 ± 6.67 days.

Effect of age at first calving

TABLE (17)

Author	Year	Breed	D.F.	Correlation	Remarks
Venkayya & Ananta Krishnan	1956	Red Sindhi	216	0.56*	
		Gir	80	0.20	
		Crossbred	241	0.28*	
Singh	1957	Tharparkar		0.025	
Batra	1961	Sahiwal		0.0786 0.2613	Phenotypic Genetic
Ahmed	1961	Hariana (Izatnagar)		0.109 0.272*	Phenotypic Genetic
Kohli et al	1961b	Hariana		0.248*	
Singh & Chaudhry	1961	Sahiwal	118	0.12	
		Tharparkar	90	0.04	
Denesoury & Bayoumi	1962	Sudanese cattle		0.117	
Singh	1964	Hariana		0.1669	

Heritability estimates

TABLE (18)

Author	Year	Breed	D.F.	$h^2 \pm$ S.E.	Remarks
Dunbar & Henderson	1950			0.01 & 0.0	
Asker et al	1953	Egyptian cattle	34	0.13	Intra sire regression of daughter on dam.
Dunbar & Henderson	1953			0.004	Paternal half sib correlation
Stoneker	1953	Red Sindhi	40	0.88	Intrasire regression of daughter on dam.
Amble et al	1958a	Red Sindhi (Hosur)	155	-0.08±0.20	Intrasire regression
		Red Sindhi (Bangiore)	125	0.13±0.19	"
		Kangayam (Hosur)	223	0.11±0.19	"
		Gir (Bangiore)	23	-0.37±0.48	"
		Kankrej (Anand)	25	-0.31±0.40	"
		Tharparkar (Patna)	204	-0.01±0.16	"
Singh	1958	Tharparkar (Patna)	58	-0.180±0.145	"
		"	58	-0.164±0.132	Intrasire correlation
Dedlani et al	1959	Hariana		0.02	
Wheat et al	1959			0.50	
Ahmed	1961	Hariana (Izatnagar)	165	0.22	Paternal half sib correlation
Batra	1961	Sahiwal	226	-0.2073	"
Kohli et al	1961a	Hariana (Hissar)	103	0.3±0.18	
Singh & Desai	1962b	Hariana	164	+0.022±0.058	Intrasire regression
			164	-0.337	Paternal half sib correlation
Mishra	1965	Dualpurpose		-0.04	

Repeatability estimates

TABLE (19)

Author	Year	Breed	D.F.	R ± S.E.	Remarks
Legates & Lush	1954			0.133	
El-Itriby & Asker	1956	Egyptian cattle	475	0.137	
		European (Friesian & short horn)	195	0.080	
		Cross bred	395	0.089	
Thompson et al	1957			0.086	
Amble et al	1958a	Red Sindhi (Hosur)	517	0.21	
		Red Sindhi (Banglore)	609	0.08	
		Kangayam (Hosur)	681	0.08	
		Gir (Banglore)	86	0.17	
		Kankrej (Anand)	66	0.17	
		Tharparkar (Patna)	1174	0.19	
Kohli et al	1958a	Hariana (Hissar)	578	0.72	
Singh	1958	Tharparkar (Patna)	582	0.226±0.047	Corrected for year and sequence of calving
			582	0.282±0.046	Uncorrected
Singh & Dasai	1962b	Hariana	336	0.101	

(10) LACTATION YIELD

The very object of cow keeping is, in addition to receiving services of good bullocks for draught purposes in case of dual purpose breeds, to get milk. Milk is the only source of animal proteins for vegeterians who make up the majority of Indian population. However, a cow must give sufficient amount of milk in her life time in order to compensate the expenditure incurred on her for raising to the productive stage, for maintaining her thereafter and with extra profit to the breeder. In other words, breeder is essentially interested in knowing the genetic and environmental factors affecting milk production and possibilities of increasing it to the maximum feasible extent.

Averages

TABLE (20)

Author	Year	Breed	Stage of lactation	n	$\bar{X} \pm S.E.$ (lbs.)
1	2	3	4	5	6
Kartha	1938	Deoni (Hingoli)	Homebred	2	2673
			Purchased	5	2943
Rahman	1956	Deoni			2400
Randhawa	1956	Deoni	Average cow		1500
			Under Farm condition		2500
Joshi	1963	Deoni (C.B.F.Udgir)	1	35	3361.4
			2	34	2978.4
			3	30.	2965.6
			4	24	2434.0
			5	21	2697.4
			6	16	2397.7
			Overall	160	2883.2± 112.23

Table 20 contd.

1	2	3	4	5	6
		(C.B.F.Hingoli)	1	26	2206.8
			2	29	2100.0
			3	28	2048.2
			4	25	1723.5
			5	22	1855.8
			6	16	1537.7
			7	11	1953.1
			8	8	1630.2
			9	5	1232.2
			10	1	1390.0
			Overall	171	1919.0 ± 55.9
		(C.B.& D.F. Rajendranagar)	1	50	3363.8
			2	38	3317.8
			3	34	3376.3
			4	21	3055.0
			5	10	2634.1
			6	7	2946.2
			7	3	2761.0
			8	2	3299.5
			9	1	3336.0
			10	1	3058.0
			Overall	167	3242.3±81.9
		Deoni (Udgir+Hingoli+ Rajendranagar)	1	111	3092.6
			2	101	2853.8
			3	92	2838.2
			4	70	2366.5

Table 20 contd.

1	2	3	4	5	6
			5	53	2336.1
			6	39	2141.3
			7	14	2126.2
			8	10	1964.1
			9	6	1918.6
			10	2	2224.0
			Overall	498	2672.3±55.17

Heritability estimates:

TABLE (21)

Author 1	Year 2	Breed 3	D.F. 4	h^2 ± S.E 5	Remarks 6
Gowen	1934			0.5	
Sikka	1934	Sahiwal		0.37	Daughter dam regression.
Plum	1935			0.18	
Johansson & Henesson	1940		1488	0.38	Intrasire regression
Seath	1940			0.21-0.25	
Lush et al	1941			0.33	
Tyler & Hyatt	1947		6887	0.31	Intrasire correlation
Johansson	1950			0.24	
Leben & Herman	1950	Holstein	270	0.36	Intrasire regression of daughter on dam.
Midtlid et al	1950	Norwegian cattle		0.46	
Rendel & Robertson	1950			0.3	

Table 21 contd.

1	2	3	4	5	6
Robertson	1950	Fulani		0.32	1st lactation yield
		"		0.47	Average of 1st and 2nd records
Sikka	1950	Sahiwal		0.372	
Chandra-shekher	1951	M.C.C. Herd	270	-0.01	
Mahadevan	1951		667	0.21 to .30	Regression of daughter on dam.
Touchberry	1951	Holstein	186	0.25	
Asker et al	1953			0.24	
Corneiro	1953			0.23	
Mahadevan	1953	Black Sinhala		0.25	
Stoneker	1953	Red Sindhi		0.25	Daughter dam regression.
Johansson	1954	Red Danish		0.58	
Mahadevan	1954		1101	0.19	Regression of daughter on dam.
Yao et al	1954	Shorthorn	162	0.28	Paternal half sib correlation
			122	0.71	Daughter dam regression
Mahadevan	1955			0.14	
	1955	Red Sindhi		0.20	Daughter dam regression.
Rognoi & Pasti	1955	Friesian		0.22 to 0.37	
Tebler & Touchberry	1955	Jersey	2809	0.25	Daughter dam regression
Taylor	1955	Ohio Dairy cattle	2024	0.264	"

Table 21 contd.

1.	2	3	4	5	6
Robertson et al	1956		500	0.25	Intrasire regression of daughter on dam.
Alim	1957			0.16	
El-shimy	1957	Friesian cattle	9549	0.37	Intra class correlation
		"	"	0.355	Daughter dam regression
ICAR Team	1957			0.12-0.45	Intrasire regression
Johnson	1957	Holstein	75	0.30	Intrasire correlation of daughter on dam
		Jersey	69	0.26	"
Rendel et al	1957			0.43	
Amble et al	1958(a)	Kangayam (Hosur)	308	0.58	Intrasire regression of daughter on dam
		Red Sindhi (Hosur)	182	0.34	"
		Red Sindhi (Banglore)	143	0.37	"
Chandermani et al	1958	Hariana (Izatnagar)		0.18	"
Hartman	1958	Schleswig Holstein	1248	0.2	Paternal half sib correlation
Lauhscher & Allen	1958	Jersey		0.36±0.08	
Bauer et al	1959		433	0.19	Daughter dam regression
O. Conner	1959			0.43	"
Singh	1959			0.2	
Tabler et al	1959		20023	0.27	Daughter dam regression
Teneja & Bhatnagar	1959	Malvi	44	0.43±0.20	"

Table 21 Contd.

1	2.	3.	4	5	6
Amble et al	1960		308	0.58	Intrasire regression of daughter on dam
Dhinsa	1960			0.32	
Mahadevan	1960			0.16	
Ahmed	1961	Hariana (Izatnagar)	189	0.259±0.096	Paternal half sib correlation
Batra	1961	Sahiwal	226	0.3389±0.2231	Paternal half sib correlation
Johnson et al	1961	Brown Swiss	645	0.42	Intra-sire regression of daughter on dam.
			381	0.36	"
			209	0.37	"
			103	0.40	"
Kohli et al	1961a	Hariana	138	0.46±0.12	"
Singh & Desai	1961b	Hariana	187	0.147±0.043	"
			177	0.196±0.0136	Paternal half sib correlation
				0.1316±0.1224	"
				0.15	Dam daughter. Av. milk yield
				0.127±0.086	Dam daughter adjusted to 1st lactation basis
Prasad	1962	Tharparkar		0.05	Paternal half sib correlation, life time production
Kaaer	1963	Tharparkar	335	0.22±0.02	Intra-sire regression of daughter on dam
		Sahiwal	127	0.44±0.32	" "
Singh	1963	Bachaur	30	0.146±0.706	Paternal half sib correlation
Bradford & Vanvleck	1964		5740	0.43±0.03	Intra-sire regression
Singh	1964	Hariana	46	0.30±0.1346	Intra sire regression of daughter on dam
			46	0.20±0.298	Intra sire correlation
			142	0.52±0.211	Paternal half sib correlation
Mishra	1965	Dual purpose breed.		0.22	Varience & covariance

Repeatability estimates

TABLE (22)

Author	Year	Breed	D.F.	R±S.E.	Remarks
1	2	3	4	5	6
Sikka	1931	Sahiwal		0.502	Intra cow correlation
Plum	1935		3544	0.40	Intra class correlation
Johansson & Hansson	1940		1488	0.38	"
Lush et al	1941		676	0.48	Daughter dam comparison
Johansson	1947	Swedish Red cattle	461	0.42	Intra class correlation
"	1949		2398	0.40	"
"	1949		1061	0.39	"
Leben & Herman	1950		619	0.41	Contemporery basis
Leben & Herman	1950		619	0.44	Non contemporery basis
Mahadevan	1950			0.46	
Ragab	1950			0.50	
Robertson	1950	Fulani cattle (Nigeria)		0.60	
Chandrashekher	1951		788	0.40	Intra class correlation
Lecky	1951	Fulani		0.60	"
		Sahiwal		0.47	"
Mahadevan	1951		1304	0.46	"
			308	0.52	"
Corneiro	1953			0.46	
Mahadevan	1953	Sinhala (Ceylon)		0.46	
		Cross bred		0.55	
Alim & Ahmed	1954	Kenana herd	517	0.550	
Hilmy	1954	Egyptian native cattle		0.744	

Table 22 contd.

1	2	3	4	5	6
Madden	1954	Holstein		0.5	
Mahadevan	1954			0.58	Intra class correlation
	1955	Red Sindhi		0.41	"
	1955		598	0.51	"
Rognoni & Pasti	1955	Simmental cattle	303	0.64	Intra cow correlation
El-Itriby & Asker	1956	Native cattle	476	0.341	Intra class correlation
		European cattle	176	0.291	"
		Cross bred	411	0.472	"
Amble et al	1958a	Sindhi (Hosur)	921	0.61	"
		Sindhi (Banglore)	958	0.54	"
Hartman	1958	Holstein	1248	0.34	"
Bauer et al	1959	Bererian cattle	433	0.24	"
Taneja & Bhatnagar	1959	Malvi	44	0.76±0.20	
Alim	1960	Konena herd		0.43	Intra cow correlation
Amble & Krishnan	1960	Kangayam	1231	0.62	Intra class correlation
Dhinsa	1960			0.377	
Mahadevan	1960			0.46	
Batra	1961	Sahiwal	872	0.4415	Intra cow correlation
Johnson & Corley	1961	Brown Swiss	526	0.47	Intra class correlation
Kohli et al	1961a	Hariana	408	0.68	
Singh & Desai	1961b	Hariana	358	0.653	Intra herd, Intra class. 2 records
			358	0.619	Intra herd Intra sire. 2 records
			273	0.506	Intra herd Intra class. 3 records
			553	0.3878	Intra herd Intra class. 3 records

Table 22 contd.

1	2	3	4	5	6
Kaaer	1963	Tharparkar		0.49±0.06	Intra class correlation
		Sahiwal		0.52±0.06	"
		Red Sindhi		0.37±0.12	"
Singh	1963	Bachaur		0.366	Intra cow correlation
Singh	1964	Hariana	333	0.4856 ± 0.043	Intra herd, intra-cow correlation.

Effect of sequence of calving:-

McLaughlin (1955) in Kenana cows, Mahadevan (1956) in imported European breeds in Ceylon, Asker et al (1958) in Egyptian cattle, Kohli & Acharya (1961) in Hariana and Jha & Biswas (1964) in Tharparkar cows observed that maximum lactation yield was in third lactation. Mature yield was found to be in the fourth lactation by Sikka (1940) in Ayrshire cows, Stoneker (1953) in Red Sindhi cows, Venkayya & Ananta Krishnan (1957) in Red Sindhi and Ayrshire x Sindhi cows, Asker et al (1958) in Egyptian cattle, Alim (1960) in Kenana cows and Robertson (1960) in Fulani cattle. The maximum yield as late as in fifth lactation has been reported by some workers [Ragab et al (1954) in Egyptian native cattle, Rognoni & Pesti (1955) and Mainardi & Dordoni (1955) in Friesian cows and Boyoumi & Demeaoury (1963) in Sudanese cattle].

However, Sharma et al (1951) in Hariana and Singh & Datt (1963) in Sahiwal cows found little variation from second to fifth lactation.

Effect of season of calving

Hammond & Sanders (1923) in Ayrshire cattle, Sanders (1927) in British cattle, Eri & Hamb (1947) in Norwegian cattle, Eikelboom (1948) in Freisland cattle, Bartsch (1950) in dairy cattle, Mahadevan

Mahadevan (1951) and Lokeesvele et al (1950) in Ayrshire cattle, Ragab et al (1954) in Egyptian cattle, Gasper & Nagy (1955) in different breeds, Bayoumi (1959) in Sudanese cattle, Dutt & Singh (1961) in Hariana cattle and Bayoumi & Danasoury (1963) in Sudanese cattle all these workers demonstrated significant effect of season of calving and found that winter calvers were the best producers compared to other seasons and that summer calvers were lenst yielders.

Frick et al (1947) found that Guernsey, Ayrshire, Holstein and Jersey cows calving in the month of Febrauery produced 13.7% more yield per lactation than those calving in July. Maoli (1959) showed that cows calving in spring had the highest lactation yield and the lowest production was recorded in autmn.

Fosgate & Welch (1960) in dairy cattle and Singh et al (1962) in Tharparkar observed that cows calving in winter and spring out produced those calving in summer or fall.

Pegg (1955) observed in Queensland cows that animals calving during July-September were best producers per lactation whereas those calving during January-March the lowest producers. Wylie (1925) found that Jersey cows calving in July were best producers.

No significant effect of season of calving on lactation yield was present [Joseph & Dave (1931) in Montgomery cows, Sikka (1931) in Sahiwal cows, Arnold & Becker (1935) in Floride cows, Carneiro & Lush (1948) in dairy cattle, Olonfa & Jones (1948) in Oregan State cows, Bettaney (1949) in Western Australia, Berge (1949) in Norwegian red and white cattle, Blau (1949) in Red low land cattle, Ragab (1950) in England, Baily (1952) in dairy Short horn, Baum et al (1952) in Washington State College cattle, Asker (1958) in Egyptian native cattle, Venkayya & Ananta Krishnan (1958) in Red Sindhi, Tomar & Mittal (1960) in Hariana, Singh & Dutt (1963) in Sahiwal, Desai & Kumar (1964) in Hariana and Sidhu (1964) in Tharparkar cows]

Effect of body weight

TABLE (23)

Author 1	Year 2	Breed 3	D.F. 4	Correlation 5	Remarks 6
Rajagopalan	1952	Red Sindhi		0.22*	Weight at first calving x 1st lactation yield
		Kangayam		0.5515**	"
Venkayya & Ananta Krishnan	1958	Red Sindhi		0.35**	Body weight x lactation yield.

Effect of service period

TABLE (24)

Author	Year	Breed	D.F.	Correlation	Remarks
Sanders	1927	British cattle		0.409*	Service period x current lactation yield.
Gains	1927	Guernsey		0.039	" "
Sikka	1931	Sahiwal		0.339*	Service period x current lactation yield
Pagalic	1952	Montafon herd	184	0.532*	" "
Ragab et al	1956	Egyptian native cattle		0.069	" "
Venkayya & Ananta - Krishnan	1958	Red Sindhi		0.179**	" "
Batra	1961	Sahiwal		0.33076*	" "
	1961	Sahiwal		0.35445*	Service period x subsequent lactation yield
Kohli & Acharya	1961	Hariana	753	0.38*	Service period x current lactation yield.

Pejalic (1952) had recommended a service period of 80 days for Montafon herd cows for maximum production. Ragab et al (1956) recommending the optimum service period concluded that buffaloes as well as cattle must be bred at post partum oestrous. In support of their suggestion they referred the conclusion of Hafez (1953) of mating the buffaloes and cows some 30-40 days after calving instead of usual practice of 60 days and the probable decrease in lactation yield due to subsequent pregnancy would be less expensive than cutting down the productive potentiality of the animal. Venkayy-a & Ananta Krishnan (1958) suggested an optimum service period of 3-4 months for Red Sindhi cows. Kohli & Acharya (1961) found that Hariana cows having service period between 189-243 days had a sufficient high lactation yield and thus could be considered to be economical to be retained in the herd as compared to those yielding more but having longer service periods.

Effect of age at first calving

TABLE (25)

Author	Year	Breed	D.F.	Correlation	Remarks
1	2	3	4	5	6
Chapman & Dickerson	1936	Holstein		0.22	Between cumulative milk yield of 2 lactations and age at first calving
Larson et al	1951			0.06*	Age at first calving x 1st lactation yield
Rajagopalan	1952	Red Sindhi	81	0.1217	"
		Kangayam	31	0.60694**	"
Ragab et al	1954	Egyptian cattle		0.034	"

Table 25 contd.

1	2	3	4	5	6
Sundaresan et al	1954	Red Sindhi	82	0.064	Age at first calving x 1st lactation yield
		½ Jersey x ½ R.S.	30	0.300	"
		½ B.S. x ½ R.S.	16	0.074	"
		¾ Jersey x ¼ R.S.	69	0.071	"
		¾ B.S. x ¼ R.S.	28	0.12	"
		¾ Holstein x ¼ R.S.	11	0.33	"
		Jersey	91	0.186	"
Rognoni & Pasti	1955	Friesian		0.21	Life time production
Venkayya & Anantakrishnan	1956	Red Sindhi	215	0.44*	Age at first calving x 1st lactation yield
		Gir	79	0.34*	"
		Ayrshire x Sindhi	240	0.19*	"
	1957	Red Sindhi		0.78**	"
		"		-0.10	Age at first calving x 2nd lactation yield
		"		-0.18	Age at first calving x 3rd lactation yield
		"		0.07 **	Age at first calving x 4th lactation yield
		Ayrshire x Sindhi		0.41	Age at first calving x 1st lactation yield
		"		0.19	Age at first calving x 2nd lactation yield
		"		0.19	Age at first calving x 3rd lactation yield
		"		0.23	Age at first calving x 4th lactation yield

Table 25 contd.

1	2	3	4	5	6
Chandermani	1958			-0.07	Age at first calving x 1st lactation yield
Singh	1959			-0.10	"
Bhatnagar & Chaudhry	1960-61	Malvi	65	0.99**	"
Ahmed	1961	Hariana		0.163	" " Phenotypic
			125	-0.187	" " Genetic
Batra	1961	Sahiwal		0.145*	" " Phenotypic
				0.812	" " Genetic
				1.6054	" " Environmental
Kohli et al	1961c	Hariana		0.143*	" " Phenotypic
Singh & Chaudhry	1961	Sahiwal	118	0.09	" " "
		Tharparkar	90	0.047	" " "
Singh & Desai	1961b	Hariana		0.078	" " Intra herd
Daneaoury & Bayoumi	1962	Sudanese cattle	131	0.402**	" " Phenotypic
Prasad	1962	Tharparkar		0.105	Age at first calving x life time production, phenotypic
				0.40	" " Genetic
Singh	1963	Bachaur	26	0.130	Age at first calving x 1st lactation yield, phenotypic
Singh	1964	Hariana	126	0.0709	" " "
				0.1118	" " Genetic

Effect of lactation period

TABLE (26)

Author	Year	Breed	D.F.	Correlation	Remarks
Sikka	1931	Sahiwal		0.695*	Phenotypic
Robertson	1950	Fulani cattle		0.90**	"
Mahadevan	1953	Black Sinhala	333	0.44*	"
	1955	Red Sinhala	696	0.66*	"
	1956	Sahiwal	237	0.42*	"
		Cross bred		0.50*-0.55*	"
Asker et al	1958	Egyptian native cattle		0.731**	"
Nigeria Northern Region Dept. of Agri.	1959	White Fulani cattle		0.89**	"
Alim	1960	Kenana		0.87	"
Batra	1961	Sahiwal		0.659**	Gross
				0.658**	Intra herd
				0.6382	Genetic
				0.037	Environmental
Singh & Desai	1961b	Hariana		0.745*	Gross
				0.688*	Intra herd
Alim	1962	Butana cattle (Sudan)		0.857	Phenotypic
Prasad	1962	Tharparkar		0.222	"
Singh	1964	Hariana	142	0.3517**	Gross. 1st lactation length x 1st lactation yield.

Effect of preceding dry period

TABLE (27)

Author	Year	Breed	D.F.	Correlation	Remarks
Pejalic	1952	Montafon herd	184	0.157	
Ragab et al	1954	Egyptian cattle		-0.519*	
Asker et al	1958	Egyptian cattle		-0.051	
Bhatnagar & Choudhry	1960-61	Malvi		-0.88**	
Singh & Desai	1962a	Hariana		-0.355**	
Jha & Biswas	1964	Tharparkar		0.12**	

Various investigators have suggested an optimum dry period of 40-60 days as a period of rest for the maximum and economical yield in the next lactation in their concerned studies. Hammond & Sanders (1923) concluded that the lactation yield was considerably lowered by very short periods but was not greatly increased by very long ones. Carroll (1931) studying records of Utah cow testing Association suggested that for a higher production a cow needed a longer rest period than one month and that a dry period of more than two months added nothing to the lactation yield. Arnold & Becker (1936) indicated that in dairy cows a dry period of 1-2 months was optimum to allow maximum production in the next lactation whereas shorter or longer dry periods depressed the subsequent lactation yield. Lecky (1951) found that the shortest dry periods caused maximum production in the subsequent lactation in Fulani cattle of Nigeria. Pejalic (1952) concluded that cows needed a dry period of 60 days for optimum production in Montafon herd. Clark (1959) observed in

Table 28 contd.

1	2	3	4	5	6
Ahmed	1961	Hariana		0.253	1st calving interval x 1st lactation yield
				-0.132	genetic
Batra	1961	Sahiwal		0.308**	Phenotypic, all lactation
Prasad	1962	Tharparkar		0.041	" "
				-0.3	genetic
Singh	1964	Hariana	113	0.307**	Phenotypic, 1st calving interval x 1st lactation yield.

CHAPTER - III.

MATERIAL AND METHODS.

CHAPTER III

MATERIAL AND METHODS

(I) MATERIAL :

The data on Deoni breed of cattle were collected from Cattle Breeding and Dairy Farm Rajendranagar, Hyderabad (A.P.). The farm is situated at Rajendranagar which is about 8 miles away from Hyderabad City.

This farm was established in the year 1930 to produce pedigreed bulls for improving the Local Cattle of the Hyderabad State like Malvi, Krishna Valley & Deoni and to evolve a dual purpose breed for both draught and milk and also to supply wholesome milk to the City consumers.

This Farm was previously known as Government Cattle Breeding & Dairy Farm, Himayat Sagar, Hyderabad. With a view to improve city supply of milk the Government had purchased in 1955 a Private Dairy Farm and shifted the Milch herd to this Farm. The Malvi and Krishna Valley cattle were transferred to Karimnagar and Munirabad Farms respectively when the Cattle Breeding Farms of the that particular breed were started there being the breeding tracts of those breeds. At present breeds of livestock maintained in the Farm are Deoni, Marathwada and Murrah.

The Deoni herd at this Farm was started from 18th December 1946 and the foundation stock of the herd consisted of 98 cows and 10 bulls. The cows along with male or female calves were purchased in 14 batches from 18-12-1946 to 3-7-1956. The foundation stock has been supplemented by the following purchases given in the Table (29)

TABLE (29)

Period	No. of animals purchased			
	Adults		Calves	
	Cows	Bulls	Female	Male
1946-1947	59	2	16	16
1948-1949	22	2	7	14
1950-1951	8	-	2	3
1952-1956	9	4	1	-

It may be seen from the above Table that the increase in strength was particularly marked at initial stages. The whole strength till April 1965 was 190 cows consisting of foundation stock 90, first generation 51, second generation 36 and third generation 5.

The herd had 15 bulls of these 8 were brought from outside 3 were the sons of foundation cows and 2 from first generation cows sired by outside bulls. The remaining two were from farm bred bulls.

The total area of the Farm is 464 acres of which 50 acres is occupied by Farm Buildings and Roads etc., 354 acres are reserved for grazing with scattered trees and hillocks and the remaining area of 60 acres is under fodder cultivation.

The climate of Telengana which consists mainly of the Plateau zone, though not salubrious, is nevertheless agreeable for the greater part of the year. Its rainy season lasts from June to September; the cold weather from October to February and hot weather from March to end of May (Randhawa et al 1961). Rainfall ranges between 33" to 30". Two third of the States rainfall is derived from the south-western monsoon. The annual normals of temperature are 93.9° to 70.8°F with 68% relative humidity. Red soils or Chalka soils predominate in the Telangana region.

Weaning of calves at birth was not practised in this Farm. Cows were housed in pucca byres. They were hand milked twice a day.

The scales of feeding for different classes of animals generally approximated to Morrison's standards. Detailed records of feeding schedules followed in different years covered by the study were not available except for last three years. Till 19th March 1965 the concentrate mixture consisted of G.N. cake 20 parts, Rice bran 50 parts and grain crushed 30 parts. As regards the quantity of concentrates given daily it was ½ Kg. for calves below 3 months, 1 Kg. for calves 3-6 months, 1½ Kg. for young stock of 6 months to 1 year and 2.72 Kg. as a maintenance ration for dry animals. For milch animals a maintenance ration of 2.27 Kg. of concentrate mixture and the productive ration at the rate of 1 Kg. per two pounds of milk was given.

However, from 19th March 1964 the composition of concentrate mixture has been changed to G.N. cake 25 parts, rice bran 15 parts grains crushed 10 parts and maize 50 parts.

From 1965 there is a complete change in the feeding schedule as cattle are fed 'OK' Premixed Cattle Feed manufactured by East Asiatic Company (India).

The livestock are fed on green fodder throughout the year. They get sufficient green leguminous fodders such as Berseem, Ali Alfa and Bullers etc. Green feeds are mostly raised in the farming land. Whenever available in abundance they are stored as silage and hay which are used during the period of shortage. Grazing facilities are provided throughout the year on the grazing lands attached to the Farm.

The data on Deoni cattle since the inception of the herd to March 1965 i.e., for about 18 years, were used for the present

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study. The incomplete lactation records which were due to purchase of cows, death of the calf, culling of the cow or due to some disease were not considered. The yield for a week in the beginning of lactation was excluded from total production as colostrum. The averages, heritability and repeatability estimates and genetic correlations were based on total production.

TABLE (30)

NUMBER OF OBSERVATIONS FOR AVERAGES AND VARIATIONS FOR DIFFERENT ECONOMIC TRAITS

Traits	n
Gestation period	485
Birth weight	506
Age at first service	89
Services per conception	642
Weight at first calving	42
Age at first calving	86
Post-partum interval to first service	479
Service period	382
Lactation length	415
Dry period	404
Calving interval	406
Lactation yield	415

TABLE(31)

NUMBER OF SIRES AND RECORDS AVAILABLE FOR HERITABILITY AND REPEATABILITY ESTIMATES.

Traits	HERITABILITY				REPEATABILITY	
	Intra sire regression & correlation		Paternal half sib correlation			
	No. of pairs	No. of sires	No. of half sib	No. of sires	No. of records	No. of cows
Gestation period	-	-	66	5	268	70
Birth weight M	108	8	232	11	-	-
F	92	7	217	13	-	-
M+ F	207	10	457	15	278	71
Age at first service	24	4	68	5	-	-
Services per conception	-	-	73	5	294	73
Weight at first calving	-	-	32	4	-	-
Age at first calving	29	4	73	5	-	-
Post-partum interval to first service	29	3	59	4	258	66
Service period	20	2	47	3	223	58
Lactation length	22	2	51	3	232	61
Dry period	20	3	47	3	195	52
Calving interval	21	2	49	3	202	55
Lactation yield	22	2	51	3	232	61

TABLE (32)

NUMBER OF OBSERVATIONS FOR THE EFFECT OF SEASON AND MONTHS ON DIFFERENT ECONOMIC TRAITS.

Traits	n
Gestation period	467
Birth weight	505
Services per conception	406
Age at first calving	86
Post-partum interval to first service	480
Service period	377
Lactation length	413
Dry period	375
Calving interval	406
Lactation yield	413

TABLE (33)

NUMBER OF SIRES, HALF SIBS AND PAIRS OF OBSERVATIONS AVAILABLE FOR CALCULATION OF INTERRELATIONSHIPS.

COMBINATION			Pairs of observation	No.of sires	No. of half sibs
Birth weight at calving	x	Birth weight of calf	229	-	-
Gestation period	x	" "	467	-	-
Preceding dry period	x	" "	350		
Weight at birth	x	Age at first calving	79	-	-
Age at first service	x	" "	83	-	-
Weight at birth	x	Weight at first calving	37	-	-

Table 32 contd.

COMBINATION			Pairs of observation	No.of sires	No.of half sibs
Age at first calving	x	Weight at first calving	33	-	-
Service period	x	Lactation period	323	-	-
Age at first calving	x	First lactation period	69	-	-
Service period	x	Dry period	353	-	-
Age at first calving	x	First dry period	61	8	47
,, ,,	x	First calving interval	64	-	-
Age at first service	x	,, ,,	62	-	-
Weight at freshening	x	Lactation yield	149	-	-
Weight at first calving	x	First lactation yield	29	-	-
Service period	x	Same lactation yield	324	6	140
Service period	x	Subsequent lactation yield	313	-	-
Age at first calving	x	First lactation yield	69	-	-
,, ,,	x	Second lactation yield	51	-	-
,, ,,	x	Third lactation yield	37	-	-
,, ,,	x	Fourth lactation yield	26	-	-
,, ,,	x	First three lactation yields	33	-	-
,, ,,	x	First four lactation yield	24	-	-
Age at first service	x	First lactation yield	65	-	-
Lactation period	x	Lactation yield	414	6	171
Dry period	x	Subsequent lactation yield	298	5	115
First calving interval	x	First lactation yield	67	-	-

(2) METHODS

Comparisons

Comparisons were made between generations. The production record of breed was assumed to be the population performance. The production of a particular generation was a random sample of whole performance. Taking this assumption in view, 't' test was applied.

$$t\ 0.05 = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{\Sigma x_1^2 + \Sigma x_2^2}{n_1 + n_2 - 2} \times \frac{n_1 + n_2}{n_1 \times n_2}}}$$

where, $\bar{X}_1$ = average performance of one generation

$\bar{X}_2$ = " " " other "

Σx_1^2 = corrected sum of squares of one generation

Σx_2^2 = " " " other "

n_1 = no. of observations of one generation

n_2 = " " " other "

Heritability :-

Variation is the characteristic of living organism. One individual phenotypically would never exactly resemble the other due to differences in genotypes (except in identical twins), environment and interaction of both. Since it is the genes and not genotype or environment that are transmitted from parent to offspring, hence to assess the inheritance of character it is necessary to know how far observed phenotypic variance is due to additive genes. To denote the relative importance of heredity in accounting for the variations that take place in the phenotype Lush used the word 'Heritability'. It is a spacio temporal entity.

All the known methods for estimating heritability of a character depend upon how closely phenotypic resemblance keeps

pace with the genetic resemblance i.e. they estimate the size of r^2_{GP} or r^2_{HP}. In terms of variance these may be represented as $\frac{\sigma^2 G}{\sigma^2 P}$ or $\frac{\sigma^2 H}{\sigma^2 P}$ if σ^2_{EH} is zero.

Since phenotypes are observed, the coefficient of correlation between phenotypes of individuals related through decent is easily calculated by intra class correlation or by linear regression technique. Hereditary resemblance is estimated by means of Wright's 'Coefficient of Relationship'. However, the heritability estimates may be computed more easily from the variance components which can be derived from the analysis of variance and covariance than by computing correlation directly, but the principle remains the same.

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

(a) Isogenic lines (b) Regression of offspring on midparent (c) Resemblance between parent and offspring (d) Intrasire correlation and regression of offspring on dam (e) Resemblance between full sibs (f) Resemblance among halfsibs.

In the present study heritability of different traits was calculated by Paternal half sib correlation, Intrasire correlation and regression of offspring on dam methods.

Paternal half sib correlation method :

In this method heritability estimate is obtained by multiplying the intra class correlation of paternal halfsibs by four. The technique of calculating intraclass correlation from components of variance as suggested by Snedecor (1956) is briefly outlined in the Table (34).

TABLE (34)

ANALYSIS OF VARIANCE FOR ESTIMATING PATERNAL HALF SIB CORRELATION AND HERITABILITY

Source of variation	D.F.	E.M.S.
Between sires	S - 1	$\sigma_e^2 + K\sigma_s^2$
Within sires	N - S	σ_e^2

Where S = number of sires

N = total number of half sibs

$K = \frac{1}{S-1}\left(N - \frac{\Sigma ni^2}{N}\right)$

ni = number of daughters of ith sire.

Thus σ_e^2 and σ_s^2 can be calculated and from these can be estimated $\frac{\sigma_s^2}{\sigma_e^2 + \sigma_s^2}$ which is the intraclass correlation among paternal half sibs. Where :

σ_s^2 = ¼th of the genetic variance plus a small fraction of epistatic variance.

σ_e^2 = ¼th of genetic variance, all dominance variance, a major part of epistatic variance and all random environmental variance.

This explains the reason for multiplying the paternal half sib correlation by four to get an estimate of heritability.

The multiplication of the statistic by four magnifies any sampling error which may be in the estimate. It also enlarges any errors that may have been in estimating and discounting the environmental component. This is a serious limitation of the method.

It does not introduce any systematic bias but merely allows the estimate to be too high or too low. The disadvantage of this method as compared to parent offspring or full sib resemblance would be cancelled if there are four times as many degrees of freedom in the data available for estimating half sib correlation as there are for full sib or parent offspring resemblance. Further the accuracy of this method depends on the number of degrees of freedom available for estimating the differences between sires.

Intra-sire regression of offspring on dam and intra-sire correlation methods :-

Let 'X' symbolize the record of dam and 'Y' of daughter. Then regression coefficient of daughter's record on dam would be,

$$b_{YX} = \frac{\Sigma xy}{\Sigma x^2} = \frac{CovXY}{VarianceX}$$

Similarly correlation would be

$$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \times \Sigma y^2}} = \frac{CovXy}{\sqrt{\text{Variance X} \times \text{Variance Y}}}$$

As the genetic relationship between offspring and its dam is ½, doubling of the intra-sire regression or correlation estimates the heritability.

The regression of offspring on dam or correlation calculated within a sire attempts to discount automatically the environmental relationship that may exist.

The intrasire correlation and regression may be interchangeable if dams were not a selected group. Selection of dams which is often practised tends to lower the correlation coefficient. Therefore, the estimate of heritability by intrasire regression of daughter on dam method which contains all the additive genetic variance and probably some of the epistatic variance, gives a

comperatively good estimate as the selection of a parent does not effect the 'b' value or heritability. Sampling variance of 'b' is least. Since it is based on random mating hence there are no material effects. If mating is not random the heritability may be misleading. This method seems to be of more useful purpose for such types of data where dams are more in number than sires as it removes the bias or error likely to be introduced in the estimate of heritability due to selective mating in the herd or due to variation in the environment.

Repeatability :

It is defined as the regression of future performance on the past. Steward (1945) described it as the regression of second record on the first record of the same animal. The only drawback this method has that more than two records for the same animal may not be utilized. As economic characters are repeated more than twice in animal's life time this method may not find much importance. Snedecor (1956) solved this problem by the method of intra class correlation (here intra cow) as shown in the Table (35).

TABLE (35)

ANALYSIS OF VARIANCE FOR ESTIMATING REPEATABILITY BY INTRA CLASS CORRELATION METHOD.

Source of variation.	D.F.	E.M.S.
Between cows	n - 1	$\sigma_e^2 + K\sigma_c^2$
Within cows	n(K - 1)	σ_e^2

$$R = \frac{\sigma_c^2}{\sigma_e^2 + \sigma_c^2}$$

Where $K = \frac{1}{n-1}\left(li - \frac{\Sigma li^2}{li} \right)$

li = number of observations for ith cow

n = total number of cows

σ_c^2 = cow component

σ_e^2 = error

Genetic correlation :

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

$$r G_A G_B = \frac{\text{Cov } G_A G_B}{\sqrt{\text{Variance } G_A \times \text{Variance } G_B}}$$

The variance of G_A & G_B and covariance $G_A G_B$ are obtained by multiplying sire component of variance and covariance respectively by four as given in the Table (36).

TABLE (36)

ANALYSIS OF VARIANCE AND COVARIANCE FOR COMPUTING COEFFICIENT OF GENETIC CORRELATION

SOURCE OF VARIATION	D.F.	A E.M.S.	AB E.M.S.	B E.M.S.
Between sires	S-1	$\sigma^2_A + K\sigma^2_{sA}$	$\sigma_{AB} + K\sigma_{sAB}$	$\sigma^2_B + K\sigma^2_{sB}$
Within sires	N-S	σ^2_A	σ_{AB}	σ^2_B

K = number of daughters per sire.

$$r\, G_A G_B = \frac{4\sigma_{sAB}}{\sqrt{4\sigma^2_{sA} \times 4\sigma^2_{sB}}} = \frac{\sigma_{sAB}}{\sqrt{\sigma^2_{sA} \times \sigma^2_{sB}}}$$

CHAPTER - IV.

R E S U L T S.

CHAPTER IV

RESULTS

1) GESTATION PERIOD

Overall

The mean gestation length of foundation, first and second generations according to sex and sequence of calving are presented in Tables (37, 38 & 39). The mean gestation length varied between 291.8 ± 3.5 days to 271.8 ± 3.9 days. The maximum and minimum coefficients of variation were 5.7% and 2.0% respectively.

TABLE (37)

MEAN GESTATION PERIOD IN DAYS OF FOUNDATION STOCK ACCORDING TO SEX AND SEQUENCE OF CALVING

SEQUENCE OF CALVING	MALES				FEMALES				MALES & FEMALES			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.
1	11	271.8	3.9	4.0	7	288.8	3.3	3.0	18	278.2	3.2	5.0
2	20	287.0	2.0	3.0	23	281.0	3.2	5.0	43	283.8	1.9	4.0
3	35	284.9	1.9	4.0	21	281.1	1.7	2.0	56	283.5	1.3	3.0
4	24	285.9	2.9	4.0	13	281.3	3.3	4.0	37	284.2	2.2	4.0
5	12	279.9	4.1	5.0	12	278.6	1.8	2.0	24	279.2	2.2	3.0
6	12	284.6	1.9	2.0	7	276.1	5.6	5.0	19	281.5	2.5	3.0
7	5	282.0	3.0	2.0	6	279.6	4.0	3.0	11	280.7	2.4	2.0
8	6	286.5	2.0	1.0	1	284.0	-	-	7	286.1	1.8	1.0
9	4	289.7	1.8	1.0	1	281.0	-	-	5	288.0	2.2	1.0
10	-	-	-	-	2	265.5	17.5	9.0	2	265.5	17.5	9.0
11	-	-	-	-	1	285.0	-	-	1	285.0	-	-

TABLE (38)

MEAN GESTATION PERIOD IN DAYS OF FIRST GENERATION STOCK ACCORDING TO SEX AND SEQUENCE OF CALVING

SEQUENCE OF CALVING	MALES				FEMALES				MALES & FEMALES			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.
1	22	291.8	2.5	4.0	24	291.2	3.1	5.0	46	285.0	2.0	4.0
2	21	282.8	2.7	4.0	19.	280.3	1.5	2.0	40	281.6	1.6	3.0
3	20	281.0	2.0	3.0	17	280.5	2.8	4.0	37	280.8	1.7	3.0
4	17	280.7	2.9	4.0	10	282.4	3.7	4.0	27	281.3	2.3	4.0
5	8	275.7	5.3	5.0	8	278.7	3.0	3.0	16	277.2	2.9	4.0
6	6	279.3	3.4	3.0	3	282.6	2.4	1.0	9	280.4	2.3	2.0
7	2	288.0	5.0	2.0	4	285.7	1.6	1.0	6	286.5	1.7	1.0
8	2	282.5	2.5	1.0	1	279.0	-	-	3	281.3	1.8	1.0
9	1	264.0	-	-	-	-	-	-	1	264.0	-	-

TABLE (39)

MEAN GESTATION PERIOD IN DAYS OF SECOND GENERATION STOCK ACCORDING TO SEX AND CALVING SEQUENCE

SEQUENCE OF CALVING	MALES				FEMALES				MALES & FEMALES			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.
1	13	276.5	4.4	5.7	18	283.7	3.8	5.7	31	280.7	2.9	5.7
2	13	282.4	2.4	3.0	9	281.0	2.1	2.3	22	281.8	1.6	2.7
3	5	281.6	4.6	3.6	4	277.0	6.1	4.4	9	279.5	3.5	3.8
4	3	278.3	7.7	4.8	4	269.7	5.5	4.1	7	273.4	4.5	4.3
5	2	295.0	15.0	7.1	2	291.5	13.5	6.5	4	293.5	8.3	5.6
6	-	-	-	-	1	269.0	-	-	1	269.0	-	-

The average gestation period of different generations are given in Table (40). The same is represented in the Figure (1). The gestation length of the herd was calculated to be 281.9 ± 0.5 days with a coefficient of variation of 4.2 % on 485 gestation records.

TABLE (40)

TABLE SHOWING GENERATION-WISE MEAN GESTATION PERIOD IN DAYS

GENERATIONS	No.	AVERAGE	S.E.	C.V.
Foundation	223	282.5	0.7	4.0
First generation	185	281.9	0.8	4.0
Second generation	74	280.7	1.5	4.7
Third generation	3	272.6	9.2	5.8
Herd	485	281.9	0.5	4.2

Generation-wise comparison of mean

There seems to be a decreasing trend of gestation length from foundation stock to third generation. However, these differences were statistically not significant (Table 41).

TABLE (41)

TABLE SHOWING GENERATION-WISE COMPARISON OF MEAN GESTATION PERIOD

D.F.	COMBINATION	DIFFERENCE	't' VALUE
406	Foundation Vs First generation (282.8) (281.9)	-0.6	0.54
295	Foundation Vs Second generation (282.5) (280.7)	-1.8	1.09
257	First Vs Second generation (281.9) (280.7)	-1.2	0.72

Effect of sex of the calf.

The average gestation length of 282.8 ± 0.7 days with 4.2 % coefficient of variation and 280.9 ± 0.8 days with 4.2 % coefficient of variation on 268 and 220 records were obtained for male and female calves respectively. The gestation period in the male and female calf did not vary significantly.

Effect of sequence of calving

From the Table (42) and Figure (1) it would be evident that heifers carried their younge for the longest period and then there was a decreasing trend up to fourth gestation in male, female and male-female groups of calves. In the fifth gestation the decreasing trend was continued in case of male group but there was an increase in female and male-female groups with a decrease in sixth calving in the latter group. The preliminary analysis of 14 sex-sequence groups revealed that the variance ratio was not significant (Table 43). Hence a simple analysis of variance of non-orthogonal data was carried out (Table 44). The differences due to sequence, sex and sequence-sex interaction were not significant.

TABLE (42)

MEAN GESTATION PERIOD IN DAYS OF FIRST & SECOND GENERATION STOCK ACCORDING TO SEX AND SEQUENCE OF CALVING

SEQUENCE OF CALVING	MALE				FEMALE				MALE & FEMALE			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.
1	36	283.0	2.3	5.0	44	282.7	2.3	5.5	80	282.9	1.7	5.6
2	34	282.7	1.9	4.0	28	280.5	1.2	2.3	62	281.7	1.2	3.3
3	25	281.1	1.8	3.3	21	279.9	2.5	4.1	46	280.5	1.5	3.6
4	20	280.4	2.7	4.3	14	276.7	3.3	4.5	34	279.7	2.0	4.3
5	10	279.6	5.4	6.1	10	281.3	3.5	4.0	20	280.4	3.1	5.0
6	6	279.3	3.4	3.0	4	279.2	3.8	2.7	10	279.3	2.4	2.7
7	2	286.0	5.0	2.0	4	285.7	1.6	1.0	6	286.5	1.7	1.0
8	2	282.5	2.5	1.0	1	279.0	-	-	3	281.3	1.8	1.0
9	1	264.0	-	-	-	-	-	-	1	264.0	-	-

TABLE (43)

PRELIMINARY ANALYSIS OF VARIANCE OF SEX-SEQUENCE GROUPS OF GESTATION LENGTH

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.
Between groups	13	846.26	42.02	0.27
Within groups	248	37767.14	152.28	
Total	261	38313.40		

TABLE (44)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEQUENCE OF CALVING AND SEX OF THE CALF ON GESTATION LENGTH.

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.
Between sequences	6	392.21	65.36	0.42
Between sexes	1	18.29	18.29	0.12
Sequence and sex interaction	6	135.76	22.62	0.14
Error	248	37767.14	152.28	
Total	261	38313.40		

Effect of season and month of freshening

Rainy and summer season calvers had the longest gestation period of 282.9 ± 1.0 and 282.6 ± 1.2 days respectively while the shortest gestation period of 281.3 ± 0.7 days was observed in cows calving during winter. The coefficients of variation were 3.8 %, 4.8 % and 3.9 % respectively. The average figures were based on 110, 131 and 246 observations (Table 45). The effect of season was not significant (Table 46).

TABLE (45)

MEAN GESTATION LENGTH IN DAYS ACCORDING TO MONTH AND SEASON OF CALVING

SEASONS	No.	Av.	S.E.	C.V.	MONTHS	No.	Av.	S.E.	C.V.
					March	55	284.3	1.6	4.3
Summer	131	282.6	1.2	4.8	April	34	284.0	2.5	5.1
					May	42	279.3	2.2	5.1
					June	37	281.2	1.7	3.7
Rainy	110	282.9	1.0	3.8	July	33	283.5	1.5	3.0
					August	25	285.4	2.9	5.1
					September	15	281.9	2.5	3.5
					October	36	286.3	1.9	4.1
Winter	246	281.3	0.7	3.9	November	56	277.6	1.1	3.1
					December	44	282.4	1.8	4.3
					January	56	281.9	1.6	4.4
					February	54	280.0	1.2	3.3

TABLE (46)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEASON OF CALVING ON GESTATION LENGTH.

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.
Between season	2	289.88	144.94	1.02
Error	484	68491.46	141.51	
Total	486	68781.34		

It would appear from the Table (45) and Figure (1) that cows calving in the month of October had the longest gestation period of 286.3 ± 1.9 days with 4.1% coefficient of variation and November calvers carried their younge for the shortest period (277.6 ± 1.1 days with 3.1% coefficient of variation). Trend of increase or decrease for different months was not definite. A significant influence of month on gestation length was observed (Table 47).

TABLE (47)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF MONTH OF FRESHENING ON GESTATION LENGTH

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.
Between months	11	3095.88	281.44	2.03*
Error	475	65685.46	138.28	
Total	486	68781.34		

Effect of sire of the calf.

Gestation records of 467 calves were organised under 12 groups according to their sires and the analysis is presented in the Table (48). There was a highly significant effect of sire on the period the calf passed in "utero".

TABLE (48)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SIRE ON THE GESTATION LENGTH OF THE CALF

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.
Between paternal half sibs.	11	3510.2	319.1	2.27**
Error	455	63727.8	140.0	
Total	466	67238.0		

Effect of dam

Upon analysis (Table 49) of 268 records of gestation lengths of 70 cows it was observed that the differences among maternal half sib groups were highly significant.

TABLE (49)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF DAM ON THE GESTATION LENGTH OF THE CALF

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.
Between maternal half sibs.	69	10423.30	151.06	1.24**
Error	198	23928.82	120.85	
Total	267	34352.12		

Heritability

The heritability of gestation length was calculated on 66 half sibs of 5 bulls by paternal half sib correlation method and was estimated to be 0.16 (Table 50)

TABLE (50)

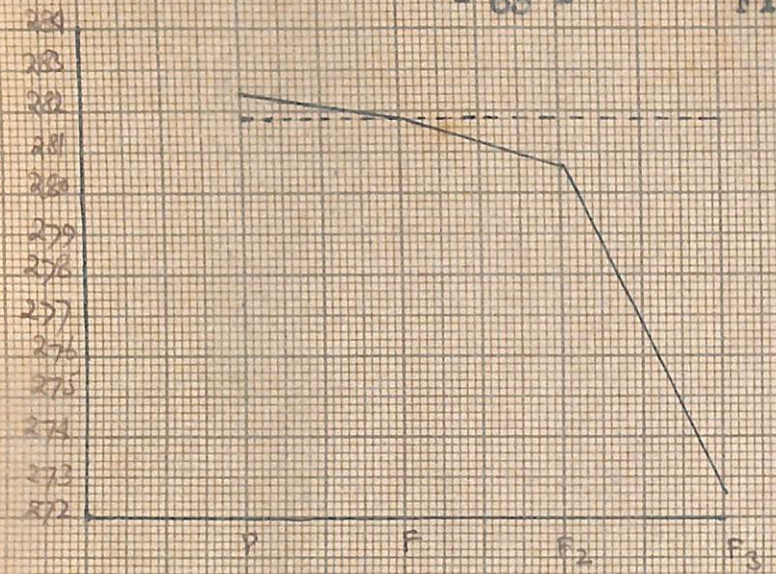
ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF GESTATION LENGTH BY PATERNAL HALF SIB METHOD

SOURCE OF VARIATION	D.F	S.S	M.S	E.M.S
Between bulls	4	1413.2	353.3	$\sigma_e^2 + 10.56\sigma_s^2$
Within bulls	61	13937.9	228.4	σ_e^2
Total	65	15351.1		

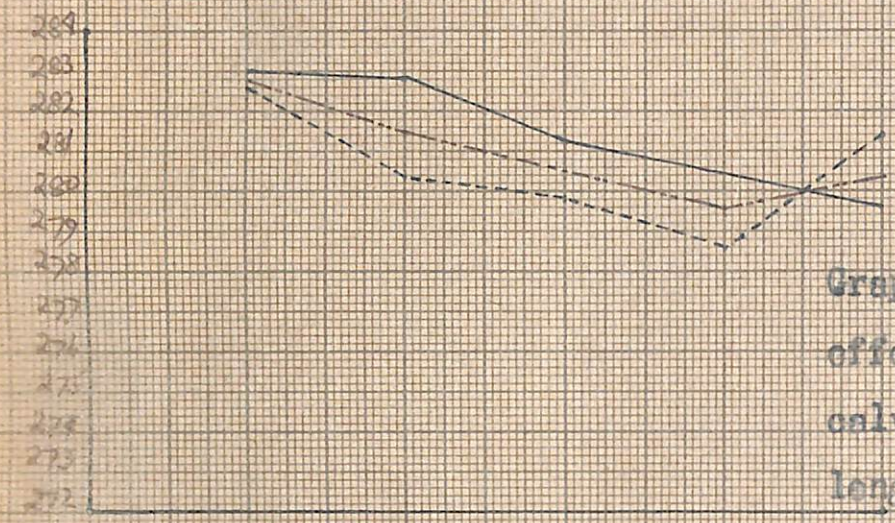
$\sigma_e^2 = 228.4$ $\quad h^2 = 0.16$

$\sigma_s^2 = 11.8$

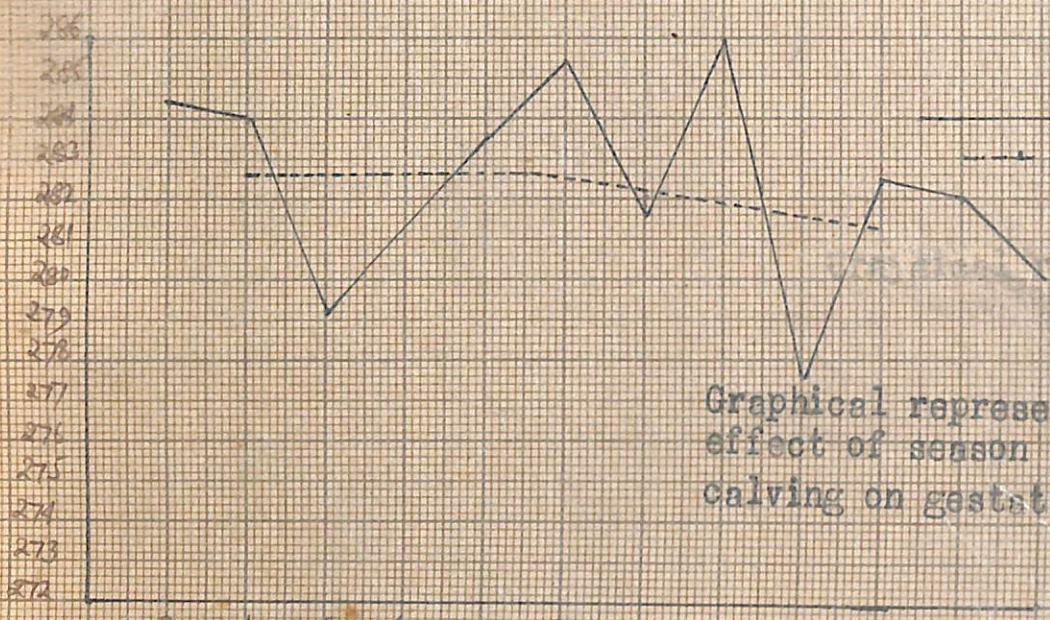
Fig. 1



Graphical representation of mean gestation length in different generations.



Graphical representation of effect of sequence of calving on gestation length.



Graphical representation of effect of season and month of calving on gestation length.

Repeatability:

The repeatability of gestation length was calculated on 268 gestation lengths of 70 cows. The analysis is given in the Table (51). The repeatability of gestation length was 0.061.

TABLE (51)

ANALYSIS OF VARIANCE FOR REPEATABILITY ESTIMATE OF GESTATION LENGTH

SOURCE OF VARIATION	D.F.	S.S.	M.S.	E.M.S.
Between cows	69	10423.30	151.06	$\sigma_e^2 + 3.81\sigma_c^2$
Within cows	198	23928.82	120.85	σ_e^2
Total	267	34352.12		

$\sigma_e^2 = 120.85$ R = 0.061

$\sigma_c^2 = 7.92$

(2) BIRTH WEIGHT

Averages

Means, standard errors and coefficients of variation of birth weight of calves born in different generations are given in the Tables (52, 53 & 54) according to sequence of calving of their dams and sexes. The mean birth weight ranged from 43.3 ± 2.2 to 53.0 ± 1.3 lb and the coefficients of variation were between 6.9% to 25.5%.

TABLE (52)

MEAN BIRTH WEIGHT OF CALVES IN POUNDS BORN FROM FOUNDATION STOCK ACCORDING TO SEX AND SEQUENCE OF CALVING

SEQUENCE OF CALVING	MALES				FEMALES				MALES & FEMALES			
	No.	Av.	S.E.	C.V.	No.	A.V.	S.E.	C.V.	No.	Av.	S.E.	C.V.
1	13	46.9	1.5	11.7	14	43.4	2.2	19.7	27	45.1	1.4	16.2
2	19	46.0	2.7	25.5	28	43.7	1.8	22.5	47.	44.6	1.5	23.7
3	27	46.9	2.1	23.9	23	46.4	2.0	21.4	50	46.7	1.4	22.5
4	19	53.0	1.3	11.3	17	51.9	2.1	16.7	36	52.5	1.2	13.9
5	11	53.0	2.6	16.2	13	50.0	2.4	17.3	24.	51.4	1.7	16.7
6	10	52.6	3.1	19.2	9	49.0	1.1	6.9	19	50.8	1.7	15.1
7	5	52.8	2.8	11.9	6	45.3	3.3	17.9	11	48.7	2.4	16.4
8	6	55.3	2.4	11.0	1	48.0	-	-	7	52.5	2.1	10.9
9	4	51.0	4.8	18.8	1	54.0	-	-	5	51.6	3.7	16.3
10	-	-	-	-	2	45.5	4.5	13.9	2	45.5	4.5	13.9
11	-	-	-	-	1	60.0	-	-	1	60.0	-	-

(2) BIRTH WEIGHT

Averages

Means, standard errors and coefficients of variation of birth weight of calves born in different generations are given in the Tables (52, 53 & 54) according to sequence of calving of their dams and sexes. The mean birth weight ranged from 43.3 ± 2.2 to 53.0 ± 1.3 lb and the coefficients of variation were between 4.9% to 25.5%.

TABLE (52)

MEAN BIRTH WEIGHT OF CALVES IN POUNDS BORN FROM FOUNDATION STOCK ACCORDING TO SEX AND SEQUENCE OF CALVING

SEQUENCE OF CALVING	MALES				FEMALES				MALES & FEMALES			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.
1	13	46.9	1.5	11.7	14	43.4	2.2	19.7	27	45.1	1.4	16.2
2	19	46.0	2.7	25.5	28	43.7	1.8	22.5	47	44.6	1.5	23.7
3	27	46.9	2.1	23.9	23	46.4	2.0	21.4	50	46.7	1.4	22.5
4	19	53.0	1.3	11.3	17	51.9	2.1	16.7	36	52.5	1.2	13.9
5	11	53.0	2.6	16.2	13	50.0	2.4	17.3	24	51.4	1.7	16.7
6	10	52.6	3.1	19.2	9	49.0	1.1	6.9	19	50.8	1.7	15.1
7	5	52.8	2.8	11.9	6	45.3	3.3	17.9	11	48.7	2.4	16.4
8	6	53.3	2.4	11.0	1	48.0	-	-	7	52.5	2.1	10.9
9	4	51.0	4.8	18.8	1	54.0	-	-	5	51.6	3.7	16.3
10	-	-	-	-	2	45.5	4.5	13.9	2	45.5	4.5	13.9
11	-	-	-	-	1	60.0	-	-	1	60.0	-	-

TABLE (53)

MEAN BIRTH WEIGHT OF CALVES IN POUND BORN FROM FIRST GENERATION STOCK ACCORDING TO SEX AND SEQUENCE OF CALVING

SEQUENCE OF CALVING	MALES				FEMALES				MALES & FEMALES			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.
1	24	49.1	1.4	14.2	25	45.4	2.2	24.9	49	47.2	1.3	20.1
2	21	52.7	1.7	15.0	20	47.5	2.1	20.0	41	50.2	1.4	17.9
3	20	50.5	1.3	11.6	17	51.4	1.6	13.4	37	50.9	1.0	12.3
4	17	49.7	2.0	16.8	10	46.7	1.5	10.6	27	48.6	1.4	15.1
5	9	45.0	2.0	13.9	9	47.9	2.0	12.8	18	46.4	1.4	13.3
6	7	51.0	2.5	13.4	3	58.8	10.4	30.7	10	53.3	3.4	20.3
7	2	44.6	12.6	40.0	4	43.4	1.5	10.7	6	43.8	3.5	20.0
8	2	49.5	1.5	4.2	1	46.0	-	-	3	48.3	1.4	5.2
9	1	26.0	-	-	-	-	-	-	1	26.0	-	-

TABLE (54)

BIRTH WEIGHT OF CALVES IN POUNDS BORN FROM SECOND GENERATION STOCK ACCORDING TO SEX AND SEQUENCE OF CALVING.

SEQUENCE OF CALVING	MALES				FEMALES				MALES & FEMALES			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.
1	16	47.9	2.7	22.7	20	47.8	1.3	12.8	36	47.8	1.4	17.7
2	13	52.7	2.5	17.2	9	53.3	2.9	16.8	22	52.9	1.8	16.5
3	6	52.9	2.0	9.4	4	49.7	3.1	12.5	10	51.6	1.7	10.4
4	3	54.6	4.9	15.8	4	48.8	3.7	15.5	7	51.3	3.0	15.5
5	2	58.9	9.0	21.6	3	50.6	3.8	13.1	5	53.9	4.0	16.8
6	-	-	-	-	1	50.7	-	-	1	50.7	-	-

Table (55) shows the mean birth weight of calves born from foundation, first, second and third generations. Figure (2) is the graphical representation of the same. A birth weight of 48.8 ± 0.3 lbs with 18.3 % coefficient of variation was obtained as an average for the herd on 506 observations.

TABLE (55)

TABLE SHOWING AVERAGE BIRTH WEIGHT OF CALVES IN POUNDS BORN IN DIFFERENT GENERATIONS

GENERATIONS	No.	Av.	S.E.	C.V.
Foundation stock	229	48.2	0.6	19.5
First generation	192	48.8	0.6	17.4
Second generation	81	50.4	0.9	16.6
Third generation	4	52.4	4.9	9.8
Herd	506	48.8	0.3	18.3

Generation-wise comparison of mean

There was an increase of average birth weight of calves in each generation but these increases were not significant (Table 56).

TABLE (56)

TABLE SHOWING COMPARISON OF MEAN BIRTH WEIGHT OF CALVES BORN IN DIFFERENT GENERATIONS.

D.F.	COMBINATION	DIFFERENCE	't' VALUE
419	Foundation (48.2) Vs First generation (48.8)	+0.583	0.65
308	Foundation (48.2) Vs Second generation (50.4)	+2.185	1.84
271	First (48.8) Vs Second generation (50.4)	+1.602	1.42

Effect of sex of the calf

The average birth weight for 259 male and 247 female calves was worked out as 49.9 ± 0.5 and 47.7 ± 0.6 lbs. respectively with 17.6% and 18.8 % coefficients of variation. The male calves were heavier by 2.2 lbs. and the difference was highly significant. Table (62) also shows that the difference between birth weights of male and female calves was highly significant.

Effect of sequence of calving

In Table (57) the data on birth weight of calves from first & second generation cows are compiled. The Table and Figure (2) show that the calves born in first calving were lighter than during second. In male and male-female calf groups there was a decrease in birth weight from second upto fifth calving. In case of female calves the increasing trend continued upto third calving followed by a sharp decrease in fourth but again increase during fifth calving. Preliminary analysis of variance of 14 sex-sequence groups was carried out (Table 58) and the variance ratio was found to be not significant. Hence, a simple analysis of variance ignoring the non-orthogonal nature of the data was carried out (Table 59) which revealed a significant effect of sequence of calving.

TABLE (57)

TABLE SHOWING MEAN BIRTH WEIGHT OF CALVES IN POUNDS BORN FROM FIRST & SECOND GENERATION STOCK ACCORDING TO SEX AND SEQUENCE OF CALVING

SEQUENCE OF CALVING	MALES				FEMALES				MALES & FEMALES			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V
1	2	3	4	5	6	7	8	9	10	11	12	13
1	42	48.6	1.3	17.4	47	46.9	1.4	20.5	89	47.7	0.9	19.0
2	34	52.7	1.4	15.6	29	49.3	1.7	19.4	63	51.1	1.1	17.5
3	26	51.0	1.1	11.1	21	51.0	1.4	13.0	47	51.0	0.8	11.8
4	20	50.4	1.8	16.6	14	47.3	1.4	11.8	34	49.1	1.2	15.1

Table 57 contd.

1	2	3	4	5	6	7	8	9	10	11	12	13
5	11	47.5	2.6	18.7	12	48.6	1.7	12.5	23	46.1	1.5	15.4
6	7	51.0	2.5	13.4	4	56.8	7.6	26.9	11	53.1	2.9	18.4
7	2	44.6	12.6	40.0	4	43.4	1.5	10.7	6	43.8	3.5	20.0
8	2	49.5	1.5	4.2	1	46.0	-	-	3	48.3	1.4	5.2
9	1	26.0	-	-	-	-	-	-	1	26.0	-	-

TABLE (58)

PRELIMINARY ANALYSIS OF VARIANCE BETWEEN SEX-SEQUENCE OF CALVING GROUPS OF BIRTH WEIGHT.

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.
Between groups	13	1542.09	118.62	1.68
Error	263	18479.22	70.26	
Total	276	20021.31		

TABLE (59)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEQUENCE OF CALVING AND SEX ON BIRTH WEIGHT

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.
Between sequences	6	1130.06	188.34	2.68*
Between sexes	1	176.18	176.18	2.50
Sequence and sex interaction	6	235.83	39.30	0.55
Error	263	18479.22	70.26	
Total	276	20021.31		

Effect of month of freshening of the dam

The birth weights were analysed according to the month of freshening of the dam. It seems that there was no definite trend of increase or decrease of birth weights during different months (Table 60 & Figure 2). The preliminary analysis of 24 sex-month groups revealed that it was not significant (Table 61). Hence, a simple analysis of variance of non-orthogonal data (Table 62) indicated that the differences among months and sex-month interaction for birth weight were not significant.

TABLE (60)

MEAN BIRTH WEIGHT OF CALVES IN POUNDS BORN DURING DIFFERENT MONTHS OF THE YEAR

MONTHS	No.	Av.	S.E.	C.V.
January	47	48.9	1.5	21.9
February	53	49.0	0.9	13.8
March	59	47.0	1.3	21.9
April	36	47.3	1.6	21.2
May	39	48.8	1.2	15.8
June	33	47.3	1.7	21.5
July	37	49.1	1.3	16.9
August	28	48.3	1.1	12.6
September	18	49.6	2.0	17.7
October	39	49.6	1.3	16.4
November	66	49.9	1.2	19.8
December	50	50.7	1.1	15.4

TABLE (61)

PRELIMINARY ANALYSIS OF VARIANCE OF SEX-MONTH GROUPS OF BIRTH WEIGHT

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.
Between groups	23	1876.6	81.5	1.46
Within groups	481	26760.7	55.6	
Total	504	28637.3		

TABLE (62)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEX AND MONTH OF CALVING ON BIRTH WEIGHT.

SOURCE OF VARIANCE	D.F.	S.S.	M.S.	F.
Between months	11	648.15	56.92	1.05
Between sexes	1	610.81	610.81	10.97**
Month and sex interaction	11	617.70	56.15	1.00
Error	481	26760.68	55.63	
Total	504	28637.34		

Effect of sire of the calf.

The birth weights of 457 calves from 14 bulls were subjected to analysis of variance (Table 63). The variance ratio was highly significant.

TABLE (63)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SIRE ON THE BIRTH WEIGHT OF CALF.

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.
Between paternal half sibs.	14	7839.09	559.93	6.15**
Error	442	40234.89	91.02	
Total	456	48073.98		

Effect of dam of the calf

Analysis of variance (Table 64) of 278 records of birth weight of calves from 71 cows revealed that the differences among maternal half sibs were highly significant.

TABLE (64)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF DAM ON THE BIRTH WEIGHT OF CALF

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.
Between maternal half sibs	70	10006.02	142.94	3.06**
Error	207	9665.05	46.69	
Total	277	19671.07		

Effect of weight of dam at freshening

A correlation coefficient of 0.024 was obtained between body weight at calving of dam and birth weight of the calf. It was based on 229 pairs of observations and was found to be not significant. Regression (0.002 lbs.) of birth weight of calf on body weight of dam at calving was also found to be not significant (Table 65)

Effect of gestation length

A value of 1.407 was obtained as correlation coefficient between gestation length of dam and birth weight of calf and the estimate was based on 467 pairs of observations. The regression of birth weight of calf on gestation length of dam was calculated to be 1.18 lbs. and was not significant (Table 65).

Effect of preceding dry period

The effect of preceding dry period of the dam on the birth weight of calf was found to be not significant with a

correlation coefficient of 0.037 on 350 pairs of observations. The regression of birth weight of calf on preceding dry period of dam (0.002 lbs.) was also not significant (Table 65)

TABLE (65)

ASSOCIATION OF TRAITS WITH BIRTH WEIGHT

TRAITS	REGRESSION	CORRELATION
Weight of dam x birth weight of calf.	0.002	0.024
Gestation length of dam x birth weight of calf	1.18	1.407
Preceding dry period of dam x birth weight of calf.	0.002	0.037

Heritability

The heritability estimate of birth weight by paternal half sib correlation method was computed on 232 male calves sired by 11 bulls, 217 female calves sired by 13 bulls and 457 male-female calves sired by 15 bulls and the estimates obtained were 0.792, 0.548 and 0.624 respectively (Tables 66, 67, 68). The heritability by intrasire regression of daughter on dam and correlation methods for birth weight for male (108 pairs), female (91 pairs) and male-female calves (207 pairs) were estimated as 0.166, 0.179, 0.068, 0.065 and 0.152 & 0.171 respectively (Tables 69, 70, 71).

TABLE (66)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF BIRTH WEIGHT OF MALE CALVES BY PATERNAL HALF SIB CORRELATION METHOD

SOURCE OF VARIATION	D.F.	S.S.	M.S.	E.M.S.
Between bulls	10	6290.74	629.07	$\sigma_e^2 + 19.58\sigma_s^2$
Within bulls	221	23796.71	107.67	σ_e^2
Total	231	30087.45		

$\sigma_e^2 = 107.67$; $\sigma_s^2 = 26.62$; $h^2 = 0.792$

TABLE (67)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF BIRTH WEIGHT OF FEMALE CALVES BY PATERNAL HALF SIB CORRELATION METHOD

SOURCE OF VARIATION	D.F.	S.S.	M.S.	E.M.S.
Between bulls	12	2901.19	241.76	$\sigma_e^2 + 15.13\sigma_s^2$
Within bulls	204	14495.64	71.05	σ_e^2
Total	216	17396.83		

$\sigma_e^2 = 71.05$, $\sigma_s^2 = 11.28$, $h^2 = 0.548$

TABLE (68)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF BIRTH WEIGHT OF MALE AND FEMALE BY PATERNAL HALF SIB CORRELATION METHOD

SOURCE OF VARIATION	D.F.	S.S.	M.S.	E.M.S.
Between bulls	14	7839.09	559.93	$\sigma_e^2 + 27.66\sigma_s^2$
Within bulls	442	40234.89	91.02	σ_e^2
Total	456	48073.98		

$\sigma_e^2 = 91.02$; $\sigma_s^2 = 16.95$; $h^2 = 0.624$

TABLE (69)

ANALYSIS OF VARIANCE AND COVARIANCE FOR HERITABILITY ESTIMATE OF BIRTH WEIGHT OF MALE CALVES

SOURCE OF VARIANCE	D.F.	S.S. (X)	S.P. (XY)	S.S. (Y)
Between sires	7	760.57	93.85	873.01
Within sires	100	8437.10	702.82	7291.66
Total	107	9197.67	796.67	8164.67

$b = \frac{702.82}{8437.10} = 0.083$ $\quad r = \frac{702.82}{7843.49} = 0.0896$

$h^2 = 2 \times 0.083 = 0.166$ $\quad h^2 = 2 \times 0.0896 = 0.1792$

TABLE (70)

ANALYSIS OF VARIANCE AND COVARIANCE FOR HERITABILITY ESTIMATE OF BIRTH WEIGHT OF FEMALE CALVES

SOURCE OF VARIANCE	D.F.	S.S. (X)	S.P. (XY)	S.S. (Y)
Between sires	6	475.92	293.03	1241.30
Within sires	85	7761.25	225.58	5452.44
Total	21	8237.17	518.61	6693.74

$b = \frac{225.58}{7761.25} = 0.029$ $\quad r = \frac{225.58}{6505.20} = 0.0346$

$h^2 = 2 \times 0.029 = 0.058$ $\quad h^2 = 2 \times 0.0346 = 0.0652$

TABLE (71)

ANALYSIS OF VARIANCE AND COVARIANCE FOR HERITABILITY ESTIMATE OF BIRTH WEIGHT OF MALE AND FEMALE CALVES.

SOURCE OF VARIATION	D.F.	S.S. (X)	S.P. (XY)	S.S. (Y)
Between sires	9	1035.79	383.68	2028.60
Within sires	197	17130.63	1302.80	13430.01
Total	206	18166.42	1686.48	15458.61

$b = \frac{1302.80}{17130.63} = 0.076$ $\quad r = \frac{1302.80}{15167.87} = 0.0858$

$h^2 = 2 \times 0.076 = 0.152$ $\quad h^2 = 2 \times 0.0858 = 0.1716$

Repeatability

The repeatability of birth weight was calculated as 0.34 on 278 records from 71 cows (Table 72).

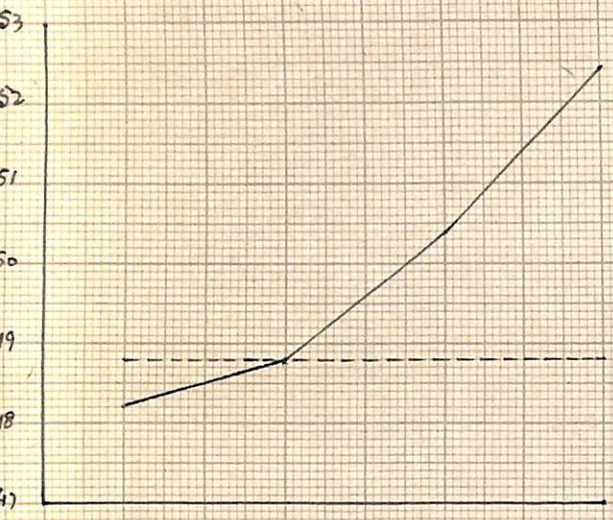
TABLE (72)

SOURCE OF VARIANCE	D.F.	S.S.'	M.S.	E.M.S.
Between cows	70	10006.02	142.94	$\sigma_e^2 + 3.900\sigma_c^2$
Within cows	207	9665.05	46.69	σ_e^2
Total	277	19671.07		

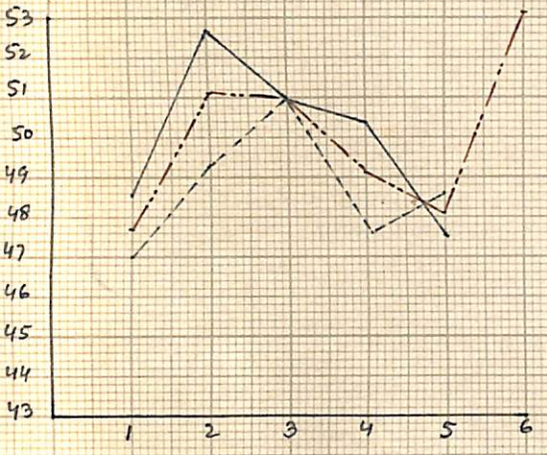
$\sigma_e^2 = 46.69$ R = 0.34

$\sigma_c^2 = 24.67$

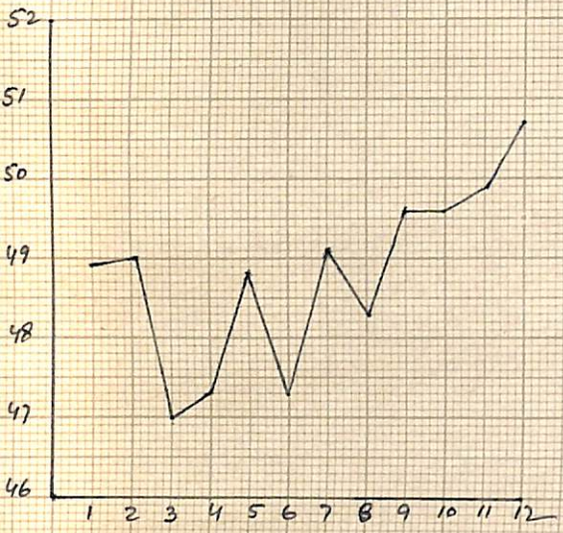
Fig. 2



Graphical representation of mean birth weight of calves in different generations



Graphical representation of the effect of sequence of calving on birth weight



Graphical representation of the effect of month of calving on birth weight

(4) AGE AT FIRST CALVING

Averages

The mean age at first calving of different generations is given in the Table (77). The herd average for age at first calving on 86 records was calculated to be 1577.8 ± 24.9 days with 14.6% coefficient of variation.

TABLE (77)

MEAN AGE AT FIRST CALVING IN DAYS FOR FOUNDATION, FIRST, SECOND AND THIRD GENERATIONS

GENERATIONS	No.	Av.	S.E.	C.V.
Foundation	7	1525.4	25.6	4.4
First	40	1552.2	37.4	15.2
Second	35	1610.2	43.2	15.8
Third	4	1640.7	34.8	4.2
Herd	86	1577.8	24.9	14.6

Differences among generations

An analysis of variance (Table 78) was run to investigate whether the means of different generations differ from each other and it was not found to be significant.

TABLE (78)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF GENERATION ON AGE AT FIRST CALVING

SOURCE	D.F.	S.S.	M.S.	V.
Between generations	3	97917.61	32639.20	0.60
Error	82	4455574.63	54336.27	
Total	85	4553492.24		

Effect of season and month of birth

Cows born in rainy season were the earliest calvers (1498.5 ± 25.5 days with 6.3 % coefficient of variation) compared to winter and summer calvers (1597.0 ± 31.6 days with 13.7% coefficient of variation and 1593.3 ± 66.0 days with 19.4% coefficient of variation respectively). The averages were based on 16, 48 and 22 records (Table 79). However, analysis of variance (Table 80) revealed that the variations among different seasons were not significant.

TABLE (79)

MEAN AGE AT FIRST CALVING IN DAYS ACCORDING TO SEASON AND MONTH OF BIRTH

SEASONS	No.	Av.	S.E.	C.V.	MONTHS	No.	Av.	S.E.	C.V.
					March	9	1532.8	104.0	20.3
Summer	22	1593.3	66.0	19.4	April	6	1507.1	72.9	11.8
					May	7	1745.9	141.3	21.4
					June	2	1492.0	74.0	7.0
					July	6	1519.8	54.1	8.7
Rainy	16	1498.5	25.5	6.8	August	5	1468.0	44.4	6.7
					September	3	1511.0	40.8	4.6
					October	11	1629.9	82.0	16.7
					November	10	1632.6	60.1	11.6
Winter	48	1597.0	31.6	13.7	December	8	1649.3	82.8	14.2
					January	6	1639.0	53.5	8.0
					February	13	1491.1	57.5	13.9

TABLE (80)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEASON OF BIRTH ON AGE AT FIRST CALVING

SOURCE	D.F.	S.S.	M.S.	F.
Between seasons	2	123793.47	61896.73	1.15
Error	83	4429698.76	53369.86	
Total	85	4553492.23		

Cows born in the month of May reached the age of first calving as late as 1745.0 ± 141.3 days with 21.4 % coefficient of variation and those in August proved to be the earliest calvers (1468.0 ± 44.4 days with 6.7 % coefficient of variation). Variations in age at first calving as affected by month of birth were not significant (Table 81)

TABLE (81)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF MONTH OF BIRTH ON AGE AT FIRST CALVING

SOURCE	D.F.	S.S.	M.S.	F.
Between months	11	572352.78	52032.07	0.96
Error	74	3981139.45	53799.18	
Total	85	4553492.23		

Effect of birth weight :-

The correlation and regression of age at first calving on birth weight were calculated to be 0.082 and 2.72 days respectively and both were not significant at 77 degrees of freedom (Table 82).

Effect of age at first service

The correlation coefficient and regression of age at first calving on age at first service were 0.921, 0.881 days respectively and both were highly significant at 81 degrees of freedom (Table 82).

TABLE (82)

TABLE SHOWING ASSOCIATION OF DIFFERENT TRAITS WITH AGE AT FIRST CALVING

Combination	REGRESSION	CORRELATION
Birth weight vs. Age at first calving	2.72	0.062
Age at first service Vs age at first calving	0.881**	0.921**

Heritability

The heritability estimates of age at first calving obtained were 1.9420, -0.2924 and -0.2186 by paternal half sib correlation, intra sire regression and correlation methods respectively. The former estimate was calculated for 73 half sibs of 5 bulls (Table 83) and the latter two on 29 dam daughter pairs (Table 84).

TABLE (83)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF AGE AT FIRST CALVING BY PATERNAL HALF CORRELATION METHOD

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between bulls	4	2756941.0	689235.25	$\sigma_e^2 + 12.450\sigma_s^2$
Within bulls	68	3676330.8	54063.68	σ_e^2
Total	72	6433271.8		

$\sigma_e^2 = 54063.68$ $\quad h^2 = 1.9420$

$\sigma_s^2 = 51017.79$

TABLE (84)

ANALYSIS OF VARIANCE AND COVARIANCE FOR HERITABILITY ESTIMATE OF AGE AT FIRST CALVING

SOURCE	D.F.	S.S.(X)	S.P.(XY)	S.S.(Y)
Between sires	3	109456.03	199078.70	2652395.78
Within sires	25	704083.42	-102991.94	1259654.43
Total	28	813541.45	96086.76	3912050.21

$b = -\frac{102991.94}{704083.42} = -0.1462$ $\qquad$ $r = -\frac{102991.94}{941754.65} = -0.1093$

$h^2 = 2 \times -0.1462 = -0.2924$ $\qquad$ $h^2 = 2 \times -0.1093 = -0.2186$

(5) WEIGHT AT FIRST CALVING

Average :-

The average weight at first calving for different generations is given in the Table (85). The herd average for the weight at first calving was estimated to be 821.3 ± 15.8 lbs. with 12.5% coefficient of variation on 42 records.

TABLE (85)

MEAN WEIGHT IN POUNDS OF HEIFERS AT CALVING

GENERATIONS	No.	Av.	S.E.	C.V.
First	14	795.6	31.5	14.8
Second	25	845.3	16.2	9.6
Third	3	741.3	91.5	21.3
Herd	42	821.3	15.8	12.5

Generation-wise comparison among means:

Second generation cows were heavier on an average, at first calving compared to the first generation cows but the difference was not significant statistically. On the contrary, the third generation stock was lighter at first calving compared to first and second generation stock but both the differences were also not significant. These results are summarised in the Table (86).

TABLE (86)

TABLE SHOWING GENERATION-WISE COMPARISON OF MEAN WEIGHT IN POUNDS OF HEIFERS AT CALVING

D.F.	COMBINATION	DIFFERENCE	't' VALUE
37	First Vs second generation (795.6) (845.3)	+ 49.7	1.5556
15	First Vs third generation (795.6) (741.3)	-54.3	0.6874
26	Second Vs. third generation (845.3) (741.3)	-104.0	1.8965

Effect of birth weight

Both correlation and regression of weight at first calving on birth weight (0.094 and 0.95 lbs. respectively) were not significant (Table 87).

Effect of age at first calving

Similarly both correlation and regression of weight at first calving on age at first calving (0.005 and 0.002 lbs. respectively) were not significant at 31 degree of freedom (Table 87).

TABLE (87)

TABLE SHOWING ASSOCIATION OF DIFFERENT TRAITS WITH WEIGHT AT FIRST CALVING

COMBINATION	REGRESSION	CORRELATION
Birth weight Vs weight at first calving.	0.95	0.094
Age at first calving Vs. weight at first calving.	0.002	0.005

Heritability

A heritability estimate of -0.2152 was obtained for weight at first calving on 32 half sibs of 4 bulls. The analysis of variance is presented in the Table (88)

TABLE (88)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF WEIGHT AT FIRST CALVING BY PATERNAL HALF SIB CORRELATION METHOD

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between bulls	3	16415.45	5471.81	$\sigma_e^2 + 7.56\sigma_s^2$
Within bulls	28	249708.79	8918.17	σ_e^2
Total	31	266124.24		

$\sigma_e^2 = 8918.17$; $\sigma_s^2 = -455.86$; $h^2 = -0.2152$

(6) SERVICES PER CONCEPTION

Averages

The average number of services per conception are given in Table (89) for different generations according to sequence of calving. The range was between 2.26 ± 0.21 and 1.18 ± 0.05. The maximum and minimum coefficients of variation were 67.0% and 38.9% respectively.

Table (90) and Figure (3) show the means for number of services per conception of different generations. For 642 records the herd average of number of services per conception was estimated to be 1.55 ± 0.03 with 61.5% coefficient of variation.

TABLE (90)

TABLE SHOWING GENERATION-WISE MEAN NUMBER OF SERVICES PER CONCEPTION

GENERATIONS	No.	Av.	S.E.	C.V.
Foundation	353	1.36	0.03	53.6
First	202	1.68	0.06	55.3
Second	82	2.09	0.16	71.3
Third	5	1.40	1.26	202.0
Herd	642	1.55	0.03	61.5

Generation-wise comparison of means

Perusal of the Table (91) indicates that the mean of the first and second generation from foundation and of the second from the first generation exceeded by 0.32, 0.73 and 0.41 respectively. All the three increases were found to be highly significant.

TABLE (89)

MEAN FOR SERVICES PER CONCEPTION OF FOUNDATION, FIRST, SECOND AND THIRD GENERATIONS ACCORDING TO SEQUENCE OF CALVING

SEQUENCE OF CALVING	FOUNDATION STOCK				FIRST GENERATION				SECOND GENERATION				THIRD GENERATION			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.
1	94	1.18	0.05	41.0	51	1.50	0.10	48.8	36	1.52	0.14	55.2	5	1.40	1.26	202.0
2	79	1.24	0.06	46.9	42	1.76	0.15	57.1	23	2.26	0.21	44.6				
3	66	1.34	0.09	58.8	38	1.55	0.13	53.3	10	2.00	0.298	47.1				
4	44	1.45	0.09	45.5	29	1.65	0.13	43.5	7	2.42	0.75	81.8				
5	25	1.72	0.20	59.3	19	2.70	0.32	66.9	5	5.40	1.28	53.3				
6	19	1.63	0.21	58.5	10	2.20	0.27	38.9	1	1.00	-	-				
7	11	2.00	0.40	67.0	8	1.25	0.16	37.0								
8	7	1.42	0.29	55.0	3	2.33	1.33	98.9								
9	5	1.40	0.07	12.3	2	2.00	1.00	70.7								
10.	2	1.50	0.15	14.9												
11	1	2.00	-	-												

TABLE (91)

TABLE SHOWING GENERATION-WISE COMPARISON OF MEAN FOR NUMBER OF SERVICES REQUIRED PER CONCEPTION.

D.F.	COMBINATION	DIFFERENCE	't' VALUE
553	Foundation Vs. First generation (1.36) (1.68)	+0.32**	4.5930
433	Foundation Vs Second generation (1.36) (2.09)	+0.73**	6.5292
282	First Vs Second generation (1.68) (2.09)	+0.41**	2.7812

Effect of sequence of calving

The number of services per conception of the 1st and 2nd generations according to sequence of calving, as given in the Table (92) indicated an increasing trend up to fifth calving with a decrease in the sixth. However, first calf heifers needed more services per conception. Analysis as given in the Table (93) and Figure (3) indicated that there was a highly significant difference among the means for services per conception at different calvings.

TABLE (92)

MEAN FOR SERVICES PER CONCEPTION OF FARM-BRED STOCK ACCORDING TO SEQUENCE OF CALVING

SEQUENCE OF CALVING	No.	Av.	S.E.	C.V.
1	92	1.51	0.08	50.9
2	65	1.93	0.12	53.1
3	48	1.64	0.12	52.5
4	36	1.80	0.18	60.5
5	24	2.79	0.42	74.9
6	11	2.09	0.25	39.7
7	8	1.25	0.16	37.0
8	3	2.33	1.33	98.9
9	2	2.00	1.00	70.7

TABLE (93)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEQUENCE OF CALVING ON NUMBER OF SERVICES PER CONCEPTION

SOURCE	D.F.	S.S.	M.S.	F.
Between sequence	6	35.04	5.84	4.94**
Error	282	335.31	1.18	
Total	288	370.35		

Effect of season and month of calving

As summarised in the Table (94) and graphically represented in the Figure (3) winter calvers required least number of services per conception (1.66 ± 0.06 with 56.1% coefficient of variation) and almost similar mean (1.68 ± 0.10 with 61.3% coefficient of variation) was observed for animals calving in rainy season but summer calvers needed slightly greater number of services (1.87 ± 0.13 with 70.4% coefficient of variation). The means were calculated on 211, 98 and 97 observations respectively. However, the differences among these means were not significant (Table 95).

TABLE (94)

MEAN NUMBER OF SERVICES PER CONCEPTION ACCORDING TO SEASON AND MONTH OF CALVING

SEASONS	No.	Av.	S.E.	C.V.	MONTHS	No.	Av.	S.E.	C.V.
					March	42	1.59	0.12	52.0
Summer	97	1.87	0.13	70.4	April	25	1.88	0.22	60.0
					May	30	2.26	0.18	44.7
					June	28	1.50	0.12	42.5
					July	30	2.06	0.24	66.1
Rainy	98	1.68	0.10	61.3	August	25	1.40	0.15	54.5
					September	15	1.73	0.28	63.5
					October	36	1.52	0.12	48.4
					November	48	1.52	0.11	54.2
Winter	211	1.66	0.06	56.1	December	39	1.61	0.14	54.4
					January	42	1.73	0.14	54.2
					February	46	1.91	0.17	61.2

TABLE (95)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEASON OF CALVING ON SERVICES PER CONCEPTION

SOURCE	D.F.	S.S.	M.S.	F.
Between seasons	2	3.05	1.52	1.35
Error	403	452.50	1.12	
Total	405	455.55		

Cows calving in May had the highest number of services per conception (2.26 ± 0.18 with 44.7% coefficient of variation) and the lowest was observed for cows freshening in the month of August (1.40 ± 0.15 with 54.5% coefficient of variation). The services per conception for different months differed significantly (Table 96)

TABLE (96)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF MONTH OF CALVING ON SERVICES PER CONCEPTION

SOURCE	D.F.	S.S.	M.S.	F.
Between months	11	23.13	2.10	1.92*
Error	394	432.42	1.09	
Total	405	455.55		

Heritability

The heritability of number of services per conception has been estimated on 73 half sibs of 5 bulls and the analysis has been given in the Table (97). It was calculated as 0.52.

Z)

LS FOR HERITABILITY ESTIMATE
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HOD

S.	M.S.	E.M.S.
	1.60	$\sigma_e^2 + 12.450_s^2$
	0.52	σ_e^2

ns of 73 cows as given in

ity of services per

ERITABILITY
PTION

Calv	M.S.	E.M.S.
	1.65	$\sigma_e^2 + 4.010_e^2$
	1.19	σ_e^2

Months

TABLE (97)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF NUMBER OF SERVICES PER CONCEPTION BY PATERNAL HALF SIB CORRELATION METHOD

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between bulls	4	6.4	1.60	$\sigma_e^2 + 12.45\sigma_s^2$
Within bulls	68	35.7	0.52	σ_e^2
Total	72	42.1		

$\sigma_e^2 = 0.52$; $\sigma_s^2 = 0.08$; $h^2 = 0.52$

Repeatability.

The analysis of 294 observations of 73 cows as given in the Table (98) revealed the repeatability of services per conception to be 0.064.

TABLE (98)

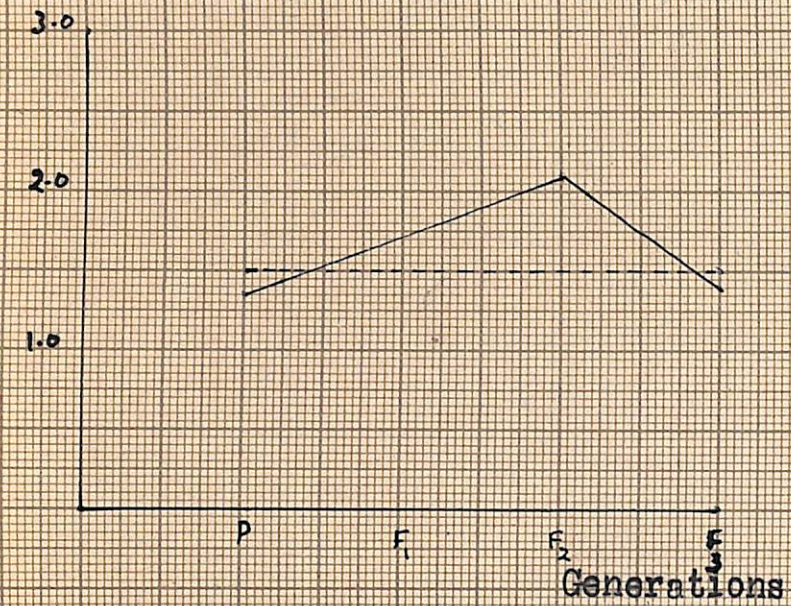
ANALYSIS OF VARIANCE TABLE FOR REPEATABILITY ESTIMATE OF SERVICES PER CONCEPTION

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between cows	72	118.99	1.65	$\sigma_e^2 + 4.01\sigma_c^2$
Within cows	221	265.08	1.19	σ_e^2
Total	293	384.07		

$\sigma_e^2 = 1.19$ R = 0.064

$\sigma_c^2 = 0.11$

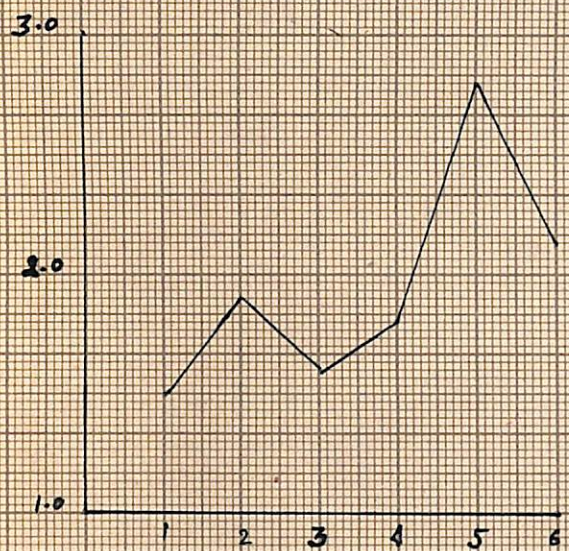
Fig. 3



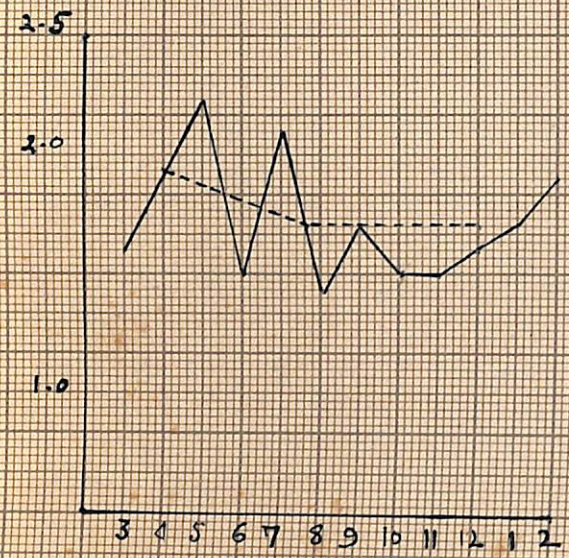
Generations

Herd

Graphical representation of mean number of services required per conception in different generations.



Graphical representation of effect of sequence of calving on number of services required per conception.



Months

Seasons

Graphical representation of the effect of season and month on the number of services required per conception.

(7) POST PARTUM INTERVAL TO FIRST SERVICE

Averages:

Table (99) incorporates calving-wise mean post-partum interval to first service of different generations. The mean interval varied from 238.4 +_ 28.2 to 106.2 ± 18.0 days and the coefficient of variation had average between 76.6% to 41.3%.

The generation-wise mean intervals are given in the Table (100). Figure (4) is the graphical representation of the same. A mean of 166.5 ± 4.9 days of post-partum interval to first service with 65.1% coefficient of variation on 479 records was calculated for the herd.

TABLE (100)

TABLE SHOWING GENERATION-WISE MEAN INTERVAL FROM POST PARTUM TO FIRST SERVICE IN DAYS

GENERATION	No.	Av.	S.E.	C.V.
Foundation stock	231	166.8	7.9	56.0
First generation	180	158.5	6.8	57.7
Second generation	66	179.0	12.8	58.3
Third generation	2	213.5	43.6	28.8
Herd	479	166.5	4.9	65.1

Generation-wise comparison of means:

From the Table (101) the mean post partum interval to first service decreased from foundation stock but the difference was not significant. The mean interval of second generation increased from foundation and first generation and in both the cases the difference was not significant.

TABLE (101)

TABLE SHOWING GENERATION-WISE COMPARISON OF MEAN POST-PARTUM INTERVAL TO FIRST SERVICE.

D.F.	COMBINATION	DIFFERENCE	't' VALUE
409	Foundation (166.8) Vs First generation (158.5)	-8.3	0.7713
295	Foundation (166.8) Vs Second generation (179.0)	+12.2	0.7471
244	First generation (158.5) Vs Second gen. (179.0)	+20.5	1.4995

TABLE (99)

MEAN POST PARTUM INTERVAL TO FIRST SERVICE IN DAYS OF FOUNDATION, FIRST, SECOND AND THIRD GENERATION STOCK ACCORDING TO SEQUENCE OF CALVING.

SEQUENCE OF CALVING	FOUNDATION STOCK				FIRST GENERATION				SECOND GENERATION				THIRD GENERATION			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.
2	33	238.4	28.2	68.0	47.	209.0	14.1	46.4	29	215.7	23.2	57.9	2	215.5	43.5	28.8
3	60	177.4	15.7	68.6	41	167.0	14.0	54.0	18.	152.3	14.8	41.3				
4	48	153.02	16.9	76.6	35	131.7	11.7	52.6	9	181.3	30.6	50.6				
5	35	161.4	18.3	67.3	25	164.7	18.8	57.3	7	107.2	31.0	76.5				
6	21	117.6	16.3	63.7	15	106.2	18.0	65.7	3	144.6	21.6	25.9				
7	15	139.5	21.1	58.7	9	100.6	11.8	35.3								
8	9	103.1	17.8	52.0	6	59.83	9.1	37.5								
9	6	157.6	35.6	55.3	2	133.5	18.5	19.6								
10	3	138.3	23.3	16.9												
11	1	176.0	-	-												

Effect of sequence of calving

To investigate the trend of post-partum interval to first service at different calvings observations on first & second generation cows are summarised in the Table (102). From the perusal of the Table and Figure (4) it is evident that the first interval length was longest than any of the succeeding ones followed by a decreasing trend which continued upto fifth lactation except at fourth where there was a rise. Analysis of variance as given in Table (103) indicated a highly significant effect of order of calving on the mean interval.

TABLE (102)

MEAN POST PARTUM INTERVAL TO FIRST SERVICE IN DAYS OF FIRST & SECOND GENERATION COWS CALVING-WISE

SEQUENCE OF CALVING	No.	Av.	S.E.	C.V.
2	78	211.6	12.0	50.3
3	59	162.5	10.7	50.8
4	44	141.9	11.4	53.5
5	32	152.1	16.5	61.6
6	18	112.6	15.6	58.8
7	9	100.6	11.8	35.3
8	6	59.8	9.1	37.4
9	2	133.5	18.5	19.5

TABLE (103)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEQUENCE OF CALVING ON THE INTERVAL FROM POST PARTUM TO FIRST SERVICE

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.
Between sequences	5	343569.91	68713.98	8.79**
Error	242	1891550.31	7816.32	
Total	247	2235120.22		

Effect of season and month of calving

Cows calving in summer had the longest interval of 173.2 ± 10.3 days and winter calvers possessed the shortest interval of 161.4 ± 7.2 days. Cows freshening in rainy season had an interval of 165.9 ± 8.3 days. The means were based on 116, 246 and 118 records with 64.6%, 70.0% and 54.9% coefficients of variation respectively (Table 104). As evident from the (Table 105) the effect of season was not significant.

TABLE (104)

MEAN INTERVAL FROM POST PARTUM TO FIRST SERVICE IN DAYS ACCORDING TO SEASON AND MONTH OF CALVING

SEASONS	No.	Av.	S.E.	C.V.	Months	No.	Av.	S.E.	C.V.
					March	50	175.0	16.3	65.8
Summer	116	173.2	10.3	64.6	April	29	177.9	20.1	60.9
					May	37	167.0	18.5	67.5
					June	33	138.0	14.8	61.9
					July	35	161.9	11.7	42.8
Rainy	118	165.9	8.3	54.9	August	32	168.9	15.9	53.2
					September	18	219.6	28.3	54.7
					October	40	150.5	14.1	59.3
					November	56	161.4	12.1	56.1
Winter	246	161.4	7.2	70.0	December	46	190.1	23.0	82.1
					January	50	158.8	16.6	74.2
					February	54	147.2	13.9	69.7

TABLE (105)

ANALYSIS OF VARIANCE TABLE SHOWING THE EFFECT OF SEASON OF CALVING

SOURCE OF VARIATION	D.F.	S.S.	M.S.	F.M.S.
Between seasons	2	11069.80	5534.90	0.47
Error	477	5571174.13	11679.61	
Total	479	5582243.93		

September calvers had the longest interval of 219.6 ± 28.3 days with 54.7% coefficient of variation while cow calvings in June were given the first service at a shortest interval of 138.0 ± 14.8 with 61.9% coefficient of variation. For rest of the months the trend showed no definite pattern as evident from the Figure (4). Analysis of variance (Table 106) indicated that the effect of month was not significant.

TABLE (106)

ANALYSIS OF VARIANCE TABLE SHOWING THE EFFECT OF MONTH OF FRESHENING

SOURCE OF VARIANCE	D.F.	S.S.	M.S.	F.
Between months	11	145494.80	13226.80	1.13
Error	468	5436749.13	11616.98	
Total	479	5582243.93		

Heritability:

The heritability of this trait by paternal half sib correlation method on 59 half sibs belonging to 4 sires was computed as 0.532 (Table 107). The heritability was also calculated by intra sire regression and correlation methods on 29 dam daughter pairs as 0.0594 and 0.0438 respectively (Table 108).

TABLE (107)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF POST PARTUM INTERVAL TO FIRST SERVICE BY PATERNAL HALF SIB CORRELATION METHOD

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between bulls	3	88129.04	29376.34	$\sigma_e^2 + 12.290\sigma_s^2$
Within bulls	55	557944.49	10144.44	σ_e^2
Total	58	646073.53		

$\sigma_e^2 = 10144.44$ $\quad h^2 = 0.532$

$\sigma_s^2 = 1564.84$

TABLE (108)

ANALYSIS OF VARIANCE AND COVARIANCE FOR HERITABILITY ESTIMATE OF POST PARTUM INTERVAL TO FIRST SERVICE

SOURCE	D.F.	S.S.(X)	S.P.(XY)	S.S.(Y)
Between sires	2	372.44	-4106.30	46907.13
Within sires	26	205030.12	6091.48	376708.12
Total	28	205402.56	1985.18	423615.25

$b = \frac{6091.48}{205030.12} = 0.0297$ $\quad r = \frac{6091.48}{277914.57} = 0.0219$

$h^2 = 2 \times 0.0297 = 0.0594$ $\quad h^2 = 0.0219 \times 2 = 0.0438$

Repeatability

An estimate of 0.292 was obtained as repeatability of the interval from post partum to first service on 258 records of 66 cows as indicated in the Table (109).

TABLE (109)

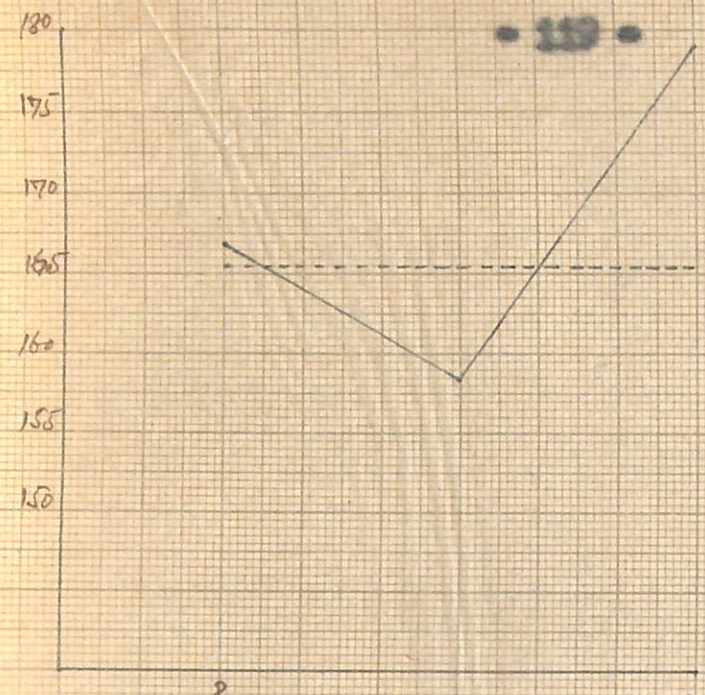
ANALYSIS OF VARIANCE TABLE FOR REPEATABILITY

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between cows	65	1024886.80	15767.48	$\sigma^2_e + 3.89\,\sigma^2_c$
Within cows	192	1161549.24	6049.73	σ^2_e
Total	257	2186436.04		

$\sigma^2_e = 6049.73$ R = 0.292

$\sigma^2_c = 2498.13$

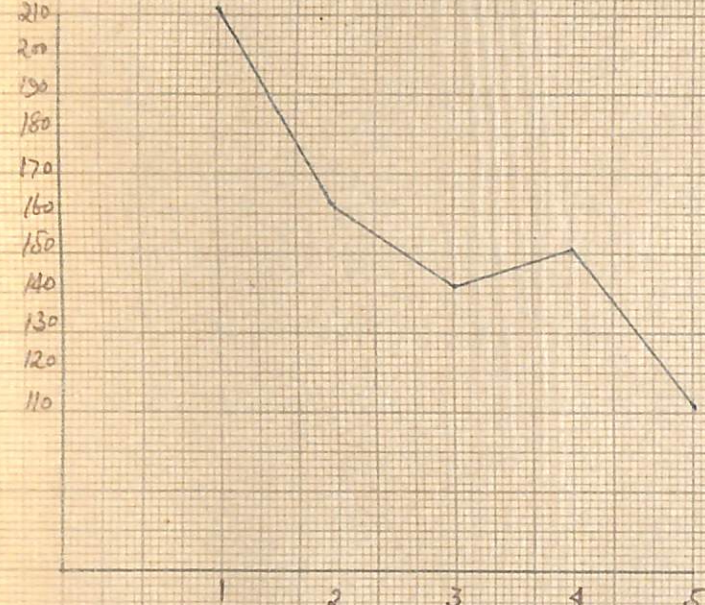
Figure 4



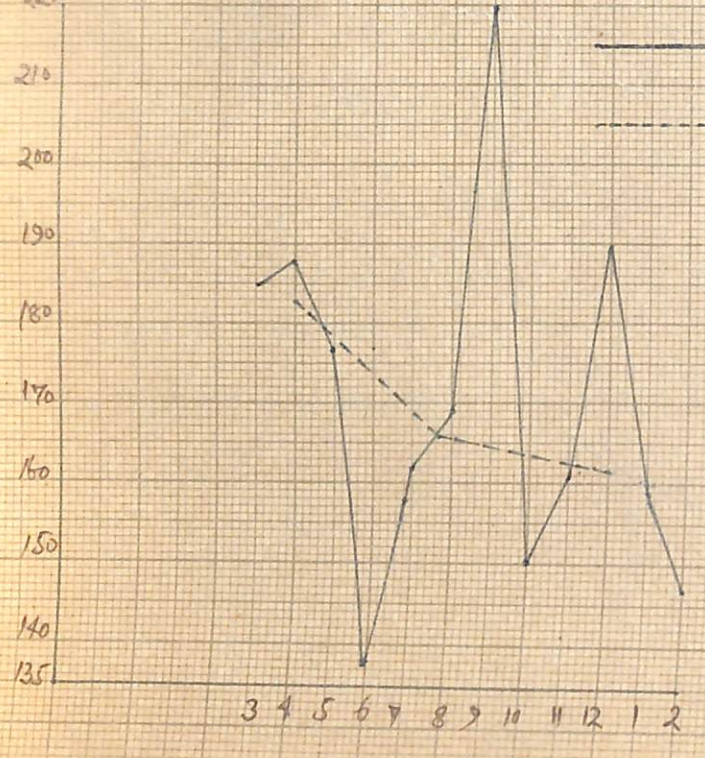
Generations

Herd

Graphical representation of cow mating post partum interval to first service in different generations.



Lactations



Months

Seasons

Graphical representation of the effect of season and month of calving on post-partum interval to first service.

(8) SERVICE PERIOD

Averages.

Average service period of different generations according to sequence of calving is summarised in the Table (110). The mean varied from 310.0 ± 70.6 to 133.7 ± 44.6 days and the range of coefficient of variation was from 162% to 42%.

TABLE (110)

MEAN SERVICE PERIOD IN DAYS OF FOUNDATION, FIRST, AND SECOND GENERATION ACCORDING TO SEQUENCE OF CALVING.

SEQUENCE OF CALVING	FOUNDATION STOCK				FIRST GENERATION				SECOND GENERATION			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.
1	10	133.7	44.6	105								
2	27	265.2	32.7	64	41	228.9	15.2	42	22	310.0	70.6	106
3	55	217.7	47.6	162	37	213.5	24.1	66	9	206.7	34.8	50
4	37	186.7	20.4	66	28	171.3	17.9	55	7	225.5	47.9	56
5	24	180.2	24.1	65	16	194.3	38.7	79	4	345.0	59.0	34
6	19	181.3	26.1	62	9	144.7	30.1	62	1	145.0	-	-
7	11	209.6	46.2	73	7	170.4	60.1	93	-	-	-	-
8	7	153.4	45.1	97	3	99.6	34.7	60	-	-	-	-
9	5	211.4	45.1	47	1	195.0	-	-	-	-	-	-
10	2	170.0	1.0	0.8								

Table (111) and Figure (5) show the average service period for foundation, first and second generations. The service period for the herd was calculated to be 209.0 ± 9.2 days with 86.6% coefficient of variation on 382 records.

TABLE (111)

TABLE SHOWING GENERATION-WISE MEAN SERVICE PERIOD IN DAYS

GENERATIONS	No.	Av.	S.E.	C.V.
Foundation stock	197	202.5	14.0	108
First generation	142	198.4	10.2	61.6
Second generation	43	274.0	20.3	48.7
Hard	382	209.0	9.2	86.5

Generation-wise comparison of mean

A reduction in the average service period in the first generation from the foundation stock (Table 112) was not significant. On the contrary, in second generation the mean service period increased by 71.56 and 75.59 days from foundation and first generation means respectively and while the former increase was significant the latter was highly significant.

TABLE (112)

TABLE SHOWING GENERATION-WISE COMPARISON OF MEAN SERVICE PERIOD

D.F.	COMBINATION	DIFFERENCE	't' VALUE
337	Foundation (202.5) Vs First generation (198.4)	-4.1	0.201
236	Foundation (202.5) Vs Second generation (274)	+71.56*	2.062
183	First (198.4) Vs Second generation (274)	+75.59**	3.483

Effect of sequence of calving

Table (113) summarises the average service period of first and second generation stock indicating the trend of increase or decrease due to sequence of calving. Figure (5) gives the graphical representation of it. The first calf heifers took longest period on an average to conceive than in any of the subsequent conceptions. The reduction trend continued upto fifth lactation with the exception.of the fourth where there is a sharp increase. On analysis (Table 114), the order of sequence of calving was found to have a highly significant effect on the service period.

TABLE (113)

MEAN SERVICE PERIOD IN DAYS OF FIRST & SECOND GENERATION COWS

SEQUENCE OF CALVING	No.	Av.	S.E.	C.V.
2	63	257.2	14.9	46.2
3	46	212.2	20.4	63.3
4	35	182.1	17.2	56.1
5	20	224.4	35.3	70.3
6	10	144.8	26.9	58.8
7	7	170.4	60.1	93.0
8	3	99.6	34.7	60.0
9	1	196.0	-	-

TABLE (114)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEQUENCE OF CALVING ON SERVICE PERIOD

SOURCE	D.F.	S.S.	M.S.	F.
Between sequence	5	243118.64	48623.72	3.09**
Error	179	2807895.92	15686.56	
Total	184	3051014.56		

Effect of season and month of calving

Mean service period according to season and month of calving is given in the Table (115). The effect of season of freshening on service period for summer, rainy and winter calvers was observed on the basis of 90, 93 and 94 records and the resulting averages were 206.7 ± 14.2 days with 64.6% coefficient of variation, 214.6 ± 12.9 days with 58.0% coefficient of variation and 209.6 ± 10.7 days with 71.6% coefficient of variation respectively. No significant effect of season on service period was observed (Table 116).

TABLE (115)

MEAN SERVICE PERIOD IN DAYS ACCORDING TO SEASON AND MONTH OF CALVING

SEASONS	No.	Av.	S.E.	C.V.	MONTHS	No.	Av.	S.E.	C.V.
					March	40	214.1	22.8	67.4
Summer	90	206.7	14.2	64.6	April	22	202.7	25.7	59.6
					May	28	205.6	25.5	65.6
					June	27	192.1	26.7	72.3
					July	30	209.8	18.8	49.3
Rainy	93	214.6	12.9	58.0	August	22	205.6	20.0	45.7
					September	14	282.4	43.5	57.7
					October	33	173.3	18.3	60.7
					November	43	186.6	21.3	74.8
Winter	194	209.6	10.7	71.6	December	36	259.9	34.1	78.8
					January	40	227.9	22.3	62.1
					February	42	201.2	20.9	67.4

TABLE (116)

ANALYSIS OF VARIANCE TABLE SHOWING EFFECT OF SEASON OF FRESHENING ON SERVICE PERIOD

SOURCE	D.F.	S.S.	M.S.	F.
Between seasons	2	2003.09	1001.54	0.05
Error	374	7398036.13	19780.84	
Total	376	7400039.22		

September and October calvers had the longest (282.4 ± 43.8 days with 57.7% coefficient of variation) and shortest (173.3 ± 18.3 days with 60.7% coefficient of variation) average service periods respectively and rest of the months did not show any definite trend Figure (5). Month of calving did not have significant effect on service period (Table 117).

TABLE (117)

ANALYSIS OF VARIANCE TABLE SHOWING EFFECT OF MONTH OF CALVING ON SERVICE PERIOD.

SOURCE	D.F.	S.S.	M.S.	F.
Between months	11	256305.90	23482.35	1.20
Error	365	7141733.32	19566.39	
Total	[illegible]	7400039.22		

Heritability :

The heritability estimates of service period obtained were 0.6920, 0.5068 and 0.3938 by paternal half sib correlation intra sire regression and correlation methods respectively. The former estimate was based on 47 half sibs of 3 bulls (Table 118) and the rest two on 20 dam daughter pairs (Table 119).

TABLE (118)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF SERVICE PERIOD BY PATERNAL HALF SIB CORRELATION METHOD

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between bulls	2	79249.24	39624.62	$\sigma_e^2 + 12.48\ \sigma_s^2$
Within bulls	44	482473.19	10965.29	σ_e^2
Total	46	561722.43		

$\sigma_e^2 = 10965.29$ $\quad h^2 = 0.692$

$\sigma_s^2 = 2296.42$

TABLE (119)

ANALYSIS OF VARIANCE AND COVARIANCE FOR HERITABILITY ESTIMATE OF SERVICE PERIOD

SOURCE	D.F.	S.S.(X)	S.P.(XY)	S.S.(Y)
Between sires	1	2720.26	40	3936.60
Within sires	18	152834.54	7	255247.20
Total	19	155554.80		259183.80

b = $\frac{38896.20}{152834.54}$ = 0.254 = 0.1969

h^2 = 2 x 0.2544 = 0.5088 = 0.3938

Repeatability

For the calculation of re... service period (Table 120), 223 observ... lized and the estimate was 0.132.

ANALYSIS VARIANCE ...

SOURCE	D.F.	S.S.
Between cows	57	12
Within cows	165	22
Total	222	34

σ_e^2 = 13668.48; σ_c^2 = 830

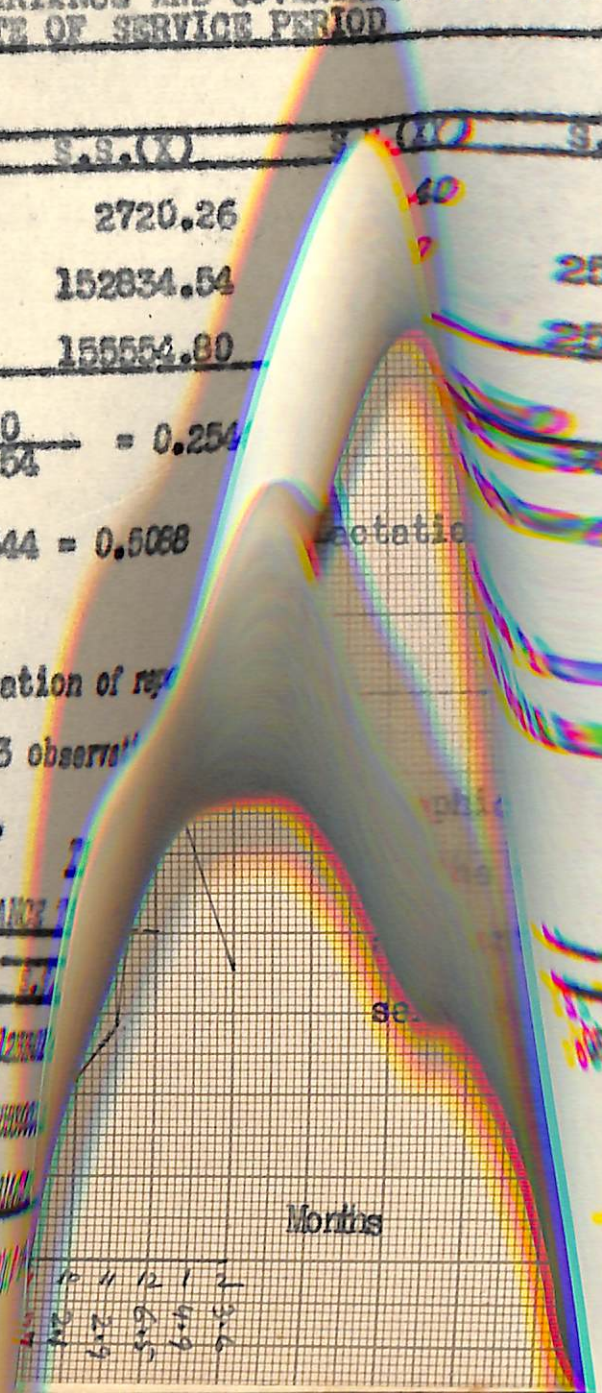


TABLE (118)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF SERVICE PERIOD BY PATERNAL HALF SIB CORRELATION METHOD

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between bulls	2	79249.24	39624.62	$\sigma_e^2 + 12.48\ \sigma_s^2$
Within bulls	44	482473.19	10965.29	σ_e^2
Total	46	561722.43		

$\sigma_e^2 = 10965.29$ $\quad h^2 = 0.692$

$\sigma_s^2 = 2296.42$

TABLE (119)

ANALYSIS OF VARIANCE AND COVARIANCE FOR HERITABILITY ESTIMATE OF SERVICE PERIOD

SOURCE	D.F.	S.S.(X)	S.P.(XY)	S.S.(Y)
Between sires	1	2720.26	-3272.40	3936.60
Within sires	18	152834.54	38896.20	255247.20
Total	19	155554.80	35623.80	259183.80

$b = \frac{38896.20}{152834.54} = 0.2544$ $\quad r = \frac{38896.20}{197510.98} = 0.1969$

$h^2 = 2 \times 0.2544 = 0.5088$ $\quad h^2 = 2 \times 0.1969 = 0.3938$

Repeatability

For the calculation of repeatability estimate of service period (Table 120), 223 observations on 58 cows were utilized and the estimate was 0.132.

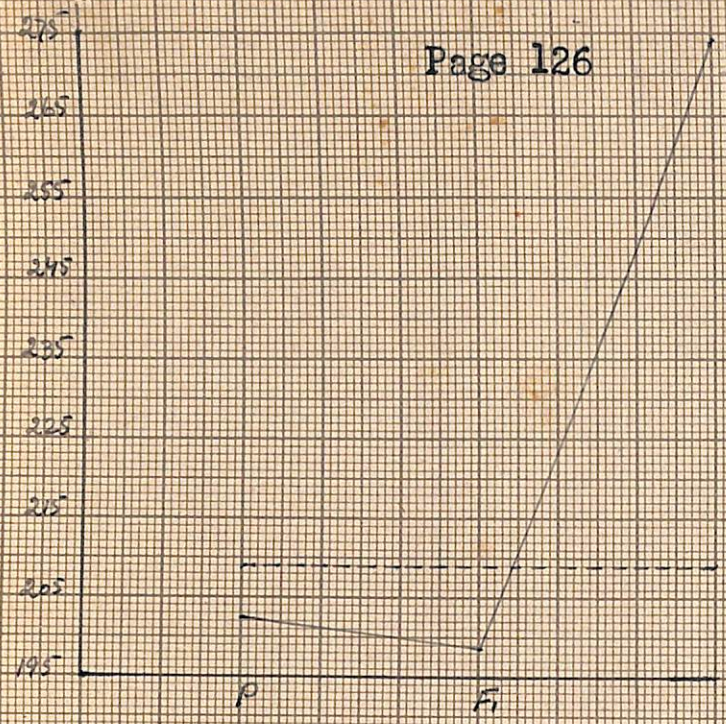
TABLE (120)

ANALYSIS VARIANCE TABLE FOR REPEATABILITY

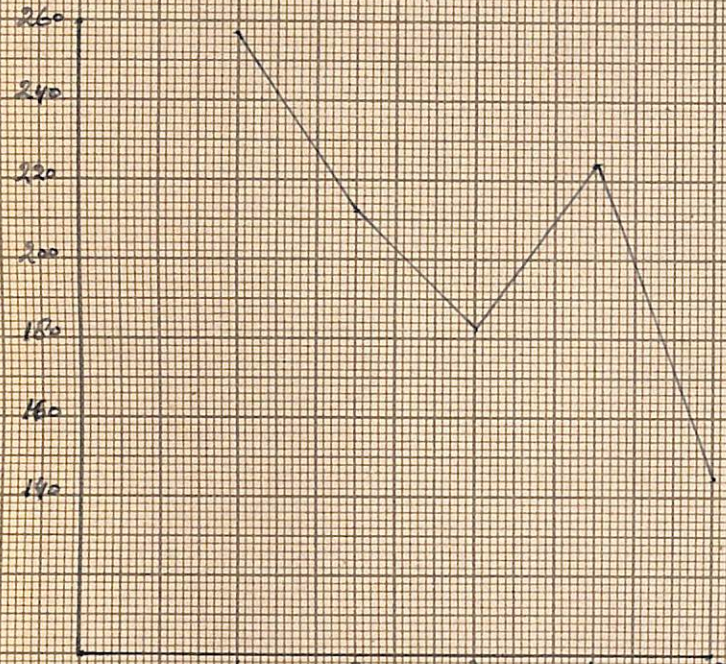
SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between cows	57	1233016.70	21631.87	$\sigma_e^2 + 3.83\sigma_c^2$
Within cows	165	2255300.02	13668.48	σ_e^2
Total	222	3488316.72		

$\sigma_e^2 = 13668.48$; $\quad \sigma_c^2 = 2079.21$; $\quad R = 0.132$

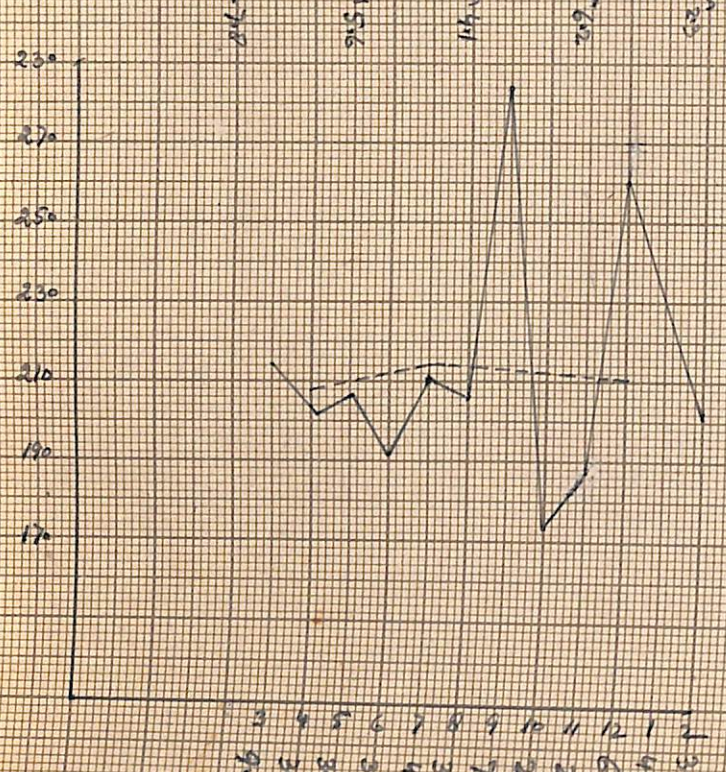
Fig. 5



Graphical representation of mean service period in different generations.



Graphical representation of the effect of sequence of calving on service period.



Graphical representation of the effect of season and month of calving on service period.

(9) DRY PERIOD

Averages :

Table (121) summarises the mean dry period calving-wise for different generations indicating the highest and lowest estimate to be 275.2 ± 25.3 and 149.7 ± 11.4 days respectively. The coefficient of variation varied between 76.8% to 10.7%

TABLE (121)

MEAN DRY PERIOD IN DAYS OF FOUNDATION, FIRST AND SECOND GENERATIONS ACCORDING TO SEQUENCE OF CALVING

SEQUENCE OF CALVING	FOUNDATION STOCK				FIRST GENERATION				SECOND GENERATION			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.
1	57	218.8	18.8	65.1	40	160.2	13.7	48.1	22	234.7	27.1	54.2
2	51	275.2	25.3	65.8	37	176.6	17.9	61.1	10	220.3	75.0	10.7
3	40	171.9	17.4	64.0	27	149.7	11.4	39.8	7	188.1	47.9	67.3
4	24	209.8	26.4	61.7	18	217.2	33.3	65.1	5	318.6	41.2	28.9
5	19	169.9	24.5	62.9	10	183.6	40.6	70.0	1	130.0	-	-
6	11	184.8	42.8	76.8	7	179.2	61.4	90.6	-	-	-	-
7	6	139.3	26.9	47.2	3	186.6	96.1	88.2	-	-	-	-
8	5	160.8	36.4	50.7	1	147.0	-	-	-	-	-	-
9	2	52.0	43.0	116.9	-	-	-	-	-	-	-	-
10	1	482.0	-	-	-	-	-	-	-	-	-	-

Table (122) shows generation-wise dry period. Figure (6) is the graphical presentation of the same. On 404 records a mean dry period 202.7 ± 6.5 days with 64.5% coefficient of variation was worked out for the herd.

TABLE (122)

TABLE SHOWING GENERATION-WISE MEAN DRY PERIOD IN DAYS

GENERATIONS	No.	Av.	S.E.	C.V.
Foundation	216	212.5	9.9	68.6
First	143	178.8	8.7	58.8
Second	45	231.2	17.6	51.0
Herd	404	202.7	5.5	64.9

Generation-wise comparison of means

From the Table(123) it may be seen that first generation mean dry period significantly reduced by 33.7 days from the foundation stock. The increase in mean dry period of the second generation from foundation was not significant but there was a highly significant increase of 52.413 days in it from the mean of first generation.

TABLE (123)

TABLE SHOWING GENERATION-WISE COMPARISON OF MEAN DRY PERIOD IN DAYS

D.F.	COMBINATION	DIFFERENCE	't' VALUE
357	Foundation Vs First generation (212.5) (178.8)	-33.7*	2.3826
259	Foundation Vs Second generation (212.5) (231.2)	+18.7	0.8054
186	First Vs Second generation (178.8) (231.2)	+52.4**	2.8297

Effect of sequence of calving

Table (124) and Figure (6) based on the observations of first and second generation stock indicate the trend of increase

of decrease of mean dry period due to sequence of calving. There was a gradual fall in the mean dry period up to fifth lactation with the exception of fourth where there is a sharp rise. However, on analysis (Table 125) it was found that sequence of calving did not have a statistically significant effect.

TABLE (124)

MEAN DRY PERIOD IN DAYS OF FIRST AND SECOND GENERATION STOCK ACCORDING TO SEQUENCE OF CALVING

SEQUENCE OF CALVING	No.	Av.	S.E.	C.V.
1	62	199.5	13.3	52.7
2	47	187.4	15.5	56.6
3	34	157.6	13.2	49.0
4	23	239.3	28.5	57.2
5	11	178.7	37.0	68.8
6	7	179.2	61.4	90.6
7	3	188.6	96.1	88.2
8	1	147.0	-	-

TABLE (125)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEQUENCE OF CALVING ON DRY PERIOD.

SOURCE	D.F.	S.S.	M.S.	F.
Between sequences	5	99934.23	19986.84	1.66
Error	182	2176412.84	11969.30	
Total	187	2276347.07		

Effect of season and month of calving

The Table (126) gives mean dry period of 194.0 ± 12.3, 218.3 ± 14.2 and 204.5 ± 9.9 days for summer, rainy and winter

calvers respectively. The estimates were based on 91, 69 and 195 observations and had 60.7%, 61.5% and 67.7% coefficients of variation. Upon analysis, the effect of season was found to be not significant (Table 127).

TABLE (126)

TABLE SHOWING MEAN DRY PERIOD IN DAYS ACCORDING TO SEASON AND MONTH OF CALVING

SEASONS	No.	Av.	S.E.	C.V.	MONTHS	No.	Av.	S.E.	C.V.
					March	41	192.1	18.2	60.9
Summer	91	194.0	12.3	60.7	April	22	206.9	29.3	66.5
					May	28	186.8	19.8	56.3
					June	24	203.5	31.4	75.7
					July	30	205.5	18.5	49.9
Rainy	69	218.3	14.2	61.5	August	21	208.7	24.6	54.1
					September	14	289.7	47.1	60.8
					October	34	156.0	12.1	45.4
					November	47	200.6	19.4	66.5
Winter	195	204.5	9.9	67.7	December	35	238.3	32.6	80.9
					January	36	222.2	20.5	55.4
					February	43	205.2	17.4	55.7

TABLE (127)

ANALYSIS OF VARIANCE TABLE SHOWING THE EFFECT OF SEASON OF CALVING ON DRY PERIOD

SOURCE	D.F.	S.S.	M.S.	F.
Between season	2	26674.30	13337.15	0.75
Error	372	6553894.41	17617.99	
Total	374	6580568.71		

September calvers had the longest dry period of 289.7 ± 47.1 days with 60.8% coefficient of variation and October calvers possessed shortest dry period of 156.0 ± 12.1 days with 45.4% coefficient of variation. Rest of the months did not show any definite trend of increase or decrease (Figure 6). The effect of month of calving on dry period was found to be not significant (Table 128).

TABLE (128)

ANALYSIS OF VARIANCE TABLE SHOWING THE EFFECT OF MONTH OF CALVING ON DRY PERIOD.

SOURCE	D.F.	S.S.	M.S.	F.
Between months	11	249207.90	22655.26	1.29
Error	363	6331360.81	17441.76	
Total	374	6580568.71		

Effect of service period

For 353 pairs of observations, the correlation between service period and dry period was found to be 0.720 which was statistically highly significant. The regression of dry period on service period was found to be significant and of the order of 0.67 days (Table 129)

Effect of age at first calving

Age at first calving was found to have not significant association with 1st dry period with correlation coefficient of -0.012. It was estimated on 61 pairs of observations (Table 129). The regression coefficient of first dry period on age at first calving was not significant (-0.005).

The genetic correlation among the traits was found to be -0.312 on data pertaining to 47 half sibs of 3 bulls (Table 130).

TABLE (129)

EFFECT OF SERVICE PERIOD AND AGE AT FIRST CALVING ON DRY PERIOD

COMBINATION	REGRESSION	CORRELATION	GENETIC CORRELATION
Service period Vs dry period	0.67*	0.720**	-
Age at first calving Vs dry period	-0.005	-0.012	-0.312

TABLE (130)

ANALYSIS OF VARIANCE AND COVARIANCE FOR GENETIC CORRELATION BETWEEN AGE AT FIRST CALVING (X) AND FIRST DRY PERIOD (Y)

SOURCE	D.F.	X		Y		XY	
		S.S.	M.S.	S.S.	M.S.	S.P.	M.P.
Between bulls	2	7264.4	3632.2	18413.0	9206.5	5979.6	2989.8
Within bulls	44	2649241.3	60210.0	446122.6	10139.1	231567.3	5262.8
Total	46	2656505.7		464536.6		237546.9	

Heritability:-

From the Table (131) the heritability of -0.0280 was estimated for dry period by paternal half sib correlation method on 47 half sibs of 3 bulls. The Table (132) gives the heritability estimate of -0.5636 and -0.5134 for dry period by intr-a sire regression and daughter on dam and correlation methods respectively estimate of -0.5636 and -0.5134 for dry period by intra sire regression and daughter on dam and correlation methods respectively for 20 pairs of dam daughter.

TABLE (131)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF DRY PERIOD BY PATERNAL HALF SIB CORRELATION METHOD

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between bulls	2	18413.10	9206.55	$\sigma_e^2 + 11.95\sigma_s^2$
Within bulls	44	446123.46	10139.16	σ_e^2
Total	46	464536.56		

σ_e^2 = 10139.16 h^2 = 0.028

σ_s^2 = -78.04

TABLE (132)

ANALYSIS OF VARIANCE AND COVARIANCE FOR HERITABILITY ESTIMATE OF DRY PERIOD

SOURCE	D.F.	S.S.(X)	S.P.(XY)	S.S.(Y)
Between sires	2	632.81	1093.50	1920.80
Within sires	17	162024.94	-45662.25	195175.75
Total	19	162657.75	-44568.75	197096.55

$b = \frac{-45662.25}{162024.94} = -0.2818$ $r = \frac{-45662.25}{177629.24} = -0.2567$

$h^2 = 2 \times -0.2818 = -0.5636$ $h^2 = 2 \times -0.2567 = -0.5134$

Repeatability

The repeatability of dry period was estimated as -0.009 for 195 observations of 52 cows(Table 133).

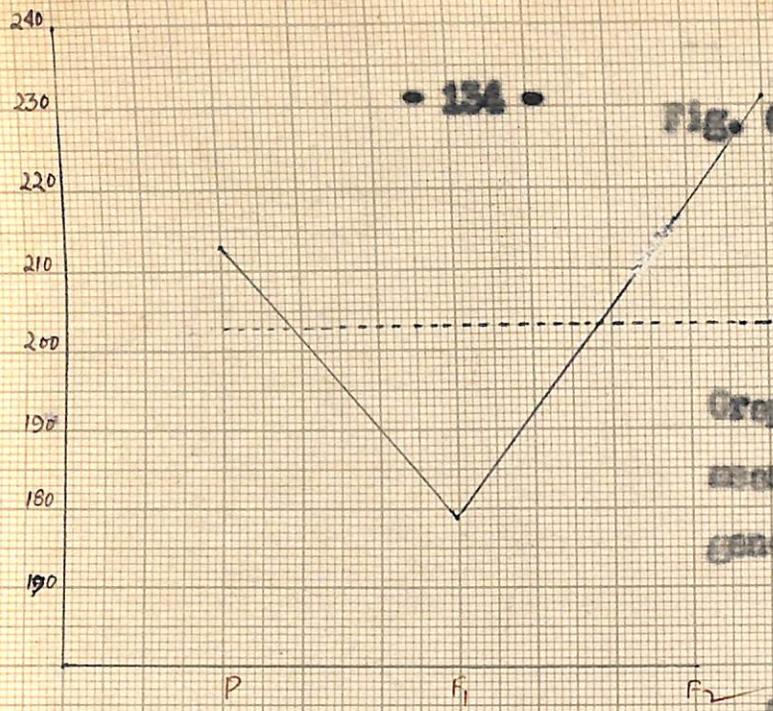
TABLE (133)

ANALYSIS OF VARIANCE TABLE FOR REPEATABILITY

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between cows	51	572486.55	11225.22	$\sigma_e^2 + 3.73\sigma_c^2$
Within cows	143	1665483.53	11646.73	σ_e^2
Total	194	2237970.08		

σ_e^2 = 11646.73; σ_c^2 = -113.00; R = -0.009

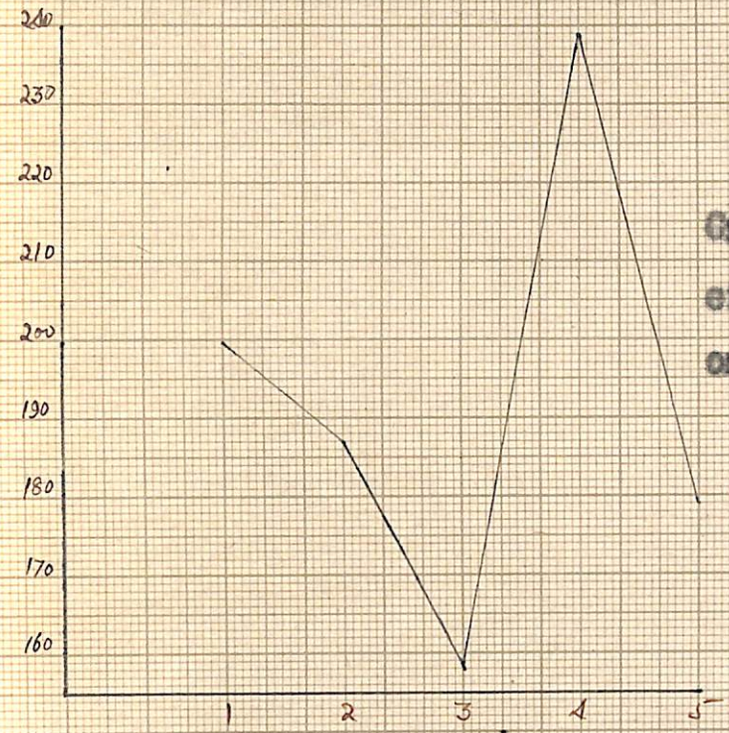
Fig. 6



Generations

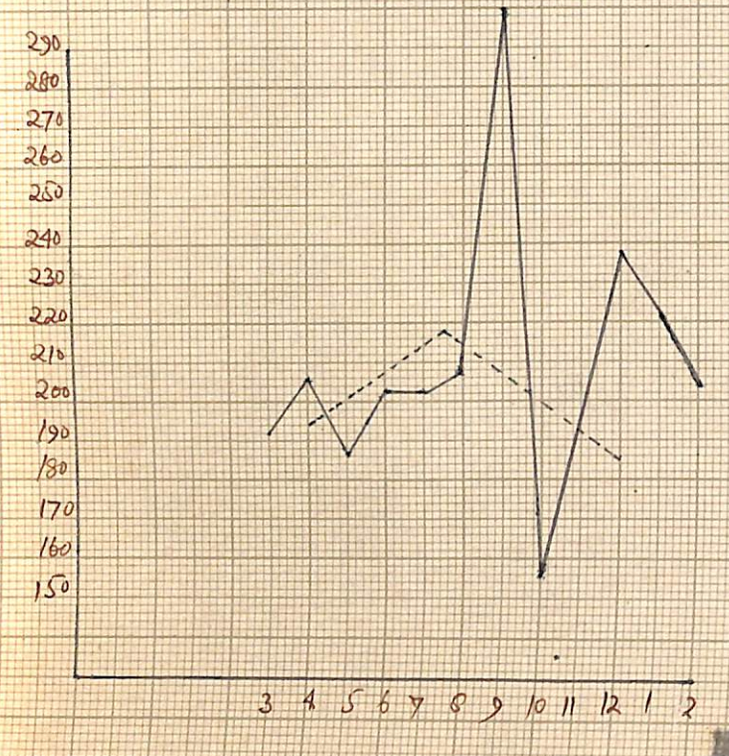
Herd

Graphical representation of mean dry period in different generations.



Generations

Graphical representation of the effect of sequence of calving on dry period.



Lactations

Months

Seasons

Graphical representation of the effect of season and month of calving on dry period.

Months

(10) LACTATION LENGTH

Averages :

The mean lactation length of different generations according to sequence of calving as given in the Table (134) varied between 379 ± 17.6 days to 275.8 ± 27.0 days. The coefficient of variation had a range of 36.6 % to 18.0%.

In Table (135) the mean lactation length of foundation, first, second and third generation stock has been given. Figure (7) is graphical representation of the same. The mean lactation length of the herd was calculated to be 318.2 ± 3.8 days with 24.6% coefficient of variation for 415 records.

TABLE (135)

TABLE SHOWING GENERATION-WISE MEAN LACTATION LENGTH IN DAYS

GENERATIONS	No.	Av.	S.E.	C.V.
Foundation	192	322.8	5.9	25.6
First	165	308.7	5.9	24.8
Second	56	328.6	8.9	20.2
Third	2	362.0	6.0	2.3
Herd	415	318.2	3.8	24.6

Generation-wise comparison of means

From the Table (136) it may be seen that the mean lactation length of the first generation when compared to foundation stock had decreased. On the other hand, in the second generation the mean lactation length increased both from foundation and first generation. All the three differences were not significant.

TABLE (134)

MEAN LACTATION LENGTH IN DAYS OF FOUNDATION, FIRST, SECOND AND THIRD GENERATIONS ACCORDING TO SEQUENCE OF CALVING

SEQUENCE OF CALVING	FOUNDATION STOCK				FIRST GENERATION				SECOND GENERATION				THIRD GENERATION			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.
1	29	379.5	17.6	25.6	42	337.9	11.4	22.0	27	350.6	14.6	21.6	2	362.0	6.0	2.3
2	40	323.0	12.8	25.1	40	311.6	10.8	22.0	12	305.5	15.7	18.0				
3	44	335.0	10.8	21.5	31	294.6	11.9	22.5	8	319.6	13.9	12.3				
4	29	281.7	12.9	24.7	23	315.0	17.7	27.0	6	301.8	22.0	17.8				
5	20	286.8	16.2	25.2	14	275.8	27.0	36.6	3	310.0	39.7	22.1				
6	13	299.3	18.5	22.3	9	258.7	17.3	20.0								
7	8	303.1	36.7	34.2	4	288.7	40.4	27.9								
8	5	338.6	17.0	11.2	2	281.5	30.5	15.3								
9	3	349.6	48.2	23.8												
10	-	-	-	-												
11	1	359.0	-	-												

TABLE (136)

TABLE SHOWING GENERATION-WISE COMPARISON OF MEAN LACTATION LENGTH IN DAYS.

D.F.	COMBINATION	DIFFERENCE	't' VALUE
355	Foundation Vs First generation (322.8) (308.7)	-14.1	1.6631
246	Foundation Vs Second generation (322.8) (328.6)	+ 5.8	0.4814
219	First Vs Second generation (308.7) (328.6)	+19.9	1.7349

Effect of sequence of calving

The mean lactation period according to sequence of calving of first and second generation stock is summarised in the Table (137). From the perusal of it and the Figure (7) it would appear that the mean lactation length resumed a decline from first to fifth lactation with a slight increase in fourth lactation. Upon analysis (Table 136) the mean lactation length for different lactations were found to differ from each other at 0.01% of probability.

TABLE (137)

MEAN LACTATION LENGTH IN DAYS OF FIRST AND SECOND GENERATION COWS

SEQUENCE OF CALVING	No.	Av.	S.E.	C.V.
1	71	343.4	8.7	21.4
2	52	309.7	9.0	21.0
3.	39	299.7	9.9	20.7
4	29	312.2	14.7	25.3
5	17	281.8	23.1	33.7
6	9	256.7	17.3	20.0
7	4	286.7	40.4	27.9
8	2	281.5	30.5	15.3

TABLE (138)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEQUENCE OF CALVING ON LACTATION LENGTH

SOURCE	D.F.	S.S.	M.S.	F.
Between sequences	5	117226.02	23445.20	4.57**
Error	217	1112739.41	5127.83	
Total	222	1229965.43		

Effect of season and month of calving

The mean lactation lengths for cows calving in rainy, summer and winter seasons were 315.1 ± 8.0 days with 25.1% coefficient of variation, 317.4 ± 7.6 days with 24.1% coefficient of variation and 319.0 ± 5.3 days with 24.6% coefficient of variation respectively for 97, 101 and 215 number of observations (Table 139). There was not significant difference among seasons (Table 140).

TABLE (139)

MEAN LACTATION LENGTH IN DAYS ACCORDING TO SEASON AND MONTH OF CALVING

SEASONS	No.	Av.	S.E.	C.V.	MONTHS	No.	Av.	S.E.	C.V.
					March	44	327.7	12.2	24.7
Summer	101	317.4	7.6	24.1	April	25	305.9	13.4	21.9
					May	32	312.1	13.6	24.8
					June	29	311.1	14.6	25.3
					July	31	303.5	14.8	27.2
Rainy	97	315.1	8.0	25.1	August	23	326.5	15.7	23.1
					September	14	330.2	21.6	24.5
					October	36	316.8	10.3	19.6
					November	53	321.6	11.2	25.3
Winter	215	319.0	5.3	24.6	December	42	323.7	13.0	26.1
					January	37	326.8	14.6	27.3
					February	47	307.3	10.9	24.3

TABLE (140)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEASON OF CALVING ON LACTATION LENGTH

SOURCE	D.F.	S.S.	M.S.	F.
Between seasons	2	1028.34	514.17	0.08
Error	410	2515503.95	6135.37	
Total	412	2516532.29		

Cows calving in September had the longest lactation period of 330.2 ± 21.6 days with 24.5 % coefficient of variation and July calvers the shortest (303.5 ± 14.8 days with 27.2% coefficient of variation). The different months did not present any definite pattern of rise or fall (Figure 7). Month of calving was found not to have significant effect (Table 141).

TABLE (141)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF MONTH OF CALVING ON LACTATION LENGTH

SOURCE	D.F.	S.S.	M.S.	F.
Between months	11	30907.87	2809.80	0.45
Error	401	2485624.42	6198.56	
Total	412	2516532.29		

Effect of service period

There was a highly significant correlation of 0.538 between service period and current lactation length (Table 142). It was estimated on the basis of 323 pairs of observations. The regression of current lactation length on service period was found to be 0.27 days and significant.

TABLE (142)

EFFECT OF SERVICE PERIOD AND AGE AT FIRST CALVING ON LACTATION LENGTH

COMBINATION	REGRESSIONS	CORRELATIONS
Service period Vs. current lactation length	0.27*	0.538**
Age at first calving Vs. first lactation length.	0.03	0.120

Effect of age at first calving

On 69 pairs of observations the correlation and regression of lactation period on age at first calving were 0.120 and 0.03 days respectively and both were not significant (Table 142).

Heritability

The heritability of lactation period calculated by paternal half sib correlation method (Table 143) and intra sire regression and correlation methods (Table 144) were found to be 0.5464, 0.5942 and 0.5778 respectively. The former estimate was based on 51 half sibs of 3 bulls and the rest two on 22 dam daughter pairs.

TABLE (143)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF LACTATION LENGTH BY PATERNAL HALF SIB CORRELATION METHOD

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between bulls	2	28503.1	14251.55	$\sigma^2_s + 13.45\sigma^2_e$
Within bulls	48	218642.6	4555.05	σ^2_e
Total	50	247145.7		

$\sigma^2_s = 4555.05$

$\sigma^2_e = 720.92$

$h^2 = 0.5464$

TABLE (144)

ANALYSIS OF VARIANCE AND COVARIANCE FOR HERITABILITY ESTIMATE OF LACTATION LENGTH

SOURCE	D.F.	S.S.(X)	S.P. (XY)	S.S.(Y)
Between sires	1	7400.22	-6249.65	9196.58
Within sires	20	117909.06	35036.65	123036.92
Total	21	125309.28	26787.00	132233.50

$b = \frac{35036.65}{117909.06} = 0.2971$ $\quad 4 = \frac{35036.65}{121273.11} = 0.2889$

$h^2 = 2 \times 0.2971 = 0.5942$ $\quad h^2 = 2 \times 0.2889 = 0.5778$

Repeatability

Table (145) incorporates the analysis on 232 lactation periods of 61 cows and the repeatability estimate of lactation period was found to be 0.267.

TABLE (145)

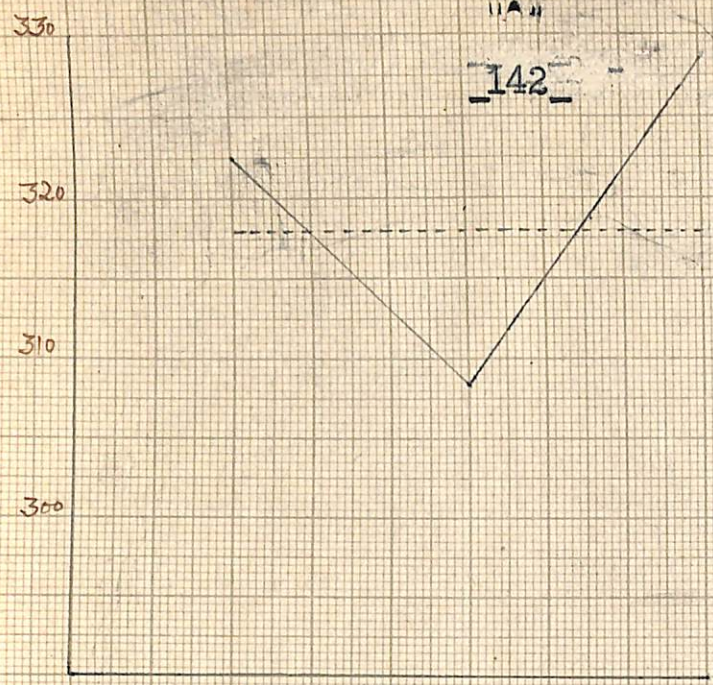
ANALYSIS OF VARIANCE TABLE FOR REPEATABILITY

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between cows	60	558817.43	9313.62	$\sigma_e^2 + 3.790\sigma_c^2$
Within cows	171	667927.33	3906.00	σ_e^2
Total	231	1226744.76		

$\sigma_e^2 = 3906.00$ $\quad R = 0.267$

$\sigma_c^2 = 1426.81$

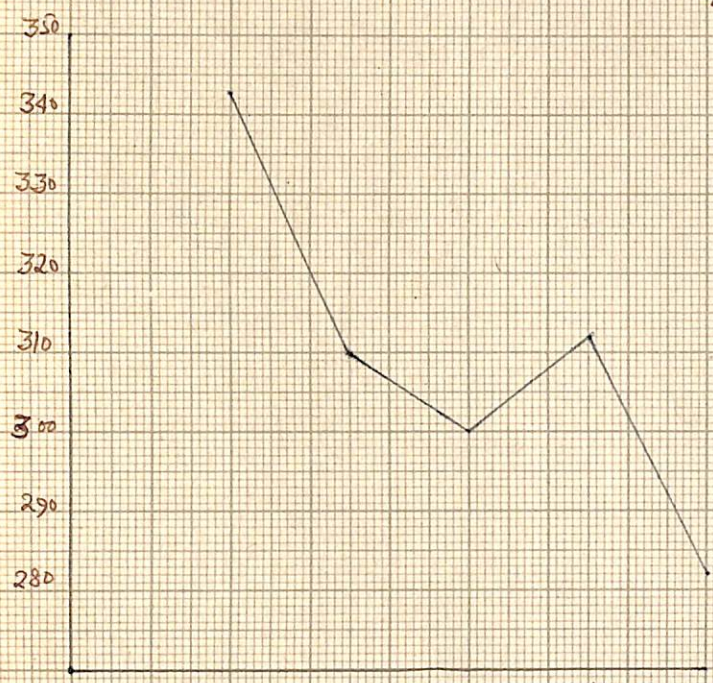
Fig. 7



Generations

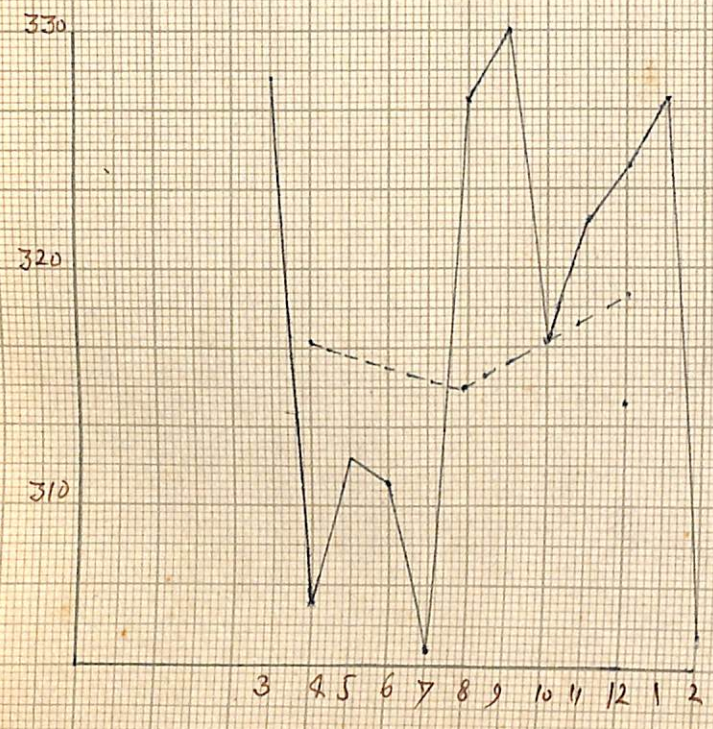
Herd

Graphical representation of mean lactation period in different generations.



Lactations

Graphical representation of the effect of sequence of calving on lactation period.



Months

Seasons

Graphical representation of the effect of season and month of calving on lactation period.

Months

(11) CALVING INTERVAL

Averages

The mean calving interval according to the sequence of calving for different generations is given in the Table (146). The range was 645.9 ± 30.3 to 449.9 ± 37.3 days. The coefficients of variation ranged between 34.5% to 17.7%.

TABLE (146)

MEAN CALVING INTERVAL IN DAYS OF FOUNDATION, FIRST AND SECOND GENERATION STOCK ACCORDING TO SEQUENCE OF CALVING

SEQUENCE OF CALVING	FOUNDATION				FIRST GENERATION				SECOND GENERATION			
	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V.	No.	Av.	S.E.	C.V
2	35	546.2	29.0	31.4	42	553.4	15.1	17.7	23	645.9	30.3	22.4
3	65	499.6	21.4	34.5	37	494.4	24.3	29.9	10	501.0	33.2	20.9
4	44	492.6	16.9	22.8	28	451.3	16.1	21.3	7	499.0	47.7	25.2
5	25	460.2	22.9	24.9	18	501.2	39.6	33.5	5	635.4	40.1	14.1
6	19	459.6	24.8	23.6	10	449.9	37.3	26.2	1	414.0	-	-
7	11	490.3	45.6	30.8	7	449.2	63.4	37.3	-	-	-	-
8	7	439.5	57.2	34.4	3	381.0	36.5	16.6	-	-	-	-
9	5	499.4	45.6	20.4	1	459.0	-	-	-	-	-	-
10.	2	435.5	16.5	5.3								
11	1	503.0	-	-	-	-	-	-	-	-	-	-

Table (147) shows the mean calving interval for foundation first and second generation stock. It is graphically represented in Figure (8). A value of 495.6 ± 7.0 days with 26.4% coefficient of variation calculated on 406 observations represented the mean calving interval for the whole herd.

TABLE (147)

TABLE SHOWING GENERATION-WISE MEAN CALVING INTERVAL IN DAYS

GENERATIONS	No.	M.	S.E.	C.V.
Foundation	214	489.9	10.0	30.1
First	146	482.4	10.5	26.3
Second	46	564.1	20.1	24.2
Herd	406	495.6	7.0	28.4

Generation-wise comparison of means

Table (148) gives generation-wise comparison of mean calving interval. In the first generation there was a reduction in mean value from foundation stock but this difference was not significant statistically. However, in the second generation an increase of as high as 74.2 days from foundation stock and 81.7 days from first generation was observed and both the increases were statistically highly significant.

TABLE (148)

TABLE SHOWING GENERATION-WISE COMPARISON OF MEAN CALVING INTERVAL

D.F.	COMBINATION	DIFFERENCE	't' VALUE
358	Foundation (489.9) Vs First generation (482.4)	-7.5	0.4982
258	Foundation (489.9) Vs Second generation (564.1)	+74.2**	3.1294
190	First (482.4) Vs Second generation (564.1)	+81.7**	3.7362

Effect of sequence of calving

The mean calving interval of first and second generation stock according to sequence of calving is incorporated in the Table (149). Figure (8) is the graphical representation of the

same. It would be seen that there was a declining trend in the average calving interval from first to fifth lactation. However, there was a sharp rise in the fourth lactation. The variation in means among different calvings were found to be highly significant statistically (Table 150).

TABLE (149)

MEAN CALVING INTERVAL IN DAYS OF FIRST AND SECOND GENERATION

CALVING SEQUENCE	No.	M.	S.E.	C.V.
2	65	540.0	15.5	23.1
3	47	495.8	20.3	28.1
4	35	460.8	17.3	22.2
5	23	530.4	33.9	30.7
6	11	446.6	33.9	25.2
7	7	449.2	63.4	37.3
8	3	381.0	36.5	16.6
9	1	459.0	-	-

TABLE (150)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEQUENCE OF CALVING ON CALVING INTERVAL

SOURCE	D.F.	S.S.	M.S.	F.
Between sequences	5	261697.98	52379.59	3.09**
Error	186	3150711.49	16939.30	
Total	191	3412609.47		

Effect of season and month of calving

The mean calving intervals of summer, rainy and winter calvers were 496.6 ± 14.1 days with 28.1% coefficient of variation, 493.6 ± 12.6 days with 25.0% coefficient of variation and 495.7 ±

10.3 days with 30.3% coefficient of variation respectively. The estimates were based on 98, 96 and 212 observations in the same order (Table 151 and Figure 8). The analysis of variance as given in the Table (152) indicated that the effect of season was not significant.

Table (151)

TABLE SHOWING THE MEAN CALVING INTERVAL IN DAYS ACCORDING TO SEASON AND MONTH OF CALVING

SEASONS	No.	M.	S.E.	C.V.	MONTHS	No.	M.	S.E.	C.V.
					March	43	497.2	22.4	29.5
Summer	98	496.6	14.1	28.1	April	25	499.9	27.8	27.8
					May	30	492.9	24.0	26.7
					June	28	469.1	25.9	29.2
					July	30	489.3	18.0	20.2
Rainy	96	493.6	12.6	25.0	August	24	482.3	19.9	20.2
					September	14	571.2	43.4	28.4
					October	37	448.7	17.0	23.1
					November	49	483.6	21.1	30.6
Winter	212	495.7	10.3	30.3	December	40	539.2	31.6	37.0
					January	42	504.5	22.1	28.5
					February	44	500.9	19.7	26.2

TABLE (152)

ANALYSIS OF VARIANCE TABLE SHOWING THE EFFECT OF SEASON OF CALVING ON CALVING INTERVAL.

SOURCE	D.F.	S.S.	M.S.	F.
Between season	2	460.33	230.16	0.01
Error	403	8100740.82	20101.09	
Total	405	8101201.15		

September calvers had the longest calving interval of 571.2 ± 43.4 days with 28.4% coefficient of variation and cows freshening in October had this interval as low as 448.7 ± 17.0 days with 23.1% coefficient of variation. Rest of the months did not show any definite trend. Month of calving did not have significant effect or the length of calving interval (Table 153)

TABLE (153)

ANALYSIS OF VARIANCE TABLE SHOWING THE EFFECT OF MONTH OF CALVING ON CALVING INTERVAL

SOURCE	D.F.	S.S.	M.S.	F.
Between months	11	275019.38	25001.76	1.25
Error	394	7826181.77	19863.40	
Total	405	8101201.15		

Effect of age at first calving

The correlation coefficient of age at first calving and first calving interval was estimated to be 0.114 (Table 154) and it was not significant. The regression coefficient of first calving interval on age at first calving was found to be 0.060 days which was also not significant.

TABLE (154)

TABLE SHOWING ASSOCIATION OF TRAITS WITH CALVING INTERVAL

COMBINATION	REGRESSION	CORRELATION
Age at 1st service Vs. First calving interval	0.065	0.135
Age at 1st calving Vs. First calving interval.	0.060	0.114

Effect of age at first service :

A correlation and regression of first calving interval on age at first service of the size of 0.135 and 0.065 days

respectively were obtained (Table (154). These estimates were calculated on 62 pairs of observations.

Heritability

The heritability of calving interval was estimated to be 0.6280, 0.6892 and 0.5172 by paternal half sib correlation, intra sire regression and correlation methods respectively. The former estimate was based on 49 half sibs belonging to 3 sires (Table 155) whereas the rest two estimates were calculated from 21 dam daughter pairs of two sires (Table 156).

TABLE (155)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF CALVING INTERVAL BY PATERNAL HALF SIB CORRELATION

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between bulls	2	87161.5	43580.75	$\sigma_e^2 + 12.71\sigma_s^2$
Within bulls	46	592694.5	12884.66	σ_e^2
Total	48	679856.0		

$\sigma_e^2 = 12884.66$ $\quad h^2 = 0.6280$

$\sigma_s^2 = 2415.11$

TABLE (156)

ANALYSIS OF VARIANCE AND COVARIANCE FOR HERITABILITY ESTIMATE OF CALVING INTERVAL

SOURCE	D.F.	S.S.(X)	S.P.(XY)	S.S.(Y)
Between sires	1	3546.72	6645.66	12080.37
Within sires	19	175514.24	60496.57	311799.44
Total	20	179060.96	53950.91	323879.81

$b = \frac{60496.57}{175514.24} = 0.3446$ $\quad r = \frac{60496.57}{233934.26} = 0.2586$

$h^2 = 2 \times 0.3446 = 0.6892$ $\quad h^2 = 2 \times 0.2586 = 0.5172$

Repeatability

Table (157) gives analysis of variance for 202 observations of 55 cows for the calculation of repeatability. It was estimated to be 0.159.

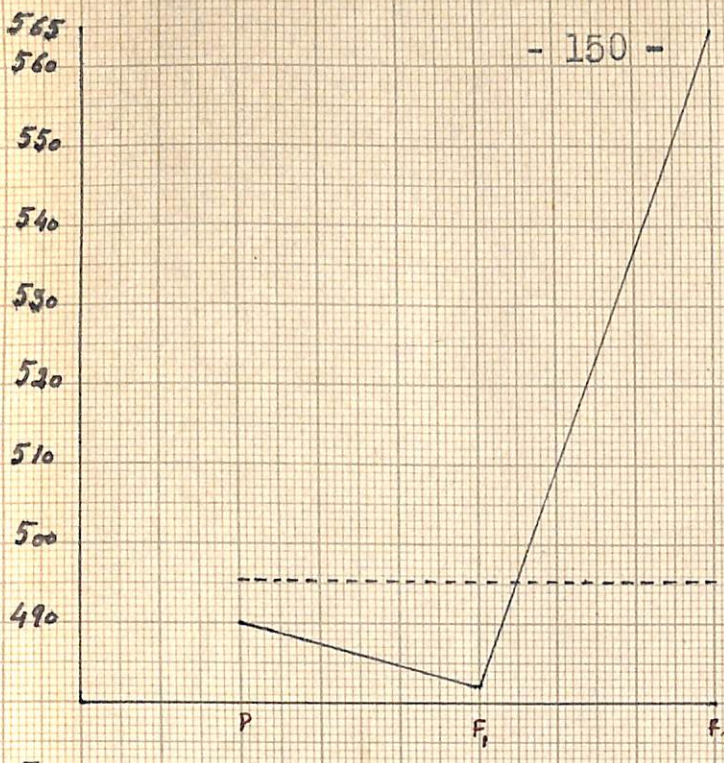
TABLE (157)

ANALYSIS OF VARIANCE TABLE FOR REPEATABILITY

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between cows	54	1249721.43	23142.98	$\sigma^2_e + 3.660\sigma^2_c$
Within cows	147	2009348.70	13669.03	σ^2_e
Total	201	3259070.13		

$\sigma^2_e = 13669.03$ R = 0.159

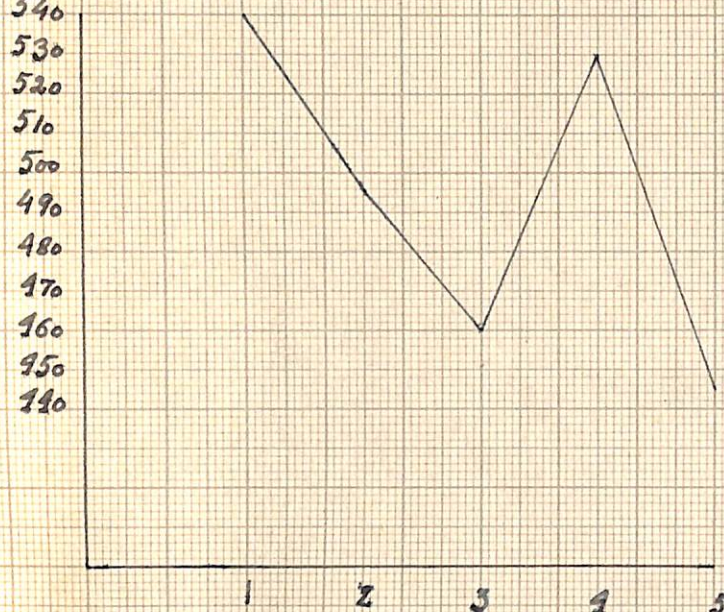
$\sigma^2_c = 2568.51$



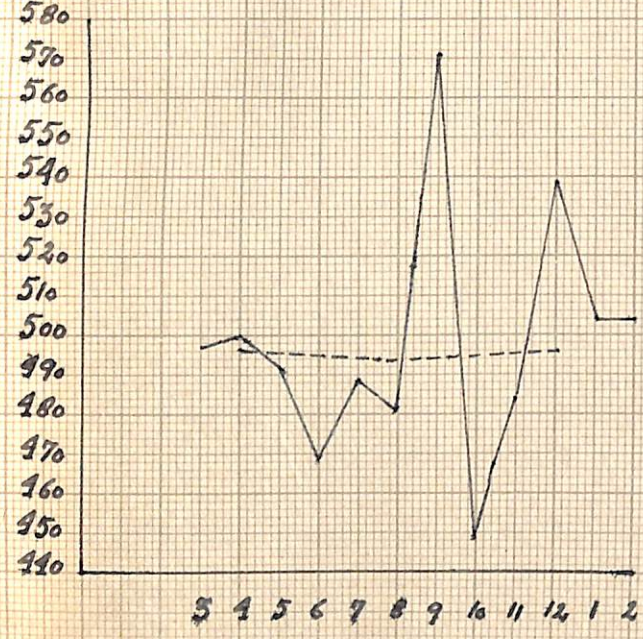
Generations

Herd

Graphical representation of mean calving interval in different generations.



Graphical representation of the effect of sequence of calving on calving interval



Months

Seasons

Graphical representation of the effect of season and month of calving on calving interval

Figure (8)

(12) LACTATION YIELD

Averages:

Mean lactation yield of different generations according to sequence of calving, presented in Table (158), revealed maximum and minimum yield as 3604.1 ± 221.7 lbs. and 2294.7 ± 160.9 lbs. respectively. The coefficients of variation varied between 41.6% to 29.6%.

Table (159) represents the mean lactation yield of foundation, first, second and third generation stock. The same is graphically represented in the figure (9). The herd average for 415 lactation records was obtained as 2903.3 ±51.6 lbs. with 36.2% coefficient of variation.

TABLE (159)

TABLE SHOWING GENERATION-WISE MEAN LACTATION YIELD IN POUNDS

GENERATIONS	No.	Av.	S.E.	C.V.
Foundation	192	2639.8	71.8	37.7
First	165	3015.3	78.5	33.4
Second	56	3512.8	140.8	30.0
Third	2	1836.6	1237.7	95.2
Herd	415	2903.3	51.6	36.2

Generation-wise comparison of mean

As summarised in the Table (160) the mean lactation yield of first generation differed from the foundation stock with an increase of 375.5 lbs. Second generation mean exceeded by 827.0 and 497.5 from foundation and first generation means respectively. All the three increases were highly significant.

MEAN LACTATION YIELD IN POUNDS OF FOUNDATION, FIRST, SECOND AND THIRD GENERATIONS ACCORDING TO SEQUENCE OF CALVING.

SEQUENCE OF CALVING	FOUNDATION STOCK No.	Av.	S.E.	C.V.	FIRST GENERATION No.	Av.	S.E.	C.V.	SECOND GENERATION No.	Av.	S.E.	C.V.	THIRD GENERATION No.	Av.	S.E.	C.V
1	29	2717.0	149.4	29.6	42	3084.9	164.5	34.5	27	3604.1	221.7	31.9	2	1836.6	1237.7	95.2
2	40	2531.5	166.8	41.6	40.	2936.4	156.3	33.6	12	3329.0	342.4	35.6				
3	44	2702.3	167.7	41.1	31	3018.4	180.2	33.2	8	3747.8	230.6	17.4				
4	29	2294.7	160.9	37.7	23	3179.8	226.8	34.2	6	3321.5	310.9	22.9				
5	20	2625.0	228.1	38.8	14	2890.8	317.2	41.0	3	3181.6	789.7	42.9				
6	13	2989.8	337.6	40.7	9	2818.2	222.9	25.7							1	
7	8	2826.6	343.7	34.3	4	2728.3	301.9	22.1							252	
8	5	3055.8	136.2	9.9	2	3023.5	727.6	34.0							1	
9	3	3005.6	434.0	25.0												
10	-	-	-	-												
11	1	3058.0	-	-												

TABLE (160)

TABLE SHOWING GENERATION-WISE COMPARISION OF MEAN LACTATION YIELD

D.F.	COMBINATION	DIFFERENCE	't' VALUE
355	Foundation Vs First generation (2639.8) (3015.3)	+375.5**	3.5827
246	Foundation Vs Second generation (2639.8) (3512.8)	+827.0**	5.6983
219	First Vs Second generation (3015.3) (3512.8)	+497.5**	3.1534

Effect of sequence of calving

Perusal of Table (161) which incorporates lactation-wise average yield of first & second generation stock would reveal that the first lactation had the maximum yield and then there was a sharp drop in the second with an increase in the third that continued upto fourth lactation. Afterwards there was a progressive fall in the average lactation yield upto sixth calving. To test whether the mean yield for different lactations significantly differ from each other, an analysis of variance was run as indicated in the Table (162) and it was found to be not significant.

TABLE (161)

MEAN LACTATION YIELD OF FIRST AND SECOND GENERATION STOCK ACCORDING TO SEQUENCE OF CALVING.

SEQUENCE OF CALVING	No	Av.	S.E.	C.V.
1	71	3246.6	136.4	35.3
2	52	3027.0	143.9	34.2
3	39	3168.0	157.0	30.9
4	29	3209.1	189.0	31.7
5	17	2942.1	286.0	40.0
6	9	2818.2	222.9	23.7
7	4	2728.3	301.9	22.1
8	2	3023.5	727.6	34.0

TABLE (162)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SEQUENCE OF CALVING ON LACTATION YIELD

SOURCE	D.F.	S.S.	M.S.	F
Between sequence	5	3265204.95	653040.99	0.58
Error	217	241148718.62	1111284.41	
Total	222	244413923.57		

Effect of season and month of calving

Winter calvers were best in that they yielded the highest quantity of milk i.e. 2944.8 ± 73.8 lbs. on an average with 36.7% coefficient of variation. Among calvers during rainy and summer season, the former was better as they produced slightly more milk and the mean yields were 2856.8 ± 112.8 lb-s.

~~112.8 lbs.~~ and 2823.8 ± 96.3 lbs. with 38.8% and 34.2% coefficient of variation respectively. These estimates are presented in the Table (163), and were based on 215, 97 and 101 lactation records. However, the analysis of variance as indicated in the Table (164) showed that there existed not significant differences among the mean lactation yield of different seasons.

TABLE (163)

MEAN LACTATION YIELD IN POUNDS ACCORDING TO SEASON AND MONTH OF CALVING.

SEASONS	No.	Av.	S.E.	C.V.	MONTHS	No.	Av.	S.E.	C.V.
					March	44	2903.3	149.9	34.2
Summer	101	2823.8	96.3	34.2	April	25	3579.0	159.0	22.2
					May	32	2749.3	188.9	38.8
					June	29	3041.6	170.3	30.1
					July	31	2996.5	223.8	46.2
Rainy	97	2856.8	112.8	38.8	August	23	2899.5	206.4	34.4
					September	14	2758.9	366.1	49.6
					October	36	2790.8	168.4	36.2
					November	62	2935.3	160.0	39.3
Winter	215	2944.8	73.8	36.7	December	42	2899.9	153.7	34.3
					January	38	3018.3	195.5	39.9
					February	47	3053.9	151.7	34.1

TABLE (164)

ANALYSIS OF VARIANCE TABLE SHOWING THE EFFECT OF SEASON OF CALVING ON LACTATION YIELD.

SOURCE	D.F.	S.S.	M.S.	F
Between seasons	2	1186799.30	593399.65	0.52
Error	410	461841759.29	1126443.31	
Total	412	463028558.59		

Cows freshening in the month of April produced the highest quantity of milk (3579.0 ± 159.0 lbs. with 22.2% coefficient of variation) and May calvers the lowest (2749.3 ± 188.9 lbs. with 38.8% coefficient of variation). No definite pattern of variation in the means of different months existed as evident from Figure (9). Analysis of variance presented in Table (165) proved that month of calving did not have any significant effect on lactation yield.

TABLE (165)

ANALYSIS OF VARIANCE TABLE SHOWING THE EFFECT OF MONTH OF CALVING ON LACTATION YIELD.

SOURCE	D.F.	S.S.	M.S.	F.
Between months	11	5363940.18	487630.92	0.42
Error	401	457664618.41	1141308.27	
Total	412	463028558.59		

Effect of weight at freshening

A highly significant correlation coefficient of 0.397 at 147 d.f. was obtained between weight at freshening and lactation yield. The regression of lactation yield on weight at freshening was found to be 3.55 lbs. which was also highly significant (Table 166).

Significant correlation and regression of first lactation yield on body weight at first calving obtained were of the order of 0.424 and 5.202 lbs. respectively at 27 d.f. (Table 166)

TABLE (166)

TABLE SHOWING ASSOCIATION OF DIFFERENT TRAITS WITH LACTATION YIELD.

COMBINATION	REGRESSION	CORRELATION	GENETIC CORRELATION
Weight at freshening Vs. lactation yield	3.55**	0.397**	-
Service period Vs. current lactation yield	1.73**	0.245**	0.894
Service period Vs. subsequent lactation yield	1.15*	0.146**	-
Age at first calving Vs. first lactation yield	1.401*	0.304**	-
Age at first calving Vs. second lactation yield	-0.01	-0.003	-
Age at first calving Vs. third lactation yield	0.07	0.014	-
Age at first calving Vs. fourth lactation yield	0.49	0.085	-
Age at first calving Vs. first three lactations yield	1.48	0.134	-
Age at first calving Vs. first four lactations yield	3.91	0.219	-
Age at first service Vs. first lactation yield	1.078*	0.261*	-
Weight of heifer at calving Vs. first lactation yield	5.202*	0.424*	-
Lactation period Vs. lactation yield	8.320**	0.619**	0.239
Dry period Vs. subsequent lactation yield	0.083	0.009	0.227
First calving interval Vs. first lactation yield	3.348**	0.434**	-

Effect of service period

The correlation coefficients between service period and yield of same and subsequent lactation were found to be 0.245 and 0.146 at 322 and 311 d.f. respectively and they were highly significant. The regressions of lactation yield in same and subsequent lactation on service period were 1.73 and 1.15 lbs. respectively and while latter was significant the former was highly significant (Table 166).

The effect of service period on the same lactation yield was further tested by organising the same data on lactation yield according to service period into nine groups having a class interval of 30 days with upper class limit of the first group and the lower class limit of last group as 60 and 271 days respectively. The mean lactation yield for different groups of service periods are indicated in the Table (167). From this Table and Figure (10) it is evident that there was an increase in the mean lactation yield with the increase in the service period excepting a slight fall in 241-270 days service period group. There was a sharp increase in the second group but very less increase in the third. Then onwards with each increase of 30 days there was an appreciable increase in the mean lactation yield. The last group had the maximum yield. Analysis of variance as shown in the Table (168) revealed highly significant differences that were existing among average yields of different groups.

TABLE (167)

TABLE SHOWING EFFECT OF SERVICE PERIOD ON CURRENT LACTATION YIELD

S. No.	SERVICE PERIOD IN DAYS	CURRENT LACTATION YIELD IN POUNDS No.	Av.	S.E.	C.V.
1	Below 60	12	2261.5	160.2	24.5
2	61-90	44	2555.8	113.7	29.5
3	91-120	37	2567.5	129.6	30.7
4	121-150	33	2775.9	152.2	31.5
5	151-180	24	2879.5	176.6	30.0
6	181-210	33	2954.9	160.0	29.1
7	211-240	22	3277.7	249.3	35.6
8	241-270	23	3258.4	183.4	27.0
9	271 and above	96	3405.5	114.5	32.9

TABLE (168)

ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SERVICE PERIOD ON CURRENT LACTATION YIELD

SOURCE	D.F.	S.S.	M.S.	F.
Between groups	8	43153603.66	5394200.45	6.04**
Error	315	281177334.22	892626.45	
Total	323	324330937.88		

The analysis of variance for genetic correlation between service period and same lactation yield is summarised in the Tables (169) and the estimate was 0.894. It was based on 140 half sibs of 6 bulls.

Effect of age at first calving

Table (166) also incorporates the correlations between age at first calving and first, second, third, fourth, total of first three and the total of first four lactation yields and the estimates in the same order were 0.304, -0.003, 0.014, 0.085, 0.134 and 0.219. These associations were calculated for 69, 51, 37, 26, 33 and 24 pairs of observations respectively. The regressions of yield at different lactations in the same sequence on age at first calving were 1.401, -0.01, 0.07, 0.49, 1.48 and 3.91 lbs. The correlation of age at first calving on first lactation yield was found to be highly significant and the regression of yield in the first lactation on age at first calving was estimated to be significant. Whereas the rest estimates were not significant.

Effect of age at first service :-

As evident from Table (166) the correlation between age at first service and first lactation yield and the regression of the latter on the former were 0.261 and 1.078 lbs. respectively. Both the estimates were significant at 63 degrees of freedom.

Effect of lactation length

A highly significant correlation coefficient as large as 0.619 for 412 degrees of freedom was obtained between lactation period and yield. The regression of lactation yield on lactation length was calculated to be 8.320 lbs. and it was also highly significant (Table 166).

To further see the effect of lactation length on lactation yield the same lactation periods were divided into nine groups having a class interval of 30 days with upper class limit of

first group being 210 days and the lower limit of the last group to be 421 days. The mean lactation yields for different lactation period groups are presented in the Table (170). From the perusal of the Table and figure (10) it is clear that there was a sharp increase in the mean lactation yield in each and upto fifth group. Between sixth and seventh group there was very slight difference but in eighth group there was again a sharp increase and the last group had the highest mean lactation yield. Analysis of variance was run as given in the Table (171) and it was observed that mean yields of different groups differed from each other to a highly significant extent.

TABLE (170)

TABLE SHOWING EFFECT OF LACTATION PERIOD ON LACTATION YIELD

Sl. No.	LACTATION PERIOD IN DAYS	LACTATION YIELD IN POUNDS			
		No.	Av.	S.E.	C.V.
1	Below 210	30	1511.6	96.1	34.8
2	211-240	34	1948.4	125.3	37.5
3	241-270	52	2482.1	110.4	32.0
4	271-300	60	2711.6	98.8	28.2
5	301-330	66	3030.9	96.6	25.9
6	331-360	59	3220.5	107.1	25.5
7	361-390	39	3233.4	154.0	29.7
8	391-420	38	3724.9	184.9	30.6
9	421 and above	36	3936.5	165.7	25.2

TABLE (171)

ANALYSIS OF VARIANCE TABLE SHOWING THE EFFECT OF LACTATION PERIOD ON LACTATION YIELD

SOURCE	D.F.	S.S.	M.S.	F.
Between groups	8	176023948.09	22002993.51	31.6**
Error	405	281561289.50	695213.06	
Total	413	457585237.59		

Table (172) incorporates the analysis of variance and coveriance for genetic correlation between lactation period and yield for 171 half sibs of 6 bulls and it was estimated to be 0.239.

Effect of dry period

The correlation and regression of lactation yield on preceding dry period of the order of 0.009 and 0.083 lbs. were obtained for 296 degrees of freedom and were not significant. This was further confirmed when the analysis of variance (Table 174) was run to test the differences among mean lactation yield of eight groups of preceding dry period having class interval of 30 days. From the perusal of the Table (173) it is evident that animals having dry periods less than 30 days yielded least in the subsequent lactation. With the increase of each 30 days in the preceding dry period there was a substantial increase in the yield upto sixth group excepting the fourth in which there was slight fall. However, in seventh and eighth groups it tended to decline.

TABLE (173)

TABLE SHOWING EFFECT OF DRY PERIOD ON SUBSEQUENT LACTATION YIELD.

S. No.	DRY PERIOD	SUBSEQUENT LACTATION YIELD NO.	AV.	S.E.	C.V.
1	Below 30	5	2348.7	446.3	42.4
2	31-60	16	2565.8	174.0	27.1
3	61-90	25	2765.4	211.7	38.0
4	91-120	31	2771.4	144.5	29.0
5	121-150	60	2886.0	137.0	36.7
6	151-180	43	3157.2	145.4	30.2
7	181-210	21	2897.7	263.9	41.7
8	211 and above	97	2873.7	112.6	38.6

TABLE (174)

ANALYSIS OF VARIANCE TABLE SHOWING THE EFFECT OF DRY PERIOD ON SUBSEQUENT LACTATION YIELD.

SOURCE	D.F.	S.S.	M.S.	F.
Between groups	7	6891746.56	984535.22	0.92
Error	290	310253885.03	1069840.98	
Total	297	317145631.61		

The genetic correlation between dry period and subsequent lactation yield was calculated for 115 half sibs of 5 bulls and the analysis of variance and coveriance is presented in the Table (175). It was estimated to be 0.227.

ANALYSIS OF VARIANCE AND COVARIANCE FOR GENETIC CORRELATION BETWEEN SERVICE PERIOD (X) AND CURRENT LACTATION YIELD (Y)

SOURCE	D.F.	X		Y		XY	
		S.S.	M.S.	S.S.	M.S.	S.P.	M.P.
Between bulls	5	170769.87	34153.97	30143410.88	6028682.17	1593607.3	31872.4
Within bulls	134	2053964.67	15328.09	96827945.05	722596.60	4820160.3	35971.3
Total	139	2224734.54		126971355.93		6413767.6	

TABLE (172)

ANALYSIS OF VARIANCE AND COVARIANCE FOR GENETIC CORRELATION BETWEEN LACTATION PERIOD (X) AND YIELD (Y)

SOURCE	D.F.	X		Y		XY	
		S.S.	M.S.	S.S.	M.S.	S.P.	M.P.
Between bulls	5	146529.8	29305.96	625482472.25	125096494.45	2287308.9	457461.78
Within bulls	165	723516.3	4384.94	138658812.43	840356.43	5869189.9	35570.84
Total	17/	870046.1		764141284.68		8156498.8	

TABLE (175)

ANALYSIS OF VARIANCE AND COVARIANCE FOR GENETIC CORRELATION BETWEEN DRY PERIOD (X) AND SUBSEQUENT LACTATION YIELD (Y)

SOURCE	D.F.	S.S. X	M.S.	S.S. Y	M.S.	S.P. XY	M.P.
		S.S.	M.S.	S.S.	M.S.	S.P.	M.P.
Between bulls	4	50516.7	12629.17	28078111.79	7019527.92	109231.2	27307.80
Within bulls	110	1184924.1	10772.03	82933278.39	753938.89	304756.1	2770.51
Total	114	1235440.8		111011390.18		413987.3	

Effect of calving interval

The correlation and regression of 1st lactation yield on first calving interval were highly significant for 65 degrees of freedom and were estimated to be 0.434 and 3.348 lbs. respectively (Table 166)

Heritability

The heritability estimate of lactation yield was calculated to be 0.2920, 0.7148 and 0.5194 by paternal half sib, intra sire regression and correlation methods respectively. The first estimate was based on 51 half sibs of 3 sires (Table 176) and the remaining two on 22 dam daughter pairs (Table 177).

Table (176)

ANALYSIS OF VARIANCE TABLE FOR HERITABILITY ESTIMATE OF LACTATION YIELD BY PATERNAL HALF SIB CORRELATION METHOD

SOURCE	D.F.	S.S.	M.S.	E.M.S.
Between bulls	2	4697044.71	2348522.35	$\sigma_e^2 + 13.450\sigma_s^2$
Within bulls	48	54334080.68	1131960.01	σ_e^2
Total	50	59031125.39		

$\sigma_e^2 = 1131960.01$ $\quad h^2 = 0.2920$

$\sigma_s^2 = 90450.73$

TABLE (177)

ANALYSIS OF VARIANCE AND COVARIANCE FOR HERITABILITY ESTIMATE OF LACTATION YIELD

SOURCE	D.F.	S.S.(X)	S.P.(XY)	S.S.(Y)
Between sires	1	244639.37	-724130.53	1981432.43
Within sires	20	19610953.27	7009917.96	37136312.94
Total	21	19675592.64	6285787.43	39117745.37

$b = \frac{7009917.96}{19610953.30} = 0.3574$ $\quad r = \frac{7009917.96}{26966635.5} = 0.2597$

$h^2 = 2 \times 0.3574 = 0.7148$ $\quad h^2 = 2 \times 0.2597 = 0.5194$

Repeatability

Analysis of variance on 232 lactation records of 61 cows was run as shown in the Table (178), to calculate the repeatability of lactation yield and was found to be 0.385.

TABLE (178)

ANALYSIS OF VARIANCE TABLE FOR REPEATABILITY

SOURCES	D.F.	S.S.	M.S.	E.M.S.
Between cows	60	122087726.18	2034795.43	$\sigma_e^2 + 3.79\sigma_c^2$
Within cows	171	103029035.36	602508.97	σ_e^2
Total	231	225116761.54		

$\sigma_e^2 = 602508.97$ $\quad R = 0.385$

$\sigma_c^2 = 377911.99$

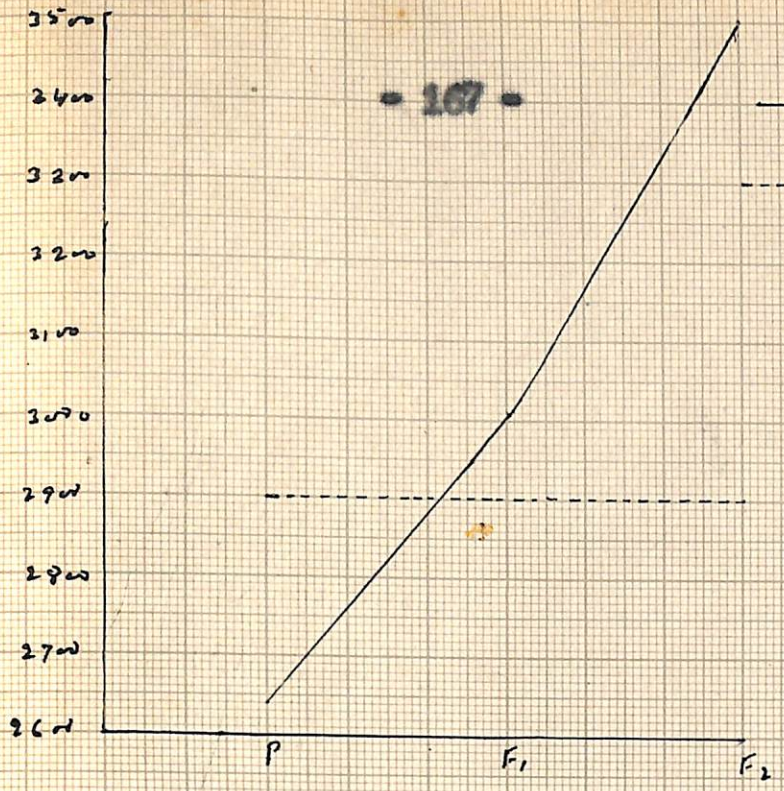
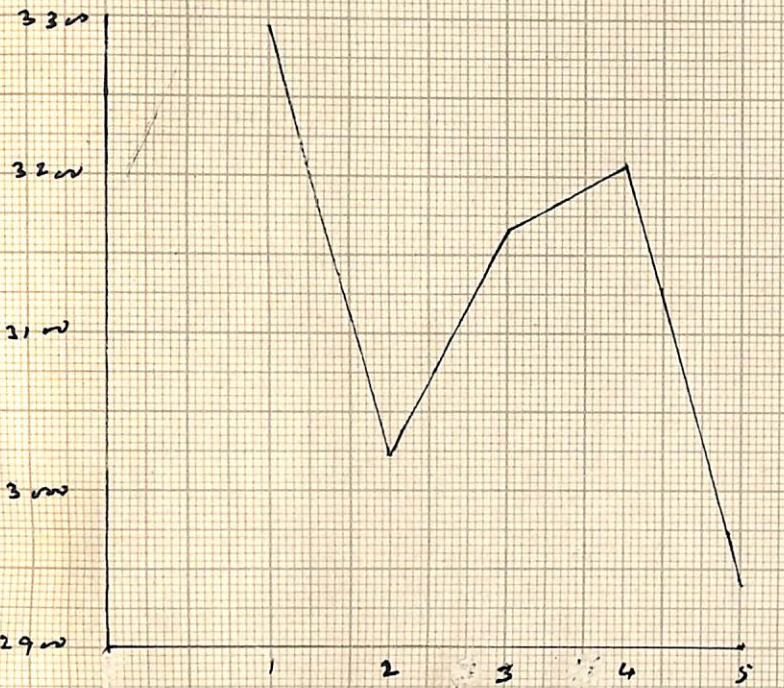


Fig. 9
Generations
Herd

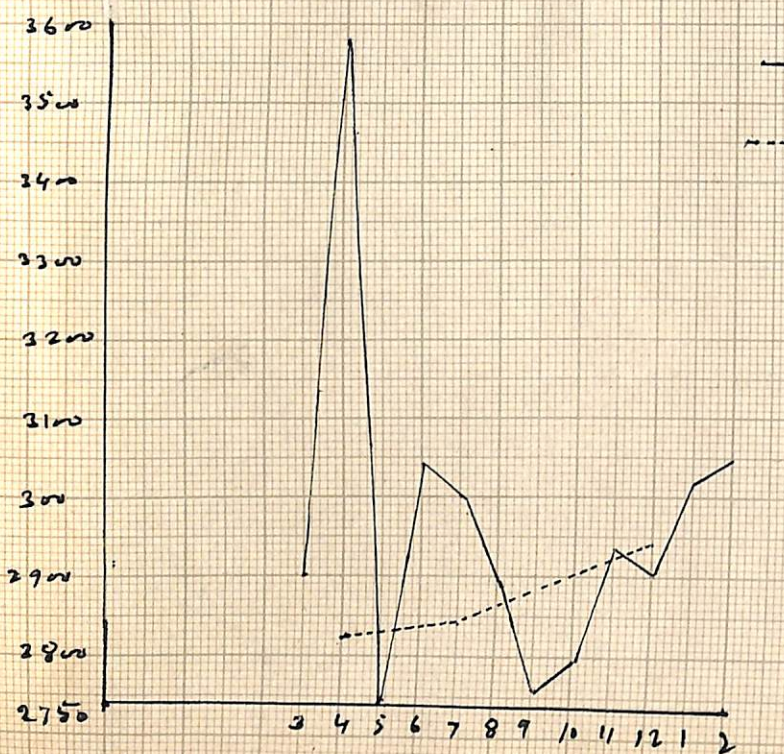
Graphical representation of mean lactation yield in different generations.

Generations



Graphical representation of the effect of sequence of calving on mean lactation yield.

Lactations

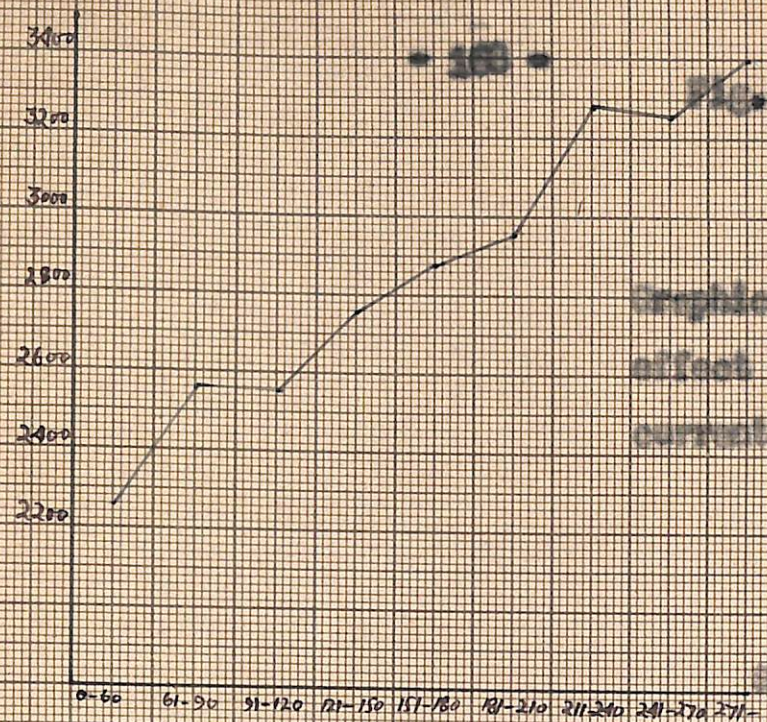


In the Season

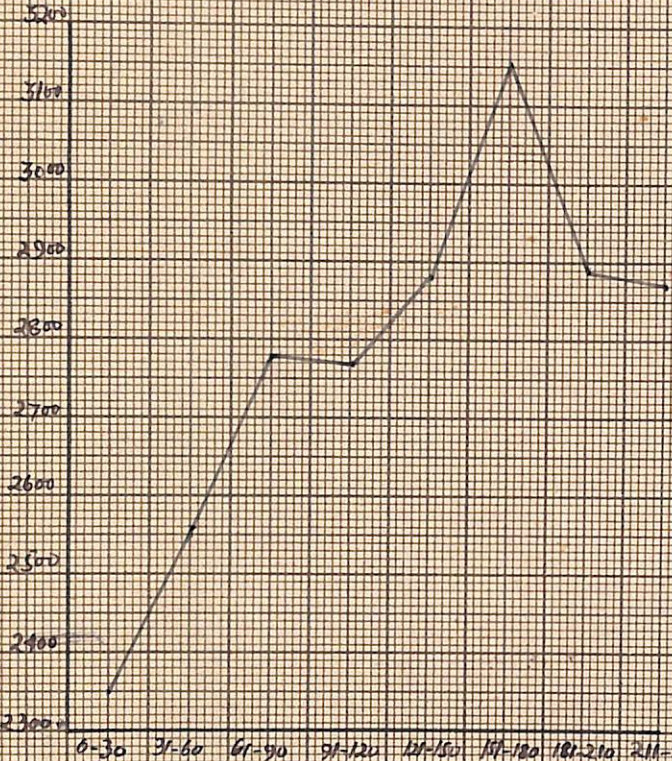
Graphical representation of the effect of season and month of calving on mean lactation yield.

Months

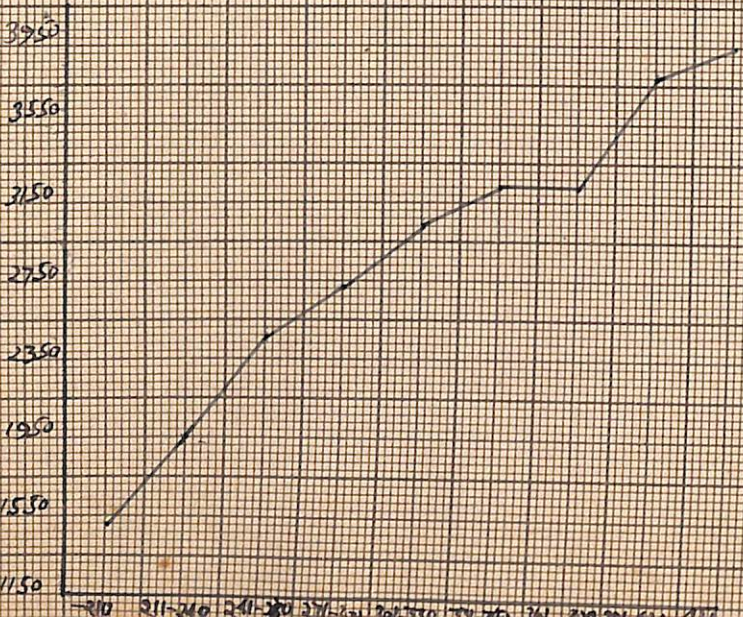
Fig. 10.



Graphical representation of the effect of service period on current lactation yield.



Graphical representation of the effect of dry period on subsequent lactation yield



Graphical representation of the effect of lactation period on lactation yield

CHAPTER - V

DISCUSSION.

CHAPTER - V

DISCUSSIONS

(1) GESTATION PERIOD

Averages

The mean gestation length of foundation, first, second generations and the herd were worked out to be 282. 5 ± 0.7, 281.9 ± 0.8, 280.7 ± 1.5 and 281.9 ± 0.5 days respectively. There are no published results on the gestation period of Deoni breed and hence results of present investigation could not be compared. Usually the gestation period ranges between 276 to 295 days in different breeds of cattle. However, the present finding was in close agreement with that of Tessier (1817), Gillard & Drumm (1924), Knott (1932), Lush (1945) for temperate breeds and Villares & Abreu (1948) for Kankrej. It may be noted that the gestation period for Deoni cows obtained was considerably much lower than most of the estimates reported on Indian cattle. This might be due to as suggested by Lush (1945) that the length of gestation period is a breed characteristic within species partly due to differences in the genetic make up of the individuals belonging to the same species and partly due to environmental factors.

The presently obtained estimate was shorter by 2 to 4 days than most of the temperate breeds and was in contradiction to the general belief that the gestation period of Bos indicous is considerably longer than that of Bos taurus. Similar conclusions were made by Lazarus & Anantakrishnan (1952) and Kohli & Suri (1957a).

Further the estimate did not agree to the belief supported by Lazarus & Anantakrishnan (1952) and Kohli & Suri (1957a) that dual purpose breeds carry their younge longer than the dairy breeds.

The coefficients of variation obtained for the three generations and the herd were 4.0%, 4.0%, 4.7% and 4.2% respectively. Similarly low coefficients of variation for gestation period of Hariana and Shahabadi cows as 5.3%, 6.1%, 5.0% and 4.7% were obtained by Singh (1964). These very low coefficients of variation for gestation period strongly suggested that gestation lengths were subjected to least variations (Asdell 1946 and Van Demark & Salisbury 1950).

Comparative study

There had been no material change in the gestation length through successive generations.

Effect of sex

A difference of approximately 2 days between the duration of in 'utero' period of male and female calves was found to be not significant. Hence a conclusion may be drawn that the sex of the calf had no influence upon the gestation period of its dam in these animals. Similar observations were made by Wing (1899), McCandlish (1922), White (1934), Weaver and Wettstein (1947), Regab & Asker (1951) and Van Graan & Joubert (1961) for temperate breeds and Briquet & Abreu (1948), Villares & Abreu (1948) and Singh et al (1958) for Zebu cattle. However, the present finding failed to collaborate the reports of Fitch et al (1924), Copeland

(1930), Knott (1932), Knoop & Hayden (1934), Littlewood (1937), Jordao and Veiga (1938), Dave (1941), Livesay & Bee (1945), Kumaran (1947), Veiga et al (1947), Long et al (1948), Ward & Castle (1948), Braunde and Walker (1949), Jafar et al (1950), Chaudhry & Sinha (1951), Jordao et al (1951), Lambardt (1951), Ragab & Asker (1951), Burris & Blunn (1952), Lazarus & Anantakrishnan (1952), Kohli & Suri (1957a), Singh & Ray (1961), Dannaoury & Bayaumi (1962) and Goswami et al (1963).

Effect of sequence of calving

There was no influence of sequence of calving on gestation length. Thus supported by McCandlish (1922), Copeland (1930), Knapp et al (1940), Weaver et al (1947), Braunde & Walker (1949), Jafar et al (1950), Ragab & Asker (1951), Lambardt (1951), Burris & Blunn (1952), Lazarus & Anantakrishnan (1952), Singh et al (1958), Singh & Ray (1961) and Dannaoury & Bayoumi (1962) the present finding failed to confirm the observations of Knott (1932), Knoop & Hayden (1934), Dinkhauser et al (1944), Herman & Spalding (1947), Ghanem et al (1955), Kohli & Suri (1957a), Van Graan & Joubert (1961) and Goswami et al 1963). Since sequence of calving is a form of interpreting the age of the animals, it may follow that age did not affect the length of gestation period in these animals.

Effect of month of freshening

Rainy, summer and winter calvers carried their youngs for a period of 282.9 ± 1.0, 282.6 ± 1.2 and 281.3 ± 0.7 days with coefficients of variation of 3.8%, 4.6% and 3.9% respectively. The effect of season was not significant. Similar observations were made by McCandlish (1922), Copeland (1930), Knapp et al (1940), Jakubec (1941), Dinkhauser (1944), Ward & Castle (1948),

Jafar et al (1950) and Burris & Blunn (1952) for temperate breeds and Lazarus & Anantakrishnan (1952), Briquet & Abreu (1948), Singh et al (1956), Singh & Ray (1961) and Goswami et al (1963) for Zebu cattle. The result may be explained on the basis of stable feeding conditions of the farm. There was significant difference among the means of months and this result was confirmed by the observations of Chaudhry & Sinha (1951), Kohli & Suri (1957a) and Prabhu (1961).

Effect of sire of the calf

In the present investigation there was a highly significant effect of sire of the calf on its intra uterine life. Similar findings were reported by Knott (1932), Rife et al (1943), Bonadonna & Valerani (1946), Rife (1948), Alexander (1950), Jafar et al (1950), Regab & Asker (1951), Lazarus & Rangaswamy (1952), Brakel et al (1952), Wheat & Riggs (1952), Chanen et al (1955), Kohli & Suri (1957a) and Dannaoury & Bayoumi (1962). This suggested that some sires caused their calves to pass a greater period in dam's womb than average and vice versa.

Effect of dam of the calf

The effect of dam on gestation length has also been found highly significant in the present study. It is in agreement with the reports of Knapp et al (1940), Jafar et al (1950) and Dannaoury & Bayoumi (1962). However, Lazarus & Anantakrishnan (1952) found that there was not significant variation in the length of gestation period between individual cows of the same breed. The tendency of some cows to carry their calves longer than average might be due to differences in the genotypes of the cows and uterine environment.

Heritability

The heritability estimate of questionable reliability of the magnitude of 0.16 has been obtained for the gestation period as it was based on very small number of half sibs and sire groups (Lush 1948).

Repeatability

The repeatability as low as 0.061 has been obtained which is almost zero.

As the repeatability estimate is based on comparatively larger data and taking into consideration all the records available on the cow, it may be regarded as reliable (Lush 1945). Whereas the heritability estimate was based on extremely small sire groups, its reliability would be uncertain (Lush 1948) and further as it was higher in magnitude than repeatability, it may be considered the attribute of sampling variation and the probable estimate was zero. The zero repeatability of gestation period for these animals suggested that the hereditary differences of the cows were not at all the contributing factor for their gestation periods and this would be a sort of contrediction to the present finding of highly significant differences among maternal half sibs. Further the zero repeatability indicated that the magnitude of permanent environmental factors were also negligible and all that present were temporary. This might be due to greater magnitude of maternal effects so that the hereditary and permanent environmental contributions had become negligible as repeatability is the ratio of two variances. The highly significant differences among paternal half sibs may be indicative of the fact that genotypes of the calves were determiners of the length of gestation. Jafar et al (1950) concluded that the genotype of the calf was responsible for 48% of total variance.

However, it may be concluded that the gestation period in these cows was highly dependent upon environmental factors and any attempt for reduction based on mass selection would be futile.

(2) BIRTH WEIGHT

Averages:

The average birth weight of calves born from foundation, first, second generation cows and for the herd were 48.2 ± 0.6, 48.8 ± 0.6, 50.4 ± 0.9 and 48.8 ± 0.3 lbs. respectively. Joshi (1963) studying the Deoni animals maintained at Hingoli and Rajendranagar Farms obtained the mean birth weight of calves as 41.1 ± 0.71 and 49.33 ± 0.36 lb respectively and 46.06 ± 0.43 lbs. for both the herds combined. It may be noted that the average obtained by Joshi (1963) for Rajendranagar Farm was almost similar to that obtained in the present study. However, he obtained lower estimate at Hingoli Farm. The reason for this may be that the animals of Hingoli Farm were originally purchased ones from the breeding tract. The selected group of animals were transferred from this farm to Rajendranagar Farm. This may be the contributing factor for higher estimate of birth weight in the herd under study.

The coefficients of variation estimated were 19.5 %, 17.4%, 16.6% and 18.3 % respectively. Slightly lower coefficients of variation were obtained by Batra (1961) for different herds of Sahiwal cows : 8.8%, 12.7%, 12.4% and 11.3%. The slightly higher variation in this herd may be attributed to different feeding and managemental practices that may have existed in different farms and also may be due to hereditary differences.

Comparative study

There was an increase in birth weight of calves born in successive generations. But this increase was not significant.

The effect of sex

The birth weight of male and female calves was estimated to be 49.9 ± 0.54 and 47.7 ± 0.57 lbs. The male calves exceeded

the opposite sex by 2.2 lbs. and the difference was highly significant. This finding was supported by Eckles (1919), McCandlish (1922), Fitch et al (1924), Morrison (1936), Littlewood (1937), Knapp et al (1940), Dave (1941), Rhoad et al (1945), Knapp & Nodskog (1946), Dawson et al (1947), Tyler et al (1947), Veiga, et al (1948), Braunde and Walker (1949), Gregory et al (1950), Lazarus and Rangaswamy (1950), Dave (1950), Chaudhry & Sinha (1951), Sharma et al (1951), Asker & Ragab (1952), Anantakrishnan & Lazarus (1953), Jobert & Bonsma (1957), Kohli & Suri (1957b), Singh & Desai (1959), Singh & Dutt (1961) and Batra & Desai (1962).

The effect of sequence of calving

Birth weight of calves increased from first calving to second. The calves born in third calving had similar weight and from fourth calving onwards there was a decreasing trend up to fifth. The effect of sequence of calving was significant. Eckles (1919), McCandlish (1922), Fitch et al (1924), Krasnov & Pak (1937), Knapp et al (1940), Dinkhauser et al (1944), Dawson et al (1947), Verge (1948), Braunde & Walker (1949), Asker & Ragab (1952), Burris & Blunn (1952), Anantakrishnan & Lazarus (1953) and Batra & Desai (1962) all obtained significant effect of sequence of calving or age of dam on birth weight. Sequence-sex interaction in the present investigation was not significant which indicated that the differences in birth weights of male and female calves separately at different calvings was not significant. The increasing trend of birth weight initially and thereafter a decreasing tendency may be due to increase in dam's weight as they advance in age and approach maturity followed by ageing process.

Effect of month of freshening

Month of freshening of dam did not have any significant effect on the birth weight of the calves. The result was in agreement with the findings of UmanYu (1933), Knapp et al (1940), Dinkheuser et al (1944), Tyler et al (1947), Braunde & Walker (1949), Abreu (1949), Asker & Ragab (1952), Burris & Blunn (1952), Anantakrishnan & Lazarus (1953) and Kohli & Suri (1957b). The main effect of the month of calving would lie in that the seasons of the year differ in the kind of pasture, feeds and temperature. The first two factors are most important in this respect. In the herd under study the feeding practice was stable throughout the year and this might be the probable reason of absence of influence of month.

Effect of sire of the calf

The differences between sire groups were highly significant. In otherwords, some sires tended to produce heavier calves while others lighter ones than the average. However, this finding was in agreement with the results obtained by Abreu (1949), Asker & Ragab (1952) and Anantakrishnan & Lazarus (1953) but Eckles (1919), Burris & Blunn (1952) and Kohli & Suri (1957b) reported to the contrary.

Effect of dam of the calf

Maternal half sibs differed highly significantly. Abreu (1949) reported a significant effect of cow on birth weight of calf.

Effect of weight of dam at calving

The coefficient of correlation of 0.024 was obtained between body weight at calving of dam and birth weight of calf

but it was not significant. The estimate was as good as zero. Eckles (1919), McCandlish (1922), UmenYu (1933), Krasnov & Pak (1937), Munoz & Rigor (1940), Knapp et al (1940), Tyler et al (1947), Gregory et al (1950), Anantakrishnan & Lazarus (1953) and Batra & Desai (1962) showed that the weight of the dam influenced the birth weight of calf. The possible explanation for not getting presently any association between birth weight of calf and weight at freshening of the dam may be that the data under this study comprised of weight of dams at all calvings. As has been shown earlier the age of the dam in terms of lactation order influenced the birth weight of calf upto certain age and after that there was a decreasing trend. This decreasing trend of birth weight of calves due to older age of the dam might have balanced the increasing effect during early age. Similarly, Batra & Desai (1962) while studying the effect of weight of dam at freshening on birth weight of calves in Sahiwal cattle observed that the birth weight of calves increased consistently upto the age of seven years of the dam and it did not show this trend afterwards.

Effect of gestation length

A value of 1.407 was obtained as a correlation coefficient between gestation period and birth weight of calf. Such an estimate might be due to experimental error.

Effect of preceding dry period

A correlation coefficient of 0.037 was obtained between birth weight of calf and preceding dry period of the dam. The estimate was not significant and was almost zero. The present finding supported the observation of Anantakrishnan & Lazarus (1953). On the contrary Umen Yu (1933), Krizenecky & Kudlicka

(1944) found positive correlation between the length of preceding dry period and birth weight of the calf. The influence of preceding dry period on birth weight of calf is a matter of nutrition of the dam. Since dry period acts as a rest period during which the cow restores the energy lost due to the strain of lactation and since most of the foetal development occurs during later half of the pregnancy the energy received during dry period may be diverted to foetal development. However, larger dry periods do not mean proportionately higher birth weights as there is limit for the storing capacity of energy by the cow. Longer dry periods included in the study might be the probable reason for low correlation between preceding dry period and birth weight of calf.

Heritability

The heritability estimates of birth weight obtained for male, female and both sexes together by paternal half sib correlation method were 0.792, 0548 and 0.624 respectively. The estimates obtained by intra sire regression of daughter on dam were 0.166, 0.058 and 0.152 for male, female and both sexes respectively. The heritability estimates obtained by intra sire correlation were 0.179, 0.065 and 0.171 respectively for male, female and both sexes together. The estimates by paternal half sib correlation method were very high compared to those obtained by intra sire regression of daughter on dam or correlation methods. The possible explanation for such differences has been advanced by Lush (1948). He observed that the covariance between half sibs is to be multiplied by four in order to get the estimate of heritability. This magnifies any error that may have been present in

Repeatability

The repeatability of birth weight was estimated to be 0.34. Batra & Desai (1962) obtained slightly higher repeatability.

The higher repeatability estimate compared to heritability indicated that permanent environmental effects were higher. As the maternal half sibs differed highly significantly, it appears that intra uterine environment was rather important. Further the lighter calves from early calvings and low magnitude of heritability indicated that birth weight was mainly an expression of the size, weight, nutrition and physiological condition of the dam rather than the foetus, although the genotype of the latter did have some effect as individual sires and dams considerably affected the birth weight of calves.

(3) AGE AT FIRST SERVICE

Averages:

The herd average for age at first service was calculated to be 1208.8 ± 27.6 days with 21.5% coefficient of variation. Rajagopalan (1962) obtained an average age at first heat in Red Sindhi and Kangayam to be 1030.6 ± 35.3 and 1114.7 ± 45.9 days respectively.

Comparative study.

There was an increasing trend in the age at first service through different generations. However, the differences were not significant.

Heritability

The estimates of heritability by paternal half sib correlation, intra sire regression and correlation methods were 1.712, -0.8562 and -0.5702 respectively. First estimate was meaningless for any practical purposes. The negative estimates might be due to sampling errors. However, this was indicative of sampling about zero. Hence, age at first service in these animals was non-heritable and reduction would be brought about solely by best nutrition and management. As the estimates were based on extremely small number of dam daughter pairs and hence might not be reliable (Lush 1945) and should be confirmed on larger data.

(4) AGE AT FIRST CALVING

Averages :

The average age at first calving for the herd obtained was 1577.8 ± 24.9 days. Averages observed for the trait by Joshi (1963) were 1648.5 ± 57.21, 1430.66 ± 54.008, 1504.59 ± 34.55 and 1504.0 ± 25.80 days respectively for Deoni cows maintained at Udgir, Hingoli, Rajendranagar Farms and all the three Farms together. The present estimate also fell within the range. The average age at first calving of these cows was higher than most of the tropical breeds but was similar to age at first calving of Hariana cows reported by Sharma et al (1951) and Johari & Talpatra (1957).

The coefficient of variation was 14.6%. Ahmad (1961), Batra (1961), Kohli et al (1961a) and Singh & Desai (1961a) observed the coefficients of variation that ranged between 12% to 21%.

Comparative study

There was an increasing trend through the successive generations but the variations were not significant.

Effect of season and month of birth

The effect of season and month of birth was not significant and thus the present study confirmed the finding of Damasoury & Bayoumi (1962). Nutrition in early stages of life is of much importance as the growth rate is high during this period. Any reduction of nutrition in the active growing stage may result in slower growth, late maturity and even stunting. McCay et al (1939) experimenting on rats observed permanent stunting if reduction in growth rate was made early in life. Uniform feeding practice observed in the Farm might be responsible for the finding investigated.

Effect of birth weight

The correlation coefficient between birth weight and weight at first calving was almost zero. This might be due to the inclusion of lower birth weights and that a particular trend might have existed after certain limit of birth weight. Batra & Desai (1962) studying Sahiwal cows reported that when all the birth weights were taken into consideration the correlation coefficient between birth weight and age at first calving was practically zero. They found that birth weights above 42 lbs. showed a declining trend on age at first calving.

Effect of age at first service

A very pronounced association of age at first service and age at first calving was obtained as the correlation and regression coefficients were 0.921 and 0.881 days respectively and both were highly significant.

Heritability

The heritability estimates obtained by paternal half sib correlation, intra sire regression of daughter on dam and intra sire correlation methods were 1.9420, -0.2924 and -0.2186 respectively. Since first estimate was above unity it was meaningless for any practical purposes. Such a high estimate might be due to sampling variations as the degree of freedom for within and between sires was extremely low. Negative estimates might be due to sampling errors. However, they are indicative of sampling about zero. Similar estimates were obtained by Singh (1957) for Tharparkar, Amble et al (1958a) for Red Sindhi, Kanagavam and Gir, Kohli et al (1961) and Singh (1964) for Hariana. Since the heritability was zero as such the trait was non-heritable in these animals and whatever variations were present among the animals may be solely attributed

to environmental conditions and managemental practices. Mass selection would fail in reducing the age at first calving and it may be lowered mainly by getting calves of higher birth weights, high level of nutrition, early detection of heat and conception. Johari & Talpatra (1957) conducted an experiment on Hariana cattle in order to see the effect of nutrition on age at first calving and observed that animals which were fed on a balanced ration consisting of concentrates, a dry and little green roughage matured much earlier than those kept in the same plane of nutrition on all roughage (green berseem and bhusa) otherwise adequate ration. They pointed out that the deficiency of phosphorus and a wide ratio of Ca: P in all roughage ration was the probable cause of delayed maturity in the roughage fed group.

However, the estimates were based on extremely small number of dam daughter pairs and hence they had questionable reliability (Lush 1945). There is overwhelming need of confirmation of these estimates on larger data that would gather in the course of breeding.

(5) WEIGHT AT FIRST CALVING

Averages :

The herd average for weight at first calving was estimated to be 821.3 ± 15.8 lbs. with 12.5% coefficient of variation. Rajagopalan (1952) observed this trait to be 551.5 ± 15.3 and 590.2 ± 10.9 lbs. for Red Sindhi and Kangayam respectively. Present estimate was much higher. Such differences might be due to different managemental practices of the herds or breed characteristics.

Comparative study

Differences of weight at first calving through different generations were not found to be significant.

Effect of birth weight

The correlation coefficient of weight at birth and weight at first calving was not significant and was of the order of 0.094 which was as low as zero.

Effect of age at first calving.

The correlation coefficient between age at first calving and weight at first calving was to be found 0.006 and that was not significant.

Heritability

A heritability estimate of -0.2152 for weight at first calving was obtained by paternal half sib correlation method. The estimate may be considered zero and indicated that reduction in this trait was a matter of management and nutrition rather than inheritance.

(6) SERVICES REQUIRED PER CONCEPTION

Averages

The average services required per conception were worked out to be 1.36 ± 0.03, 1.68 ± 0.06, 2.09 ± 0.16 and 1.55 ± 0.03 respectively for foundation, first, second generations and the herd respectively. No published results are available on Deoni animals for the comparison of the present findings. However, study of the literature indicated that the mean services required per conception for different breeds worked out by various workers were as low as 1.24 (Singh 1964) and as high as 2.33 (Davis & Benjamin 1953). The estimates presently obtained were well within the reported range. Mean number of services per conception very close to the herd average in the present investigation were found by Perry et al (1945), Bhattacharya & Prabhu (1955), Panasenko (1959) and Ahuja et al (1961). However, the herd average was not very high still it may be taken as appreciably high.

The coefficient of variation of the means (53.6%, 55.3%, 71.3% and 61.5%) were indicative of high variations among different generations.

Comparative study

There was an increasing trend in mean values through different generations and all the increases were highly significant. This clearly indicated that with the generation the reproductive efficiency of cows in terms of services per conception has gone down. It has been decided to improve the performance of these animals instead of by selective breeding of the farms. The contradictory result of the effect of month to that of season might be due to the inclusion of different months having lower and higher means among seasons in such a way there was no appreci-able difference.

Heritability

The heritability by paternal half sib correlation method for services per conception was calculated to be 0.52. It may be noted that the estimate was based on extremely small number of half sibs and sire groups. Lush (1948) has pointed out that the accuracy of heritability estimate by paternal half sib method using sire component depends largely on the number of sires and to a less degree on the number of offspring per sire. The method may also be considered to be reliable if the sires be considered as random samples of unselected population. Sampling and non-random errors are increased by four with the half sib estimate of heritability. Taking into account the extremely small number of sires used for the estimate and its much higher magnitude compared to repeatability estimate (which is zero) it may be assumed that the estimate cannot be considered reliable.

Repeatability

The repeatability estimate for services per conception was found to be 0.084 which was almost zero. This meant the prediction of number of services a cow would require for conception in subsequent calvings would not be done as there was very less contribution of heredity and permanent environment on the trait and was mostly depended upon the temporary environment. Similar estimates were obtained by Legates (1945), Dunbar & Henderson (1950), Ragab et al (1956) and Singh (1961).

Thus any attempt to select the animals for better breeding efficiency on the basis of phenotype would be futile. The rigid control of managemental practices i.e. keeping close eye on the cow after parturation for correct diagnosis of

subsequent heat, the use of teaser bulls for detection of heat, natural or artificial service at the proper time of heat period, technical efficiency on the part of inseminator, high quality semen, and better transporting arrangement of the latter would be required to improve it.

(7) POST PARTUM INTERVAL TO FIRST SERVICE

Averages:

The average post-partum interval to first service as obtained in this study for foundation, first, second generations and the herd were 166.8 ± 7.9, 158.5 ± 6.8, 179.0 ± 12.8 and and 165.5 ± 4.9 days in the order mentioned. There is no published work so that the above estimates may be compared. The intervals as large as and even greater than these were obtained while working on different breeds by workers Nazarano (1954), Kohli & Suri (1957a & 1960) and Singh (1964). However, the estimates were higher in this herd as compared to the results achieved by other workers. The probable reason for the delayed occurence of the first oestrous following parturation would be the practice of unweaning the calves exercised in this farm. Clapp (1937) observed that cows that were milked twice a day, on an average, came into heat following calving earlier than did cows milked four times daily and nurse cows suckling the calves showed first oestrous after calving somewhat later than four times milked cows.

The coefficients of variations obtained and the present study were 56.0%, 57.7%, 58.3% and 65.1% respectively. Similarly the coefficients of variation obtained by Singh (1964) were as high as 65.3%, 73.5%, 61.1% and 66.9% for different herds.

Comparative study

There was no material change in successive generations with regard to this character. It may be due to constant and similar managemental practices for example the unweaning of calves was practised throughout the period that was under study.

Effect of sequence of calving

The present investigation revealed that the first interval between calving and subsequent heat was longest than any of the succeeding ones and there was a decreasing trend upto sixth lactation with the exception in fourth where there was a sharp rise. Effect of sequence of calving was highly significant on the interval. The present findings substantiated the results of Herman & Edmondson (1950), Hafez (1952), Kohli & Suri (1957) and Singh (1964). The possible reasons for longest post partum interval to first service during first lactation may be initial suckling stimulus, depressing effect of high output on ovulation (Hammond 1727 and Basu 1962) and the general practice of deliberately delaying the first service in order to avoid stunting growth of the heifer. From second lactation ~~lactation~~ onwards there was a decreasing trend in the interval upto sixth lactation with a sharp increase in fourth. This declining trend was exactly the same as lactation yield trend. Keeping constant the suckling stimulus the trend may be explained as follows. Due to lack of persistancy, and effect of pregnancy in the second half of the normal lactation period the major part of the yield is obtained in the first half. The greater the yield in the first half period more would be the lactation yield. Then it may be possible that for higher lactation yield the nutrients fed go more for production of milk than for reproduction (Basu, 1962), thus causing a delay in the occurrence of first heat after parturation depending upon the lactation yield.

Effect of season and month of calving

Septembers calvers had the highest intervals whereas June calvers the lowest. However, this finding was not in agreement with Kohli & Suri (1957) who recorded highest and lowest interval

in April-May and September respectively. The effect of month and season was not significant and confirmed the finding of Herman & Edmondson (1950) and contradicted the observation of Kohli & Suri (1957). No relationship of season and month with the interval might be due to uniform feeding practice throughout the year.

Heritability

The heritability estimate obtained by paternal half sib correlation method was 0.532 while that obtained by intra sire regression of daughter on dam and correlation methods were 0.059 and 0.0438 respectively. The last two estimates may be considered zero and they agreed with the observations of Carman (1955). The estimates of heritability by different methods were as low as zero and as high as 53.2%. Such fluctuations may be due to sampling variation as the estimates were based on extremely small number of sire groups, half sibs and dam daughter pairs and may be considered unreliable (Lush 1945 & 1948).

Repeatability

The estimate obtained was 0.292 and fully agreed with that obtained by Olds & Seath (1953) and also closely with that observed by Carman (1955). Since the repeatability was based on much larger number of observations compared to heritability estimates with due consideration of all available records of a cow (Lush 1945) it may be considered as reliable. As the repeatability estimate was moderately high and in the absence of any certain estimate of heritability, it would be difficult to draw any definite conclusion regarding the extent of the inheritance of the interval from post-partum to first service. Hence there is strong necessity of the estimation of reliable heritability on larger data that would be obtained in the course of breeding.

(8) SERVICE PERIOD

Averages

The generation-wise average service periods were 202.5 ± 14.0, 196.4 ± 10.2, 274.0 ± 20.3 and 209.0 ± 9.2 days for foundation, first second generations and the herd respectively. Published information is lacking on average service period of Deoni cows. The service period found in the present study was high as compared to the results reported by workers on temperate and tropical breeds. However, few workers like Gains (1927), Edwards (1932), Sharma et al (1951), Dave (1958), Kohli & Suri (1960), Kohli & Acharya (1961), Kohli et al (1961b) and Carneiro et al (1962) obtained similar service periods or even higher. The possible reasons for high service period in the present study might be the late post-partum oestrous as investigated in the present study. The post partum interval to first service ranged between 158 to 179 days on an average. This fact along with managemental practice may be taken as contributing factors for high service period.

The coefficients of variations were 108.0%, 61.6%, 48.7% and 86.6% respectively. These very high coefficients would reveal that this trait was subjected to much variations. Similar conclusions were made by Asdell (1940) and Van Demark & Salisbury (1950). Prasad (1958) and Batra (1961) also obtained high coefficients of variation of the order 60.7% and 67.0% respectively.

Comparative study

Study of the trait in successive generations would clearly indicate the breeding and managemental practices that were followed in the herd. There was no material change in the mean service period of the first generation compared to foundation stock. It may follow that whatever managemental practices that were existing initially

were continued with the advance of time. Not only this but situation worsened in second generation stock to the extent that the service period increased from first generation with highly significant difference and it increased at 0.05% level even from the foundation stock. The longer service periods in successive generations may be due to highly significant increases in services required per conception.

Effect of sequence of calving

There was a highly significant effect of sequence of calving on service period and the first service period was longest than any of the succeeding ones followed by a decreasing trend upto fifth lactation with a sharp increase in fourth. The finding in the present study that first service period was longest than any of the subsequent ones fully agreed with the reports made by Sanders (1927), Sikka (1931), Ragab et al (1956), Venkayya &Anantakrishnan (1958), Batra (1961) and Kohli & Acharya (1961). The investigation of significant variation in service period at different lactations confirmed the findings of Prasad (1958) but was contradictory to the observations of Venkayya & Anantakrishnan (1958) and Kohli & Acharya (1961). The reason for accounting the longer service periods during first and fourth lactation may be due to the fact that the post partum interval to first service was highest during first lactation followed by a decreasing trend with a sharp increase during fourth lactation. Another reason would be the highest services per conception for second and fifth calvings.

Effect of season and month of calving

The effect of month and season of calving on service period in this study, was not significant and thus confirmed the findings of Prasad (1958) and Singh & Dutt (1963) while disagreed with Malik et al (1960) and Kohli & Suri (1960).

Heritability :

Very high estimates of heritability of service period by paternal half sib correlation, intra sire regression and correlation methods of the order of 0.692, 0.5088 and 0.3938 respectively were obtained. However, the validity of these estimates may be questioned as they were based on extremely small group of sires, half sibs and dam daughter pairs (Lush 1945 & 1948). Further the estimates were higher than the repeatability estimate for this character which was based on such high number of observations. Since the repeatability is the upper limit of heritability in theoretical sense such higher estimates may be treated as the consequences of sampling variations.

Repeatability

A repeatability as low as 13.2% was obtained for service period. Katre (1961) obtained a repeatability of approximately twice of the present estimate while Berge (1942) and Rasab et al (1956) obtained zero repeatability.

Taking the repeatability estimate to be more reliable as was based on larger observations with due attention to all available records of a cow (Lush 1945) and considering its magnitude i.e. 113.2% the probable low heritability would be indicative of non-heritable nature of service period. Hence the effective way of controlling the service period would be rigid managemental practices. However, the exact magnitude of heritability needs to be worked out on additional data that would be available in the course of time.

(9) DRY PERIOD

Averages :

The mean dry period of foundation, first, second generations and the herd were 212.5 ± 9.9, 178.8 ± 8.7, 231.2 ± 17.6 and 202.7 ± 0.5 days respectively. Kartha (1938) recorded the dry period for Deoni animals kept at Hingoli to be 121 and 113 days for home bred and farm bred stock respectively. However, these observations were based on extremely small number of observations. Except this no published information is available for comparison. The reason for these high dry periods may be the feeding and management practice of the farm.

The coefficients of variation were 66.6%, 58.8%, 51.0% and 64.8% in the order mentioned above. Similarly, Asker et al (1954), Batra (1961) and Singh & Desai (1962) obtained high coefficients of variation of dry period as 57.0%, 47.3% and 62.2% for Egyptian, Sahiwal and Hariana cows respectively. This high order of variation for dry period seems to be the feature of tropical cattle.

Comparative study

The significant reduction of dry period by 33.7 days in the first generation from the foundation stock indicated that care was exercised initially to reduce it but subsequently this aspect was overlooked and as such the mean dry period in the second generation stock rose above the foundation stock mean with highly significant difference from the first generation. The overall success of the policy relating to breeding and management can be studied by comparing the performance of cows belonging to successive generations. The comparative study made above would clearly indicate

the magnitude of success achieved. The highly significant increases in service periods at successive generations might be the cause of increase in dry periods in different generations as there was a highly significant correlation between service period and dry period.

Effect of sequence of calving

There was a decreasing trend of the mean dry period with the advance of lactation number. Similar results were obtained by Bhatnagar & Chaudhry (1960-61) and Batra (1961). However, Sanders (1927), Lonka (1946) and Jha & Biswas (1964) observed that the first dry period was shorter than any of the later ones while Sikka (1931) found on upward trend with the increase in age. In the present investigation the longer dry period during first and fourth lactation and the decreasing trend in the rest may be explained on the reasons that the dry period acts as a rest period for the cow to replenish the energy lost in the preceding lactation. Thus it may be expected that greater the lactation yield greater would be the rest period, on an average. In the present study, the yield was highest in first and fourth lactation with a decreasing trend in the rest ones.

Effect of season and month of calving

The absence of significant effect of season and month of calving on dry period may be expected on the basis of similar effect of season and month of calving on lactation yield and the uniform nutrition throughout the year that is practised in the herd under study. Joseph & Dave (1931) also observed that the length of dry period was not affected by the season of calving.

Effect of service period

Statistically highly significant correlation between service period and dry period of the same calving interval of the order of 0.72 was obtained. Similarly, Pajalic (1952)

obtained the correlation coefficient between service period and dry period as high as 0.427. However, Sikka (1931) claimed that the length of dry period was not affected by the length of service period. The regression of dry period on service period was 0.67 days and was also highly significant. This pointed out that for every rise of one month in the average service period there would be an increase of 20 days in the average dry period. Such a high relationship may be explained in the manner that longer service period would increase the lactation yield with the result that cows would require longer period of rest subsequent to that lactation. Thus any increase in the service period would also mean an increase in the dry period and reducing the former may also shorten the latter.

Effect of age at first calving :

Both the correlation and regression of first dry period on age at first calving were not significant. The calculated estimates were -0.012 and -0.005 days respectively and may be taken as zero for practical purposes. They indicated that no relationship existed between age at first calving and first dry period. Similar conclusions were made by Asker et al (1959) and Donaseury & Bayoumi (1962).

The negative genetic correlation of the order of -0.312 indicated that early calvers would possess longer dry periods. However, its realiability was uncertain as it was based on small number of sire groups (Lush 1948).

Heritability

The heritability estimate of dry period obtained by paternal half sib correlation, intra sire regression and correlation

methods were -0.028, -0.5636 and -0.5134 respectively which were not different from zero. Similarly the estimate nearer to zero was obtained by El-Itriby & Asker (1956). Negative estimates might be due to sampling errors.

Repeatability

It was found to be -0.009 which was also zero. Such estimates were obtained by El-Itriby & Asker (1956) and Singh & Desai (1962). Negative estimate might be due to sampling variations.

The zero heritability and repeatability estimates indicated definitely that the chances of improving dry period through selection were nil. This character was strongly influenced by environmental factors. In normal cases this period closely corresponds with the latter half of the pregnancy period. It appears to be true, therefore, that feeding and managemental practices i.e., reduction of service period, would be the only effective means of reducing the dry period to 'optimum level'.

(10) LACTATION LENGTH

Averages :

The mean lactation period of foundation, first, second generations and the herd were 322.8 ± 5.9, 308.7 ± 5.9, 328.6 ± 8.9 and 318.2 ± 3.8 respectively. Kartha (1938) recorded a lactation period of 363 days and 263 days for Deoni cows kept at Hingoli Farm and these averages were based on too small number of observations to be reliable. Rahman (1958) suggested a lactation period of 300 days for Deoni cows. Joshi (1963) calculated lactation period as 332.9 ± 8.1, 281.7 ± 10.8, 319.4 ± 6.2 and 300.5 ± 5.2 days for Deoni cattle at Udgir, Hingoli, Rajendranagar and all three farms together respectively. These results were in quite agreement with the present findings with the exception of average for Hingoli Farm that constituted the inferior stock.

The coefficients of variation observed were 25.6%, 24.8%, 20.2% and 24.6% respectively. The results were in close agreement with those reported by Kartha (1934) as 21.7%, 23.7% and 22.5% respectively for Hariana, ordinary Sahiwal and Red Sindhi cows. Batra (1961) obtained a coefficient of variation of 23.8 % for Sahiwal.

Comparative study

There was no material change in the average lactation period in successive generations.

Effect of sequence of calving

The descending trend from first to fifth lactation was substantiated by the similar findings of Singh & Desai (1961), Joshi (1963) and Singh (1964). The fact that there were highly significant variations among lactation periods at different calvings

was also supported by Singh & Dutt (1963). The maximum lactation period in the first lactation may be explained on the reason that first calf heifers possessed longest service period as there was highly significant association between service period and lactation period. Similar argument can be put forward for the fourth lactation period.

Effect of season and month of calving

Both season and month failed to exert any significant effect on lactation period and these findings were in collaboration with the reports of Joseph (1931), Sikka (1931), Venkayya & Anantakrishnan (1958), Singh et al (1962) and Desai & Dharmendra (1964). However, the present study could not confirm the findings of Weiland (1959), Tomer & Mittal (1960) and Singh & Dutt (1961).

Effect of service period

The highly significant correlation between service period and lactation length confirmed the observations of Sikka (1931), Kartha (1934), Pejalic (1952) and Ragab et al (1956). A highly significant regression suggested that for every 30 days delay in conception, on an average, would increase the average lactation period by 8 days. Service period may be considered as a potent factor in determining the lactation period. According to Kartha (1938) the length of lactation depended mainly upon the time interval between calving and conception. If conception takes place within 2 or 3 months after calving the animal would remain in lactation for a period of 10 months and the lactation period will be longer if conception was delayed. Thus lactation period can be increased by increasing service period.

Effect of age at first calving

The correlation and regression of first lactation period on age at first calving are not significant and these results were

supported by the findings of Batra (1961), Singh & Chaudhry (1961) and Dannsoury & Bayoumi (1962). However, workers like Venkayya & Anantakrishnan (1956) and Singh (1964) got significant association among the traits. The result indicated that lactation period was not affected by the age at first calving in the animals under study. Probably the different methods used for raising heifers as well as feeding and managemental practices were responsible for the discrepancies between results obtained in the present study and other herds.

Heritability

The estimates of heritability obtained by paternal half sib correlation, intra sire regression of daughter on dam and correlation methods were of the same magnitude 0.5464, 0.5942 and 0.5778 respectively. Since these estimates were based on very few sire groups, half sibs and dam daughter pairs and further they were greater than repeatability estimate that was based on comparatively larger number of observations, their reliability may be questioned. Lush (1945) has pointed out that for reliable estimates of heritability it needs several hundred pairs of records. The accuracy of heritability estimate using sire component depends largely on the number of sires and to a lesser degree on the number of offspring per sire (Lush 1948). In the face of these remarks there is every need for the confirmation of the presently obtained estimates on larger number of data that would gather in the course of breeding.

Repeatability

The repeatability estimate of lactation period was 0.267. It was quite in agreement with estimates obtained by El-Itriby & Asker (1956) and Singh & Desai (1961). The interpretation of the

present estimate of repeatability is that if cow's first record expressed as deviation from the contemporary herd average is 100.0 days of lactation period, her future life time average is best estimated as + 26.7 days deviation from the herd average. Since the repeatability estimate was based on larger number of observations and taking into consideration also all the available records of cow (Lush 1945) it may be considered much more reliable. As the estimate was moderately high it would be difficult to decide the degree of inheritance of lactation period.

(11) CALVING INTERVAL

Averages

The mean calving interval for foundation, first, second generations and the herd were found to be 489.9 ± 10.0, 482.4 ± 10.5, 564.1 ± 20.1 and 495.6 ± 7.0 days respectively. Joshi (1963) calculated the average calving interval for Deoni cows kept at Udgir, Hingoli, Rajendranagar Farms and all the three Farms together as 502.8 ± 12.9, 441.008 ± 12.4, 491.9 ± 11.8 and 479.9 ± 6.7 days in similar order. The above figures for different farms of this breed were in well agreement with the observed estimates for different generations presently. Particularly the estimate for Rajendranagar Farm obtained by Joshi (1963) fully agreed with the present estimates. However, the higher estimates of calving interval for these animals may be accounted by the high magnitudes of its components.

The coefficients of variation calculated were 30.1%, 26.3%, 24.2% and 28.4% respectively and they were in good agreement with the results of other workers. Ahmad (1961), Batra (1961) Kohli & Suri (1961[b]) and Singh (1964) reported coefficients of variations to be 25.0%, 21.6%, 23.8% and 27%, 29%, 24% & 22% respectively for Hariana at Izatnagar, Hissar, Sahiwal and Hariana at Pusa, Dumraon, Sahabadi at Dumraon & Seraikella respectively.

Comparative study

There was not significant reduction in the mean calving interval from foundation stock. However, there was highly significant increase in second generation stock from foundation and first generation. These findings may be best accounted by the behaviour of service period or dry period - the components of calving interval - through successive generations.

Effect of sequence of calving

There was a decreasing trend in the average calving interval from first to fifth lactation with the exception at fourth where there was a sharp rise and the variations among different lactations were highly significant. The decreasing trend obtained in the present investigation was supported by Watson (1929) and Bhatnagar & Chaudhry (1960-61). The inter calving period in Deoni cows resumed a decline as the age advanced (Joshi 1963). The significant effect of sequence of calving on inter calving period in the present study substantiated the findings of Brown et al (1954) and Singh (1958). The decreasing trend of calving interval from first to fifth with a sharp rise in fourth lactation may be explained on the basis of variations in its components like service period, dry period and lactation periods at different lactations. Mahadevan (1956) pointed out that the first calving interval was usually somewhat longer than the subsequent ones on account of higher persistancy of cows and the first service was also delayed deliberately by postponing the service to avoid stunting growth (Singh 1964).

Effect of season and month of calving

The effect of season and month of calving on inter calving period was not significant and it was supported by the findings of Alim (1957) and Singh (1958) but disagreed with the reports of Singh et al (1956). The result may be explained on the basis of similar effect of season and month of calving on its components service period, dry period and lactation period.

Effect of age at first calving

The correlation coefficient of 0.14 was obtained between age at first calving and first calving interval and it was not

significant. This finding substantiated the observations of Venkayya & Anantakrishnan (1956), Singh (1957), Ahmad (1961), Batra (1961), Singh & Chaudhry (1961), Danasoury & Bayoumi (1962) and Singh (1964). However, the present observation could not support the findings of Venkayya & Anantakrishnan (1956), Kohli, et al (1961c). The present investigation, however, revealed that age at first calving did not influence the first calving interval in these animals. The result may be explained on the basis of similar effect of age at first calving on the component of calving interval.

Effect of age at first service

Absence of significant correlation and regression of first calving interval on age at first service may be supported on the basis of similar effect of age at first calving on first calving interval as the correlation between age at first calving and age at first service was found to be highly significant.

Heritability

The heritability of calving interval was estimated to be 0.628, 0.6892 and 0.5172 by paternal half sib correlation, intra sire regression and correlation methods respectively. The estimates obtained in the present study were very close to that obtained by Wheat et al (1959). However, these very high estimates may not be interpreted to mean that calving interval in these animals was a highly heritable trait due to the fact that they were based on extremely small number of sires groups, half sibs and dam daughter pairs. (Lush 1945 & 1948). Further these estimates were higher than the repeatability estimate of 0.159 for this character which was based on comparatively larger number of observations. Taking

all these facts into consideration, these high estimates may be regarded unreliable for practical purposes considering them as sampling variations.

Repeatability

The repeatability estimate calculated for calving interval was 0.159 which was very close to that obtained by Amble et al (1956a) for Gir and Kankrej cows.

The repeatability estimate may be considered more reliable as it was based on comparatively larger number of observations involving all the records available for the cow (Lush 1945). As its magnitude was low the probable heritability would indicate that variations in the calving interval were mainly due to environmental influences and there would be very less scope for reducing calving interval through selection. Best environment in the form of nutrition and required management would seem to be the only possible means of reducing it.

However, there is necessity of confirming the reliability of the repeatability and finding out correct heritability estimate with the additional data that would accrue in the course of breeding.

(12) LACTATION YIELD

Averages

The average lactation yield of foundation, first, second generation stock and the herd was estimated to be 2639.8 ± 71.8, 3015.3 ± 78.5, 3512.8 ± 140.8 and 2903.3 ± 15.6 lbs. respectively. Kartha (1938) studying this breed at Cattle Breeding Farm, Hingoli reported 2673.0 and 2943.0 lbs. of lactation yield for farm bred and purchased stock respectively. However, these averages were based on 2 and 5 records only and hence may not be taken as very reliable estimates. Rahman (1958) recorded an average lactation yield for Deoni animals to be 2400 lbs. Randhawa (1958) gave average estimates of 1500 lbs. and 2500 lbs. for an average Deoni cow and for cows under farm bred conditions respectively and he classified these animals under 'milch' group. Joshi (1963) obtained an average lactation yield of 1919.0 ± 55.99, 2883.2 ± 112.23, 3243.3 ± 81.9 and 2672.3 ± 55.17 lbs. for Deoni cows kept at Hingoli, Udgir, Rajendranagar Farms and all the three farms taken together and accepted the superiority of the herd kept at Rajendranagar. Taking into consideration the average yield of different generations and herd obtained in the present study it may be safely concluded that the animals kept at this farm are best in respect to lactation yield compared to all other farms of this breed. The higher average yield obtained by Joshi (1963) for this herd may be explained on the basis that he had not taken into consideration the different generations and further his estimate was based on smaller number of observations. The animals maintained at Hingoli Farm were purchased from the breeding

tract of the breed. Improved stock of this farm was transferred to Udgir Farm. Selected animals from both the farms constituted the foundation stock of the herd of Rajendranagar Farm which is under study. Thus improved genetic material coupled with continued selection for higher lactation yield that has been practised since the inception of the herd might be the probable cause of better performance.

The coefficients of variation were 37.7%, 33.4%, 30.0% and 36.2% respectively for foundation, first second generation stock and the herd. No published data on Deoni animals are available to compare these estimates. However, the result for coefficients of variation in the present study was in quite agreement with the findings of Kohli (1961), Ahmed (1961) and Singh (1964) who obtained coefficients of variation for Hariana (a dual purpose breed) herd at Hissar, IVRI and Pusa and Dumaraon as 37.0%, 60.0% and 35.8% and 47.6% respectively. These higher order of variations in lactation yield are common feature of all tropical dairy cattle, whereas in European dairy cattle the usual magnitude of variation is 22% (Singh 1964). Mahadevan (1956) pointed out that this high order of variation in this trait for tropical dairy cattle is mainly due to the differences in husbandry practices.

Comparative study

There is a substantial increase in average lactation yield in each generation and the differences among generations were highly significant statistically. This might be due to the use of improved bulls, heavy culling and managemental practices.

The sire No. I was evaluated on the basis of 15 dam daughter pairs and the sire index exceeded even herd average by 729.0 lbs. The sire index of other bulls could not be estimated since all the relevant data were not available.

The percentage of cows retained in the herd were 25.3, 18.5, 16.8, 14.8, 9.5, 5.8, 4.3, 2.5, 1.5, 0.5 and 0.5 after completion of first to eleventh lactation records respectively. As large as 25 % cows were culled on the basis of first lactation performance and by the time the animals completed fourth lactation 75% of them were culled. This heavy culling practice might be one of the causes for shooting up averages in each generation.

The most important managemental practice that appears to have been involved is service period. There was a substantial increase in the service period in each successive generation and these differences were highly significant. Further, as has been investigated presently, the service period had a highly significant effect on the lactation yield. Hence it may be stated that high service period in succeeding generations may be the probable reason of the finding that the lactation yield in succeeding generations was higher.

As there was no material change in the lactation period in successive generations it might not be the contributing factor for higher lactation yield in successive generations although the former had highly significant effect on the latter.

Effect of sequence of calving

In the present study the first lactation yield was highest, fourth lactation yield next highest and then there was a decreasing trend till the fifth calving. Variations in average lactation yield for different lactations were not significant. Similarly Joshi (1963) studying this breed observed highest yield in the first lactation in Udgir, Hingoli farms and Udgir, Hingoli and Rajendranagar farms taken together. However, he observed the average 1st lactation yield to be

slightly lower than the maximum yield at third lactation in Rajendranagar Farm. Sharma et al (1951) in Hariana cows and Singh and Dutt (1963) in Sahiwal cows found little variation from second to fifth calving. On the contrary several workers obtained an increasing trend of lactation yield upto third fourth or even fifth lactation. The highest first lactation yield obtained in the present study might be due to the fact that first calf heifers required higher number of services per conception, possessed longest post-partum interval to first service, both these factors made the first service period to the longest in the sequence which in turn determined the highest lactation period. Both the highest service period and lactation period seperately or combined might have resulted in highest yield in the first lactation. Similar conditions were existing during fourth lactation.

The effect of month and season of calving

Lactation yield was highest in winter and lowest in summer calvers and this is in quite agreement with the reports of Hammond & Sanders (1923), Sanders (1927), Eri & Homb (1947), Eikelboom (1948), Bartsch (1950), Mahadevan (1951), Laksesvela et al (1950), Ragab et al (1954) Casper & Nagy (1955), Bayoumi (1959), Dutt & Singh (1961) and Bayoumi & Donnaoury (1963). But the effects of season and month of calving were not significant and thus disagreed with the above mentioned workers in this respect. The present study confirmed the findings of Joseph & Dave (1931) Sikka (1931), Arnold & Becker (1935), Carneiro & Lush (1948), Olanfa & Jones (1948), Bettinay (1949), Berge (1949), Blau (1949) Ragab (1950), Baily (1952), Baum et al (1952), Asker et al (1958), Venkayya & Anantakrishnan (1958), Tomar & Mittal (1960), Singh & Dutt (1963), Desai & Kumar (1964) and Sidhu (1964).

The possible reasons for variations in lactation yield due to season and month of calving are greater pasture supply during favourable period and climatic factors such as thermal variations, humidity, air movements and solar radiations singly or in combination affecting the physiological system of milk production through thermal stress. Hammond (1957) had suggested that the influence of the season is mainly one of nutrition and only to a limited extent of environmental temperatures. Green feeds and fodder are mostly raised in the farm under study and whenever available in abundance they are stored as silage and hay which are used in the period of shortage. Grazing facilities are provided throughout the year on the grazing lands attached to the farm. The climate of Hyderabad though not salubrious, is nevertheless agreeable for the greater part of the year with a temperature range of 93.9° to 70.8°F and 68% hermidity. The Indian cattle are known to exhibit no fluctuations in lactation yield upto 90F° (Ragsdale et al 1951). Under such uniform feeding conditions throughout the year with lower temperature range, the absence of any significant effect of season and month of calving on lactation yield is not contrary to the expectation.

Effect of weight at freshening

The high correlation (0.39**) of body weight with lactation yield was in quite agreement with that obtained by Venkayya and Anantakrishnan (1958). The positive and high regression (3.55** lbs.) of lactation yield on weight of cow at freshening indicated that with every 100 lbs. increase in herd average of weight of the cow at calving would result in an increase of 355.0 lbs. of yield per lactation over the herd average. The highly significant correlation and regression are suggestive of the fact that change

in the size and structure are intimately correlated with the change in function. This may be largely due to intensity of lactation metabolism on the assumption that the amount of protoplasm involved in lactation is proportional to live weight. Thus by increasing the body weight it may be expected to get higher yields. However, Touchberry (1951), Harvey & Lush (1952) and Freeman & Dunbar (1955) analysing Ayrshire and Jersey records concluded that type which includes different body measurements is inherited independently of production because of very low genetic correlation between these items. Hence body weight may not constitute the sole criterion of selection for higher yields.

Significant correlation and regression of first lactation yield on weight at first calving obtained were 0.424 and 5.202 lbs. respectively. Similar results were obtained by Rajagopalan (1952) and Venkayya & Anantakrishnan (1958) for Red Sindhi. The significant regression indicated that for every 100 lbs. increase in the herd average for weight at first calving would result in 520 lbs. of increase in the first lactation over its herd average. Hence body weight at first calving may constitute one of the earliest measure of selection.

Effect of service period

The highly significant correlation between yield in same and subsequent lactation and service period were 0.245 and 0.146 respectively. The present study was in confirmation with the findings of Sanders (1927), Sikka (1931), Pajalic (1952), Venkayya & Anantakrishnan (1958), Batra (1961) and Kohli & Acharya (1961) who obtained positive and significant correlations. However, Gaines (1927) and Regnb et al (1956) reported to the contrary.

Significant regression indicated that as the length of service period increased by one month over the herd average the yield in the same and subsequent lactation would be increased by about 52 and 35 lbs. respectively over the herd average. The effect of service period on the lactation yield may be due to (a) lengthening of lactation period (b) shifting the phase of pregnancy effect on persistency of lactation and (c) the combined effect of both lactation length and intensity of secretion. Gavin (1912) and Sanders (1927) opined that the drop in yield occurred after 20th week of pregnancy and thus the larger service period shifted the phase of decline. Sikka (1931) considered service period as a potent factor in determining the lactatin yield by affecting the length of lactation period. He found that the correlation between service period and lactation length was 0.524. In the present study also a highly significant correlation of 0.538 was obtained between service period and lactation length. The latter in turn was highly correlated with lactation yield. Hence by increasing the service period the producing ability of the cow can be increased.

The genetic correlations between service period and same lactation yield was 0.894. The estimate and its corresponding correlation suggested that this association is largely affected by environment. Freeman et al (1955) also obtained large differences between genetic and phenotypic correlations and they concluded that the relative magnitudes of the genetic and phenotypic correlation very considerably from one pair of traits to another. This may be due to the fact that phenotypic correlations consist of genetic and environmental components and in this case effect of environmental component may be very pronounced. They further observed that phenotypic correlations

were of limited value in selection unless something is known of their environmental and genetic components. However the reliability of the presently obtained genetic correlation is questionable due to extremely small sire groups used. Lush (1948) pointed out that the accuracy of genetic correlation by paternal half sib method using sire component depends largely on the number of sires and to a less degree on the number of offspring per sire.

Effect of age at first calving

The correlation coefficient between age at first calving and first lactation yield obtained was 0.304. This estimate was highly significant and collaborated the findings of Larson et al (1951), Rajagopalan (1952), Venkayya & Anantakrishnan (1956, 1957), Bhatnagar & Chaudhry (1960-61), Batra (1961), Kohli et al (1961c), Dannaoury & Bayoumi (1962). Workers like Rajagopalan (1952), Ragab et al (1954), Sundaresan et al (1954), Chandermani (1958), Singh (1959), Singh & Chaudhry (1961), Singh & Desai (1961) and Singh (1964) failed to obtain any significant association between age at first calving and first lactation yield. The significant regression of first lactation yield on age at first calving meant that every delay of one month in average age at first calving would result in the increase of 42 lbs. of milk over the first lactation average yield. In other words late calvers would produce more milk. This might be due to increased production in normal lactation period or lengthened lactation period or both. However in the present study age at first calving was found not to effect the first lactation period. Since late calvers would be comparatively heavier than early calvers and hence increase in body weight resulting in increased udder development might be the possible cause for

higher yield in late calvers.

Correlations and regression coefficients between age at first calving and second, third, fourth, first three and first four lactation yields were found to be not significant. This indicated that age at first calving had definite influence only on first lactation yield. Similar conclusions were made by Chapman & Dickerson (1936), Johansson and Hansson (1940), Ostergaard (1950), Venkayya & Anantakrishnan (1957), Singh & Sinha (1960) and Kohli et al (1961). However, Mahadevan (1951) working on Ayrshire records has observed that age at first calving had some influence up to fifth lactation but thereafter the effect was nil. Sundaresan et al (1954) reported negative correlation between age at first calving and life time production. Sidhu (1964) in Tharparkar cows observed a highly significant and negative correlation of age at first calving and production for first four lactations.

Effect of age at first service

The significant correlation (0.261) between first lactation yield and age at first service was not in agreement with those obtained by Rajagopalan (1952) for Sindhi (0.046) and Kangayam (0.8167). Since the correlation between age at first calving and age at first service and the regression of former on the latter were 0.921 and 0.881 days respectively and both were highly significant statistically, age at first service may be expected to have a similar effect as age at first calving on first lactation yield.

Effect of lactation length :

In the present investigation a highly significant correlation coefficient of 0.619 between lactation period and lactation yield was obtained. Similar results were obtained by

Sikka (1931), Robertson (1950), Mahadevan (1953, 1955 and 1956), Asker et al (1958), Batra (1961), Singh & Desai (1961) and Singh (1964). The highly significant regression suggested that every one month's increase in the average lactation period would cause an increase of 25 lbs. of milk over the herd average. Such positive, high and significant correlations between lactation yield and period is the usual feature of dairy cattle of tropics. However, in temperate breeds correlations among these traits are low. It is due to the fact that the breeders of temperate cattle through rigid environmental or managemental practices keep the lactation periods ranging to a limited extent and only about 5% lactation periods end before 200 days and the number of lactation lengths ending after 300 days is also small (Singh 1964). This low variation of lactation periods would have little variation in lactation yield and hence low correlation among them. On the contrary in Indian cows about 60% of lactation periods end before 300 days (Mahadevan 1956).

The genetic correlation between lactation period and lactation yield was estimated to be 0.239. Although this estimate was lower to that obtained by Batra (1961) in Sahiwal cattle, nevertheless there is ample space of improving lactation yield by practicing selection on lactation period.

Effect of dry period

The correlation between preceding dry period and lactation yield was found to be 0.009 which was not significant. It is supported by the findings of Pajalic (1952) and Asker et al (1958). On the contrary Rogab et al (1954), Bhatnagar & Chaudhary (1960-61) and Singh & Desai (1962) obtained negative and highly

significant correlations. Jha & Biswas (1964) obtained positive and lower but highly significant correlation. Dry periods act as a rest period to recoup the energy lost for the cows and hence an optimum dry period is essential for maximum production in the next lactation. But very high dry periods do not mean high yields in the subsequent lactations as there is a limitation for the storage capacity of the animals. In the present investigation, the dry periods ranged from below 30 days to as high as 400 days. Thus any attempt to correlate such high dry periods with yields in subsequent lactations may not be significant. The present study indicated that it was possible to lower the dry period without affecting the subsequent lactation yield.

The genetic correlation between dry period and subsequent lactation yield was found to be 0.227. It bears questionable reliability as it was based on small number of sire groups.

Effect of calving interval

First calving interval had a pronounced effect on first lactation yield as the correlation (0.434) was highly significant. Similar results were obtained by Sikka (1931), Lecky (1951), Venkayya & Anantakrishnan (1956) and Singh (1964). However, Singh (1951) and Sundaresan (1954) did not find significant relationship between first lactation yield and first calving interval. The highly significant regression of first lactation yield on first calving interval indicated that for every rise of one month in the average 1st calving interval the average first lactation yield could be increased by about 100 lbs. It means that greater the calving interval the higher the current lactation yield. In other words by lengthening the calving interval it would be possible to get greater yields. This high association of calving

interval with lactation yield may be due to greater service periods (as gestation period is less variable to account for greater inter calving periods).

Heritability

The estimate of heritability obtained by paternal half sib correlation method was 0.292. However, no published results are available on the heritability estimate of lactation yield of Deoni breed, but the estimate was in quite agreement with those obtained by Rendel & Robertson (1950) and Yao et al (1954). The estimates obtained by intra sire regression of daughter on dam and correlation methods were 0.7148 and 0.5194 respectively. The latter estimates are very high compared to the former and further they are of greater magnitude than the estimates obtained by various workers. Such differences might be due to extremely low number of observations. Lush (1945) has pointed out that for reliable estimates of heritability it needs several hundred pairs of records. The accuracy of heritability estimate using sire component depends largely on the number of sires and to a less degree on the number of offspring per sire (Lush 1945). All the three estimates were based on extremely small number of offspring, sire groups and dam daughter pairs and hence their reliability would be questionable. Any concluding remarks for the inheritance of lactation yield in these herd would be difficult and the obtained estimates need confirmation with additional data that would accrue in the course of breeding.

Repeatability

The repeatability estimate obtained was 0.385. Similar estimates were obtained by Johanson & Hanson (1940), Johansson (1949) and Singh & Desai (1961). Since this estimate was based

on more number of observation it may be taken as reliable. Lush (1945) observed that increasing the number of observations or records on an animal causes a gradual reduction in the temporary variance and an increase in the proportion of total variance, much of which is genetic, caused by permanent differences between animals. Hence while calculating the present estimate of repeatability all the records available on cows were used. The interpretation of the present estimate of repeatability would be that if a cow's first record expressed as deviation from the contemporary herd average as + 100.0 lbs. of milk, her future life time production is best estimated as ± 38.5 lbs. as a deviation from the herd average.

APPLICATION OF THE PRESENT INVESTIGATION

From the present investigation following recommendations may be made in order to improve the productive and reproductive efficiency of the cows under study.

(1) The calving size of the heifers in the herd was not a heritable character and hence heifers may be made to reach the size earlier by better nutrition and management.

(2) It is easier to conceive that calves with greater birth weight would have higher growth rate, attain safe calving size earlier and hence such calves can be put to service soon thereby increasing the productive life of the cow and their economic maintenance. The heritability of birth weight of female calves was found to be zero. Hence the best way of getting calves with higher birth weights would be by giving better nutrition and care of dams during pregnancy.

(3) The average age at first calving was higher than most of the temperate breeds and its heritability was zero. Better nutrition and care of the growing heifers would be the possible way of reducing age at first calving. However, early calving resulted in low yield during first lactation in these animals. But the late calvers were in no way superior to early calvers when the total production upto fourth lactation was considered. In other words the early calvers though had lower yields during first lactation compensated in the long run. Further it would be expected that upto a particular age limit the early calvers may produce one or two more calvings and in this way they may even exceed the late calvers.

(4) In the present study the calving interval was very high. Although these long calving intervals were beneficial temporarily but they might effect the useful life of a cow in terms of number of lactations.

There was very high variability in service period which was mostly non-genetic in nature. It is the service period, it seems, which was of worth blaming than the other components of calving interval as service period was the potent factor for determining the lactation length and dry period. From the table (167) the service period group of 121-150 days had sufficiently high lactation yield (2775.92 lbs.) and this period may be considered as optimum service period for these animals. Though it appeared that longer service periods resulted in higher yields in current lactation it would not be beneficial in the long run as longer service period might result in longer calving intervals. To settle the cows by 4-5 months after calving it would be necessary to give up the practice of unweaning the calves. It was due to delay in the post-partum oestrous coupled with higher number of service per conception that the service period had increased. By unweaning the calves it would be possible to get earlier heats. Even though the uterus attains involution, size and tonus in 60 days after parturation, it is not advisable to serve cows by 60 days as it may influence the peak production with lower yields (Table 167). Very high coefficient of variation of service period and its non-genetic inheritance indicated that most of the differences present were managemental in origin.

Services per conception was also found to be non-heritable. Hence a prompt detection of heat by keeping a close eye on the

cow or by teaser bull, natural service or artificial insemination at the desirable time i.e., just before the end of oestrous, good quality semen, efficiency on the part of inseminator would add much toward improvement in breeding efficiency of these animals. If a routine practice is followed to examine the cows after calving any silent heater may begin to show heat symptoms as manual examination of the reproductive organs of the cow frequently caused anestrous cows to start cycling (Salisbury & Van Demark 1961). Further this practice would be helpful in detecting conception and non-conceivers during the scheduled period would be detected and a thorough examination of such cows might reveal the probable cause of infertility. Such cows would be treated at earlier stages. From the table (170) it would be evident that to get approximately same quantity of milk as the optimum service period group had a lactation period of 271-300 days would be required. The dry period then would be 130 days. The longer dry periods may be reduced by better nutrition and management as its heritability was zero.

Thus an optimum calving interval of '14' months may be suggested for these cows.

(5) The present study suggested that live weight may be taken into consideration while selecting the cows for production but not as the sole criterion.

CHAPTER - IV

SUMMARY

Genetic and phenotypic parameters of the economic traits in Deoni cattle of Government Breeding & Dairy Farm Rajendranagar, Hyderabad (A.P) were estimated. The pertinent data of the farm from December 1946 to March 1965 were analysed. The traits studied included Gestation period, Birth weight, Age at first service, Age at first calving, Weight at first calving, Services required per conception, Post-partum interval to first service, Service period, Lactation length, Dry period, Calving interval and Lactation yield.

Gestation period

The gestation length of the herd was calculated to be 281.9 ± 0.5 days with a coefficient of variation of 4.2%.

The month of calving had a significant effect on the duration of pregnancy.

The heritability and repeatability of gestation period were estimated to be 0.16 and 0.061 respectively.

Birth weight

A birth weight of 48.8 ± 0.3 lbs. with 18.3% coefficient of variation was obtained as an average for the herd.

Male and female calves had a birth weight of 49.9 ± 0.5 and 47.7 ± 0.6 lb. respectively and the difference was highly significant.

Birth weight of calves increased from first to second calving. The calves born in third calving had similar weight and from fourth calving onwards there was a decreasing trend upto fifth. The effect of sequence of calving was significant.

The heritability coefficients by paternal half sib correlation method for male, female and male & female calves together were 0.792, 0.648 and 0.624. By intra sire regression method the estimates were 0.166, 0.058 and 0.152. The estimates of heritability of the order of 0.179, 0.065 and 0.171 were obtained by intra sire correlation method. The repeatability of birth weight was 0.34.

Age at first service

The herd average for age at first service was calculated to be 1208.8 ± 27.6 days with 21.5 % coefficient of variation.

The heritability estimates were 1.712, -0.8562 and -0.5702 respectively by paternal half sib correlation, intra sire regression and correlation methods respectively.

Age at first calving

The average age at first calving for the herd was found to be 1577.8 ± 24.9 days with 14.6 % coefficient of variation.

The heritability estimates of age at first calving obtained were 1.9420, -0.2924 and -0.2186 by paternal half sib correlation, intra sire regression and correlation methods respectively.

Weight at first calving

Heifers attained 821.3 ± 15.8 lb with 12.5 % coefficient of variation, on an average, at the time of first calving. A heritability estimate of -0.2152 was obtained for this trait.

Service per conception

The herd average for number of services per conception was estimated to be 1.55 ± 0.03 with 61.5 % coefficient of variation.

The increasing trend through different generation was highly significant.

Heifers needed more number of services per conception and there was an increasing trend upto fifth calving. The variations were highly significant.

The heritability coefficient was found to be 0.52 by paternal half sib correlation method while the repeatability coefficient was 0.084.

Post-partum interval to first service

A mean of 165.5 ± 4.9 days of post-partum interval to first service with 65.1 % coefficient of variation was calculated for the herd.

The longest first interval was followed by a decreasing trend which continued upto fifth lactation except at fourth where there was a rise and the effect of order of calving was highly significant.

The heritability of the interval by paternal half sib correlation, intra sire regression and correlation methods was found to be 0.532, 0.0594 and 0.0438 respectively.

An estimate of repeatability was 0.292.

Service period

The service period for the herd was calculated as 209.0 ± 9.2 days with 86.6 % coefficient of variation. The mean service period of second generation stock increased highly significantly from first and foundation stock means.

The heifers required longest period to conceive and afterwards there was a decreasing trend upto fifth lactation with the

exception of fourth where there was a sharp rise. The order of sequence had highly significant effect.

The heritability estimates were 0.692, 0.508 and 0.393 respectively by paternal half sib correlation, intra sire regression of daughter on dam and correlation methods.

The repeatability was estimated to be 0.132.

Dry period

A mean dry period of 202.7 ± 6.5 days with 64.5% coefficient of variation was calculated for the herd.

There was a significant decrease in mean dry period of first generation stock from foundation stock but second generation possessed longer dry periods than first generation cows and the differences was highly significant.

Service period was the potent factor for determining the length of dry period as the correlation of 0.72 was highly significant. The regression coefficient of 0.67 days was significant.

The heritability coefficient was calculated to be -0.028, -0.5636 and -0.5134 by paternal half sib correlation, intra sire regression and correlation methods respectively. The repeatability was estimated to be -0.009.

Lactation length

The mean lactation length of the herd was calculated to be 318.2 ± 3.8 days with 24.6 % coefficient of variation.

The mean lactation length at different calvings varied at 0.01 % of probability.

There was a highly significant correlation of 0.538 between service period and current lactation length and the regression coefficient (0.27 days) was significant.

The heritability estimates were 0.5464, 0.5942 and 0.5778 by paternal half sib correlation, intra sire regression and correlation methods respectively. The repeatability estimate was 0.267.

Calving interval

A value of 495.6 ± 7.0 days with 28.4 % coefficient of variation represented the mean calving interval for the herd.

There was a decreasing trend in the mean calving interval with the stage of lactation except at fourth. The variation among means was highly significant.

The heritability of calving interval was estimated to be 0.628, 0.689 and 0.517 by paternal half sib correlation, intra sire regression and correlation methods respectively. The repeatability was 0.159.

Lactation yield

The herd average was obtained as 2903.3 ± 51.6 lbs. with 36.2 % coefficient of variation.

The increasing trend of lactation yield at different generations was highly significant.

Heavier cows yielded more as the correlation and regression (0.397 and 3.55 lbs. respectively) were highly significant. Similarly heavier heifers proved better producers. The correlation and regression of first lactation yield on weight at first calving were 0.424 and 5.202 lbs. respectively, and both were significant.

Service period had a pronounced effect both in same and subsequent lactation yield.

The correlation coefficient and regression (0.304 and 1.401 lbs.) of age at first calving and first lactation yield were highly significant.

Age at first service influenced the first lactation yield as the correlation and regression coefficients were significant.

A highly significant correlation coefficient as large as 0.169 was obtained between lactation period and yield. The regression of lactation yield on lactation length was calculated to be 8.320 lbs. and was significant. The genetic correlation among the trait was 0.239.

First calving interval had a pronounced effect on the first lactation yield as the correlation and regression (0.434 and 3.348 lbs.) were highly significant.

The heritability estimate of lactation yield was calculated to be 0. 292, 0.714 and 0.519 by paternal half sib correlation, intra sire regression and correlation methods respectively. The repeatability of lactation yield was found to be 0.385.

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