STUDIES ON GENETIC PARAMETERS OF SOME ECONOMIC TRAITS IN HARIANA COWS

M. V. SC. THESIS

1968

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CERTIFICATE

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Animal Genetics & Breeding, has been working

under my supervision during the session and that the

accompanying thesis entitled "STUDIES ON GENETIC PARAMETERS OF SOME ECONOMIC TRAITS IN HARIANA COWS"

which he is submitting is his genuine work.

DATED 29/4/68

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STUDIES ON GENETIC PARAMETERS OF SOME ECONOMIC TRAITS IN HARIANA COWS

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C E R T I F I C A T E

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CHAPTER - I.

I N T R O D U C T I O N

CHAPTER - I

INTRODUCTION

Since the beginning of the history, we have seen the close association between human and animal. The cow have had converted the rough fodders, by-products etc. into milk, meat, butter fat, the basic diet of mankind. The role of cattle breeder has always been to produce the genetic populations that are superior to ones already in being. The materials at his command for creation of such populations are the genes. The task is to produce individuals, whose genotypes represent optimum contributions of the available genes and devise breeding systems with which these superior genotypes are reproduced. For doing this, information on the genetic parameters are needed.

In the present piece of work, therefore, an attempt has been made to find out heritability, genetic and phenotypic correlations of several economic characters of Hariana cattle. There is no possibility for any improvement in the economic production unless and until the breeder resorts and depends upon the population genetics as a tool

for manipulating the genes necessary for further improvement. Populationg Genetics become indispensable for the breeders. Population Genetics, as a science, art and tool for the direction of animal production, along with my great interest as well as my feelings of loyality towards my country (Syria) have made me to feel the necessity to take part in this work. It was, the Dr. B.P. Singh, M.V.Sc., Ph.D. (USA), Professor and Head of Animal Genetics and Breeding Department to intensify, indirectly, the interest to the subject during B.V.Sc. & A.H., 1965.

In the advanced countries where the mechanization is well established, the cow is maintained particularly for production. In India, the Hariana breed of cattle is kept, perhaps by nature to be a dual purpose breed. This breed is maintained for milk production as well as for draught, ploughing, etc. due to its power and speed. It appears that this breed of cattle has got the potentialities for milk production.

The Hariana breed with the exception of colour and hump is apparently similar to the Shamy breed in my country (Syria). It was a great pleasure

and interest for me to study the parameters of economically important traits in Hariana cattle to explore the possibilities for further improvement.

CHAPTER - II

REVIEW OF LITERATURE

CHAPTER - II

REVIEW OF LITERATURE

GENERAL CONSIDERATION:

Quantitative Genetic theory applied to problems in Animal Breeding is mainly descriptive. Mean, variation and covariation observed in a population find one way or the other expression as statistics for which explanation is sought by reference to various genetic concepts. To the breeder, these estimates of genetic parameters have utility in knowing a population mean for a particular character, which undergoes when a given amount of selection is applied.

In order to make any breeding plan effective the knowledge of genetic parameters, namely heritability of traits for which improvement is sought and the genetic correlation between these traits is essential. By heritability term, one try to define that portion of the parental superiority which will be passed on to the offspring generation. Genetic correlations indicate the degree of positive

or negative genetic associations between traits and hence the direction and the amount of correlated response that might be experienced.

Precise definition of heritability and genetic correlation requires that these be done in terms of additive genetic variance. Since it is the individual gene, which remains a unit of transmission from parent to offspring, the ratio of these additive genetic variance of the total phenotypic variance has been defined by Lush (1940) as heritability in narrow sense, and in selection it is this consideration of the heritability concept, with which we are concerned. In the similar manner a genetic correlation measures the degree to which the additive portion of the variance between two traits has a common genetic basis.

Phenotypic correlation between two traits provides an estimate of linear relationship between traits measured in the same animal. This, in addition to the genetic association, includes environmental, dominance and epistatic effects. The phenotypic correlations are used in the possibility of utilizing easily measurable character to predict another character which is more difficult and expensive to measure.

The present investigation is restricted to the determination of mean, heritability, phenotypic and genetic correlations of several economically important traits with respect to the population studied. The following review is limited to the consideration of the characters studied.

1. AGE AT FIRST CALVING:

The age at first calving is the first indication of the breeding ability of an animal and in terms of economics one day increase in the age at first calving increases expenditure of Rs.1/- (Desai and Kumar, 1963). Early age at first calving would reduce the unproductive period of our cattle and hence increase their life-production. The reduction in age at first calving would result in the reduction of generation interval. The reduction in the generation interval would increase the rate of genetic gain under any selection programme per unit of time.

(a) Average:-

The average age at first calving for Hariana breed of cattle as reported by various

workers is given in Table 1.

TABLE 1. AVERAGE AGE AT FIRST CALVING FOR HARIANA COWS.

Author	Year	Amount of data	Average age at first calving (months)
Amble *et al*	1958	-	46.7±0.3
Bhasin & Desai	1967	117	46.0±1.2
Dutt & Desai	1965	50	45.5±1.2
Johari & Talapatra	1957	439	51.2
Kohli & Suri	1957	1917	58.8±0.3
Kohli *et al*	1961	-	59.3±1.2
Sharma *et al*	1951	230	53.9±0.3
Singh *et al*	1964	221	40.9±6.4
Singh & Desai	1961	417	46.7±0.4

The average age at first calving of the other breeds of cattle is given in Table 2.

TABLE 2. AVERAGE AGE AT FIRST CALVING.

Author	Year	Amount of data	Average age at first calving (months)	Breed
1	2	3	4	5
Amble *et al*	1958	-	42.0	Red Sindhi
Amble *et al*	1958	-	44.0	Kangayam

Table Contd....

TABLE 2. (Contd.....)

1	2	3	4	5
Asker et al	1958	198	44.3	Egyptian cows
Batra & Desai	1964	160	38.4±0.4	Sahiwal
Copeland	1939	1582	26.5	Jersey
Dhandapani	1962	34	41.0	Red Sindhi
Giuliani	1952	-	25.0	Friesian
Giuliani	1953	-	27.0	Brown Alpine
Mahadevan	1953	600	18-42.4±.4	Black Sinhala
Ragab et al	1954	177	34.3	Egyptian cows
Rigor	1949	[illegible]	38.8	1/2 Ayrshire X Red Sindhi
Rigor	1949		43.4	3/4 Ayrshire X Red Sindhi
Rigor	1949		48.7	7/8 Ayrshire X Red Sindhi
Singh	1957	209	48.7±0.4	Tharparkar
Singh and Sinha	1960	131	41-46	Tharparkar
Sundaresan et al	1954	82	42	Red Sindhi
Sundaresan et al	1954	30	29	Jersey X Red Singhi
Venkayya & Anantakrishnan	1956	216	42.9	Red Sindhi
" "	1956	80	47.3	Gir
" "	1956	241	35.1	Ayrshire X Red Sindhi

From the averages given in the Tables it can be inferred that on an average the milch breeds of Indian cattle mature early and calve at an early age as compared to the drought breeds or dual purpose cattle of India. The average age at first calving of some European breeds and the crossbreds have been reported to be lower than the Indian breeds of cattle. Looking at the wide variability in the average figures reported by various authors for the Hariana breeds of cattle, it could be said that there is a great promise for reducing the age at first calving by way of better feeding and management and following specified breeding plans to reduce the age at first calving.

(b) Heritability:-

The estimates for heritability of age at first calving of Hariana as well as other Indian breeds of cattle are given in Table 3.

TABLE 3. HERITABILITY OF AGE AT FIRST CALVING

Author	Year	Method of Estimation	Amount of data	Heritability Estimates	Breed
1	2	3	4	5	6
Amble et al	1958	Intra-sire regression	-0.	-0.09	Red Sindhi

Table Contd....

TABLE 3. (Contd....)

1	2	3	4	5	6
Amble et al	1958	Intrasire regression		-0.08	Kangayam
Batra & Desai	1964	Halfsib correlation	160	0.50±0.19	Sahiwal
Bhasin & Desai	1967	Regression	21 pairs	0.17±0.13	Hariana
Singh	1957	Intrasire regression	140 "	-0.36±0.10	Tharparkar
Singh	1957	Dam-daughter correlation	140 "	-0.30±0.08	"
Singh & Desai	1961	Intrasire regression	244 "	0.34±0.12	Hariana
Singh & Desai	1961	Halfsib correlation	322	0.34±0.19	Hariana
Stonaker	1953	Intrasire regression	90 "	0.39	Red Sindhi

The estimates of heritability reported by various authors have ranged from very low estimate of heritability to medium to high estimate of heritability for age at first calving. The magnitude of heritability estimates suggests that the genetic improvement in this trait could be brought about by proper selection so as to overcome the late maturing tendency of Indian breeds of cattle.

(c) Correlation:-

The phenotypic and genetic correlations

of age at first calving with several other economically important traits as reported by various authors are given in Table 4.

TABLE 4. CORRELATION COEFFICIENT OF AGE AT FIRST CALVING WITH OTHER TRAITS.

Author	Year	Correlated traits	Amount of data	Phenotypic Correlation	Genetic Correlation	Breed
1	2	3	4	5	6	7
Batra & Desai	1964	First Lactation Milk Yield	160		0.81	Sahiwal
Bhasin & Desai	1967	" "	117	-0.03	-	Hariana
Bhasin & Desai	1967	Milk Production Upto 6 Years of Age	68	-0.62**		Hariana
Bhasin & Desai	1967	Milk Production Upto 8 Years of Age	41	-0.57**		Hariana
Larson et al	1951	First 305 days Milk Production in First Lactation	306	0.06		D.H.I.A.Record
Ragab et al	1954	First Lactation Milk Yield	177	0.03		Egyptian Cows
Singh	1957	First Calving Interval	109	0.02		Tharparkar
Singh	1969	First Milk Yield	322	-0.1	0.654	Hariana
Singh	1969	First Lactation Period	322	0.07	0.982	Hariana
Singh et al	1964	Milk Production Upto Age at Culling	321	0.32		Hariana
Singh et al	1964	Longevity	321	0.23		Hariana

Table Contd.....

TABLE 4. (Contd.....)

1	2	3	4	5	6	7
Singh *et al*	1964	Useful life	321	0.33		Hariana
Sundaresan *et al*	1954	First Lactation Milk Yield	82	0.06		Red Sindhi
Venkayya & Anantakrishnan	1956	First Lactation Milk Yield	216	0.44**		Red Sindhi
" "	1956	Lactation Period		0.49**		Red Sindhi
" "	1956	First Calving Interval	216	0.56**		" "
" "	1956	" "	80	0.20		Gir
" "	1957	First Lactation Milk Yield	64	0.78**		Red Sindhi
" "	1957	Second Lactation Milk Yield	64	-0.10		" "
" "	1957	Third Lactation Milk Yield	64	-0.18		" "
" "	1957	Fourth Lactation Milk Yield	64	0.07		" "

** - Significant at 1% level of probability.

The perusal of Table 4 reveals that very few studies have been made for knowing the genetic association of age at first calving with other economically important traits in cattle. The reports on the gross correlation of age at first calving

with other traits are conflicting.

2. GESTATION PERIOD:

(a) Average:-

The average gestation period for various breeds of cows has been given in Table 5. The average gestation period over all the breeds has ranged from 275 to 290 days. For the Hariana breed the average gestation period reported by various authors has ranged from 285 to 290 days. From the perusal of the Table 5 it appears that the crossbreds have little bit shorter gestation period as compared to the purebreds.

TABLE 5. AVERAGE GESTATION PERIOD

Author	Year	Amount of data	Breed of Cattle	Average ± S.E. Gestation Period (days)
1	2	3	4	4
Anantakrishnan et al	1952	66	Sahiwal	283.38±0.87
" "	1952	856	Red Sindhi	283.22±0.23
" "	1952	56	Tharparkar	284.70±0.53
" "	1952	329	Gir	285.21±0.32

Table contd.....

TABLE 5. (Contd.....)

1	2	3	4	5
Anantakrishnan et al	1952	400	Ayrshire X Red Sindhi	277.03±0.34
" "	1952	27	Ayrshire X Ayrshire	277.70±0.75
" "	1952	67	Ayrshire X Hariana	278.33±0.68
" "	1952	175	Ayrshire X Sahiwal	277.70±0.45
" "	1952	17	Ayrshire X Tharparkar	278.47±0.96
" "	1952	41	Holstein Friesian X Red Sindhi	277.98±1.06
Bawa & Gulati	1960	161	Jersey X Nondescript	275.99±0.56
Choudhuri & Sinha	1951	1146	Tharparkar	287.15±34
Dutt & Desai	1965	50	Hariana X Gangatiri	288.9±1.4
Goswami et al	1963	1001	Hariana	284.90±0.27 to 290.14±0.55
"	1963	1001	Hariana	289.11±0.17 to 286.46±0.17
"	1963	1001	Hariana	287.87±0.13
Hadi	1966	212	Deoni cows	284.83±0.39
"	1966	99	Deoni cows	285.26±0.59
"	1966	113	Deoni cows	284.49±0.47
Joseph & Dave	1931	1553	Montgomery	283
Rajulu & Rao	1966	345	Ongole	288.43±6.53
Rao	1966	48	Molvi	284.02
Roy & Goswami	1960	60	Friesian X Zebu	285.74±0.67
Sharma et al	1951	230	Hariana	290.15 ±0.22

Table Contd....

TABLE 5. (Contd....)

1	2	3	4	5
Sikka	1931	1844	Sahiwal	280
Singh et al	1958	681	Tharparkar	288.36±0.35
Singh & Dutt	1961	177	Sahiwal	285.92±5.8
Wheat & Riggs	1951		Hareford X Brahman	286.32

(b) Heritability:-

The heritability of gestation period has been reported by Singh et al (1958) for the Tharparkar breed of cattle. The estimate on the basis of 681 records was very low (0.002) and associated with relatively large standard error.

(c) Correlation:-

Ana-ntakrishnan et al (1952) estimated the phynotypic correlation of gestation period with dry period for Red Sindhi, Gir and Ayrshire X Red Sindhi. The gross correlation coefficient between the traits mentioned above for various breeds ranged from 0.007 to 0.057. The correlation

coefficients for the various breeds were not-significant. Singh and Dutt (1961) reported the gross correlation of gestation period with age of dam in Sahiwal cattle to be nonsignificantly negative.

3. MILK YIELD:

The amount of milk produced from a herd is of greatest economic value for any dairy enterprize. Whatsoever may be the level of production, a high milk producing cow is more economical to the owner as compared to the low producing one. The average milk yield from a given herd will vary with the genetic constitution of the animal in the herd, the feeding and management practices and the climatic conditions.

(a) Average:-

The average milk yield of Hariana cows as reported by various workers has been reviewed in Table 6.

The average milk yield of dairy breeds of Indian cattle is reported to be higher than the Hariana breed (Table 7). The average milk yield

per lactation of the crossbred cows involving Indian and exotic breeds have been reported to be greater than those of the dairy breeds of Indian cattle.

TABLE 6. AVERAGE MILK YIELD IN HARIANA COWS.

Author	Year	Amount of data	Average ± S.E. Milk Yield	S. D.	C.V. (%)	Source of data
1	2	3	4	5	6	7
			(lb.)			
Bhasin &Desai	1967	117	1941.69±51.01 (Ist.Lactation)	551.47	28.40	Bassi
" "	1967	117	4002±125.82 (Ist.2 Lacta.)	1052.79	26.30	"
" "	1967	117	3582.75±191.48 (Upto age of 6 years)	1578.94	44.49	"
" "	1967	117	7175.83±377.85 (Upto age of 8 years)	2419.43	33.72	"
" "	1967	28	3814±186			"
Kohli and Acharya	1961	247	1891.48±28.4			
Kohli *et al*	1961	230	1458			
Sharma *et al*	1951	517	1749±40.25			
"	1951	133	1284.9 (Ist.Lactation)			
"	1951	17	2077 (Sixth Lactation)			

Table Contd.....

TABLE 6. (Contd....)

1	2	3	4	5	6	7
Singh and Prasad	1967	421	2550±44.5		35.8	Pusa
"	1967	901	1875.2±29		47.6	Dumraon
Singh	1959	39	1837.3±80.6 (Ist.Lactation)	499.1	27.16	Mathura
Singh	1959	39	2801.7±142.0 (Ist.Lactation)	886.1	31.62	"
Singh	1959	414	2656.9±51.5 (Ist.Lactation)	1047.8	39.43	"
Singh	1959	1159	2223.8±30.7 Overall Average 1010.8 Kg.	1044.9	46.98	Mathura, Madhurikund, Bharari, Babugarh.
Singh	1959	434	2115.6 (Ist.Lactation)			"
Singh	1959	283	2164.3 (2nd.Lactation)			"
Singh	1959	188	2373.1 (3rd.Lactation)			"
Singh	1959	112	2358.2 (4th.Lactation)			"
Singh	1959	74	2451.0 (5th.Lactation)			"

TABLE 7. AVERAGE MILK YIELD IN OTHER BREEDS OF CATTLE

Author	Year	Amount of data	Breed of Cattle	Average ±S.E. Milk Yield	C.V %	Remarks
1	2	3	4	5	6	7	8
Bhasin and Desai	1967		Sahiwal	4017±227 lb. (1825±103 Kg.)			Bassi
"	1967		Red Sindhi	2897±207 lb. (1316±94 Kg.)			"
"	1967		Hariana X Sahiwal	4258±96 lb. (1935±43 Kg.)			"
"	1967		Hariana X Red Sindhi	3014±337 lb. (1370±153 Kg.)			"
"	1967		Friesian X Sahiwal	7322±194 lb. (3328±88 Kg.)			"
"	1967		Friesian X Red Sindhi	6157±276 lb. (2798±125 Kg.)			"
"	1967		Friesian X Hariana	7170±278 lb. (3259±126 Kg.)			"
Dutt and Desai	1965	50	Gangatiri graded to Hariana	1119.4 Kg.			Arazilines
"	1965	50	"	1255.9 Kg.			"
Mishra and Biswas	1963		Tharparkar	4027±32.6 lb. (1830±14 Kg.) 1st.lactation			Patna
Sikka	1931	1844	Sahiwal	4200 lb. (1909 Kg.)	40% (18)		Military Farms
Singh and Dutt	1963	241	"	3804±27 lb. (1729±12 Kg.)			Mathura
Singh	1963	270	Friesian X Sahiwal Southern area	4462±83 lb. 1st.300day milk yield	30.6%		Southern area

Table Contd....

TABLE 7. (Contd.....)

1	2	3	4	5	6	7	8
Singh	1963	306	Friesian X Sahiwal Northern area	4209±58 lb. 1st.300 days milk yield	24.3%		Northern area
"	1963	162	Sahiwal	3691±83 lb. 1st.300 days milk yield	28.6%		"
"	1963	189	Friesian X Sahiwal Southern area	5356 lb. 2nd.300 days milk yield			Southern
"	1963	139	"	5929 lb. 3rd.300 days milk yield			"
"	1963	245	" Northern	5117 lb. 2nd.300 days milk yield			Northern
"	1963	201	"	5670 lb. 3rd.300 days milk yield			"
"	1963	142	Sahiwal	4271 lb. 2nd.300 days milk yield			"
"	1963	111	"	4660 lb. 3rd.300 days milk yield			"
Venkayya & Anantakrishnan	1956	216	Red Sindhi	3323 lb. (1510 Kg.) 1st.lactation			
"	1956	80	Gir	3149 lb. (1431 Kg.) 1st.lactation			
"	1956	241	Ayrshire X Red Sindhi	4458 lb. (2026 Kg.)			

(b) Heritability:-

That the milk yield has a genetic basis is now pretty well established. The heritability estimates for milk yield have been reviewed in Table 8. The heritability estimates vary with the type of data and the method of analysis. In general the milk yield has been reported to be moderately heritable, although individual estimates have varied from negative heritability to 0.71. Most of the reports of the heritability estimate are not associated with the standard error of the estimates. Hence it is not possible to know the precision of these estimates.

(c) Correlation:-

The estimates for genetic and phenotypic correlations between milk yield and other traits in dairy cattle have been given in Table 9. Very few studies appear to have been made on determining th e genetic association of milk yield with other traits. The milk yield for a shorter duration of time has been found to be very highly genetically associated with first lactation milk yield.(Madden et al, 1955; Singh et al, 1967).

TABLE 8. HERITABILITY ESTIMATES OF MILK YIELD IN SEVERAL BREEDS OF CATTLE.

Author	Year	Method of Estimation	Amount of data	Breed	Heritability Estimates	
1	2	3	4	5	6	
Bhasin & Desai	1967	Regression Method	21	Hariana	0.218±0.50	
Carneiro	1953				0.23	
Gowen	1934				0.5	
Johansson	1954			Red Danish	0.58	
Kohli *et al*	1961	Intrasire Regression	140	Hariana	0.46±0.12	Ist.Lactation
"	1961	"	69	"	0.33±0.19	
Laben & Herman	1950				0.36	
Lush *et al*	1941	"	3010	Holstein-Friesian	0.33	
Mahadevan	1951	"	903	Ayrshire	0.31	Ist.180 days milk yield
"	1951		732	"	0.27	
"	1954		1102	Red Sindhi	0.19	
"	1955	Simple Regression	91	"	0.2	
Madden	1954		599	Holstein	-0.08	
"	1954		599	"	0.4	
"	1954		599	"	0.34	
"	1954	Simple Regression	599	"	0.63	

Table Contd.....

TABLE 8. (Contd.....)

1	2	3	4	5	6	
Mason and Robertson	1958	Correlation Method	13000	Red Danish	0.05	
"	1958	"		"	0.15	
"	1958	"		"	0.22	
Midtlid & Berge	1950	"		Norweign	0.4	
Mishra *et al*	1964	Intrasire Regression	18	Tharparkar	0.017	Ist.Lactation
"	1964	"	18	"	-0.37	2nd. "
"	1964	"	18	"	0.16	3rd. "
Rendel & Robertson	1950	"			0.3	
Rognoni & Pasti	1955	"	93	Simmental cattle	0.22	
"	1955	"	714	Friesian	0.37	
Seath	1940	"	8010		0.21	
"	1940	"	4087		0.25	
Shanker	1951		396		0.01±0.08	
Singh	1959	"	178	Hariana	0.147±0.043	
Singh	1963	Halfsib Correlation	149	Friesian X Sahiwal	0.229±0.22	Ist.300 days milk yield
"	1963	"	170	"	0.149±0.199	"
"	1963	"	124	Sahiwal	0.210±0.291	"

Table Contd.....

TABLE 8. (Contd.....)

1	2	3	4	5	6	
Singh	1963	Halfsib Correlation	178	Friesian X Sahiwal	0.51±0.26	Ist.300 days milk yield
"	1963	"	204	"	0.56±0.25	"
Singh et al	1964	Intrasire Regression	321	Hariana	0.29±0.11	Upto age at culling
"	1967		186	"	0.32±0.21	Ist.Lactation
Singh & prasad	1967	"	421	"	0.30±0.13	
"	1967	"	901	"	0.20±0.29	
"	1966	"	21	"	0.21±0.50	Ist.Lactation
Tabler & Touchberry	1955	"	2146	Jersey	0.25	"
Taylor	1955	"	2025	Guernsey Friesian & Jersey	0.26	Pooled "
"	1955	"	2025	"	0.46	" "
Touchberry	1951	"	187		0.25	
Tyler & Hyatt	1947	"	6888	Ayrshire	0.31	300-day milk yield
Yao et al	1954	"	123	Shorthorn	71.1%	
"	1954	Halfsib Correlation	163	"	28.4%	

TABLE 9. PHENOTYPIC AND GENETIC CORRELATIONS BETWEEN MILK YIELD AND OTHER TRAITS.

Author	Year	Correlated Traits	Amount of data	Phenotypic Correlation	Genetic Correlation	Breed
1	2	3	4	5	6	7
Batra & Desai	1964	Age at first calving with first lactation milk yield	160		0.812**	Sahiwal
"	1964	Lactation period	160		0.638**	"
"	1964	Peak yield	160		0.607**	"
Bhasin & Desai	1967	Age at first calving with first lactation milk yield	117	-0.033		Hariana
"	1967	Age at first calving with production in first two lactation milk yields.	117	-0.122*		"
"	1967	Age at first calving with milk production upto 6 years of age	117	-0.617**		"
"	1967	Age at first calving with milk production upto 8 years of age	117	-0.570**		"
"	1967	Age at first calving with milk yield upto 10 years of age	117	-0.477**		"

Table Contd....

TABLE 9. (Contd.....)

1	2	3	4	5	6	7
Bhasin & Desai	1967	Age at first calving with first milk yield upto 6 years of age	117	-0.706**		Hariana
"	1967	Age at first calving with first milk yield upto 8 years of age	117	-0.738**		"
"	1967	Age at first calving with first milk yield upto 10 years of age	117	-0.603**		"
"	1967	First lactation milk yield with production upto 6 years of age	117	0.445**		"
"	1967	First lactation milk yield with production upto 8 years of age	117	0.499**		"
"	1967	First lactation milk yield with production upto 10 years of age	117	0.667**		"
"	1967	First lactation yield with first two lactation milk yields.	117	0.798**		"
Farthing & Legates	1957	Milk yield with fat percentage	5458		-0.38±0.06	Holstein Friesian
"	1957	"	1825		-0.57±0.10	Guernsey

Table Contd.....

TABLE 9. (Contd.....)

1	2	3	4	5	6	7
Jha & Biswas	1964	Preceding dry period with successive lactation milk yields.	158	0.12**		Tharparkar
Madden *et al*	1955	Ist. 300 days mi-lk yield with that of 243 days	253		0.91	Holstein-Friesian
"	1955	Ist.300 days mi-lk yield with that of 274 days	253		0.92	"
"	1955	Ist.300 days milk yield with that of 305 days	253		0.96	"
Rendel & Robertson	1950	Milk yield and fat percentage			0.20	
Sikka	1931	Milk yield and service period	1844	0.339±0.015		Sahiwal
"	1933	Between mean milk yield of four lactation periods and maximum milk yield of a lactation	776	0.876±0.011		"
Singh	1959	Age at fi-rst calving and Ist milk yield	322	-0.1	0.654	Hariana
Singh *et al*	1964	Age at first calving and milk production upto 6 years of age	221	-0.758**		"

Table Contd.....

TABLE 9. (Contd.....)

1	2	3	4	5	6	7
Singh *et al*	1964	Age at first calving & milk production upto 8 years of age	221	-0.582**		Hariana
"	1964	Age at first calving & milk producti-on upto 10 years of age	221	-0.640**		"
Singh & Prasad	1966	Between first lactation milk yield & first lactation period	1322	0.35*		"
"	1966	Between first lactation yield & first two la-ctation yields.	1322	0.798**		"
Singh *et al*	1967	Between 135 days milk yield & that of 305 days	186		0.98±0.02	"
Tabler & Touchberry	1955	Between type & milk yields	2146		0.07	Jersey
Tyler & Hyatt	1947	Between milk & butter fat percentage	6888	-0.14	-0.20	Ayrshire
Ullah	1952	Between peak yield and total milk yield in a lactation		0.51±0.12		
Venkayya & Anantakrishnan	1957	Age at first calving & milk yield in first lactation	64	0.78**		Red Sindhi

Table Contd.....

TABLE 9. (Contd.....)

1	2	3	4	5	6	7
Venkayya & Anantakrishnan	1957	Age at first calving & milk yield in 2nd. lactation	64	-0.10		Red Sindhi
"	1957	Age at first calving & milk yield in 3rd. lactation	64	-0.18		"
"	1957	Age at first calving & milk yield in 4th. lactation	64	0.07		"
"	1957	Age at first calving with milk yield in 1st.lactation	65	0.41**		Ayrshire X Red Sindhi
"	1957	Age at first calving with milk yield in 2nd.lactation	65	0.19		"
"	1957	Age at first calving with milk yield in 3rd.lactation	65	0.19		"
"	1957	Age at first calving with milk yield in 4th.lactation	65	0.23		"

* - Significant at 5% level of probability

** - Significant at 1% level of probability.

The milk yield has been reported (Farthing and Legates, 1957; Tyler and Hyatt, 1947) to be negatively genetically associated with the fat per cent and positively associated with the butter fat production (Tabler and Touchberry, 1955; Touchberry, 1951; Tyler and Hyatt, 1947). Batra and Desai (1964) reported significantly positive genetic correlation of milk yield with lactation period and peak yield for Sahiwal cattle. Singh (1961) reported a positive genetic association between services per conception and 150 days milk yield. Tabler and Touchberry (1955) reported positive genetic association between type and milk production.

Bhasin and Desai (1967) have reported significantly negative phynotypic correlation between first lactation milk yield and age at first calving and also with the age at first calving and milk yield for specified period. The same authors have reported a significantly positive association between first lactation milk yield and milk production upto a specified age. Singh et al (1964) have also reported significantly negative phynotypic correlation between age at first calving and milk production upto a specified age.

Venkayya and Anantakrishnan (1957) have reported significantly positive correlation between age at first calving and milk yield in first lactation for Red Sindhi and Ayrshire X Red Sindhi cattle.

4. LACTATION PERIOD:

The amount of milk produced by a particular cow in a lactation depends on the initial maximum milk secretion, persistency of milk production and the lactation period. Lactation length of 305 days is desirable since it closely associates with the reproductive cycle of the cow calving once a year.

(a) Average:-

The average lactation periods of Indian breeds of cattle are given in Table 10. The estimates reported by various authors for the Hariana breed vary from 263 to 315 days of milk in a particular lactation. On the basis of published reports it can be inferred that the average lactation period of Indian breeds of cattle is less than 305 days. The lactation length for the crossbred cattle has been reported to be longer than the purebreds.

TABLE 10. AVERAGE LACTATION PERIOD IN SOME BREEDS OF CATTLE.

Author	Year	Amount of data	Breed of Cattle	Average ± S.E. Lactation Period (days)	C.V.	Remarks
Batra & Desai	1964	160	Sahiwal	295.8±4.7	23.8%	Military Farms
Bhasin & Desai	1967	51	"	301.75±8.30		Bassi
"	1967	59	Red Sindhi	254.82±10.25		"
"	1967	67	Hariana X Sahiwal	284.34±11.06		"
"	1967	6	Hariana X Red Sindhi	231.20±21.04		"
"	1967	35	Friesian X Sahiwal	326.66±12.89		"
"	1967	27	Friesian X Red Sindhi	327.86±15.63		"
"	1967	49	Friesian X Hariana	327.79±10.57		"
"	1967	75	Hariana	274.45±7.67		"
Dutt & Desai	1965	50	Gangatiri	274.4±3.5		Arazilines
Kartha	1934		Hariana	310	21.7%	Karnal
Kohli & Acharya	1961	247	Hariana	295.74±8.01		Hissar
Sharma et al	1951		Hariana	273		"
Singh	1959	198	Hariana	315.3 1st.lact. period		Mathura
"	1959	198	Hariana	290.0 2nd. "		"
"	1959	198	Hariana	285.6 3rd. "		"
Singh & Dutt	1963	241	Sahiwal	299±4.8		Mathura
Singh & Prasad	1966	901	Hariana	294.2±4.2	29%	Pusa
"	1966	421	Hariana	263.4±2.8	31%	Dumraon

Singh (1959) has reported a decline in the lactation period with the increase in lactation number in Hariana breed of cattle.

(b) Heritability:-

The heritability of lactation period has been reported by Lush and Shultz (1936), who found the variability of lactation period in foreign breeds to be 10 per cent. Singh (1959) found it to be 0.32±0.03 by intra sire regression of offspring on dam and 0.83±0.29 by half sib correlation method. Singh and Prasad (1966) analysed 1322 records of Hariana cows and reported heritability of lactation period by intra sire regression method as 0.59±0.14 and by paternal half sib correlation method 0.38±0.18.

(c) Correlation:-

The genetic and phenotypic correlations of lactation period with other traits are reported in Table 11.

A highly significant genetic correlation between milk yield in first lactation and lactation period has been reported by Batra and Desai (1964). A high positive phenotypic correlation between the

TABLE 11. PHENOTYPIC AND GENETIC CORRELATIONS OF LACTATION PERIOD WITH SOME OTHER TRAITS.

Author	Year	Correlated Traits	Amount of data	Phenotypic Correlation	Genatic Correlation	Breed	Remarks
Asker et al	1958	Milk Yield	900	0.731**		Egyptian cows	U.A.R.
Batra and Desai	1964	Milk Yield in first lactation	160		0.638**	Sahiwal	Military Farms
Mahadevan	1953	Milk Yield		0.44±0.04		Sinhala	
"	1955	Milk Yiel-d	481	0.6±0.02		Red Sindhi	
Robertson	1950	Milk Yield		0.9		Fulani	
Sikka	1931	Milk Yield	1844	0.695±0.009*		Sahiwal	Military Dairy Farm
"	1931	Service Period	1844	0.522±0.013*		"	"
Singh and Prasad	1966	Between 1st. Lactation Milk Yield & 1st.lactation period		0.3517*			
Singh	1959	Age at 1st. calving and 1st.lactation period	322 "	0.0009 0.070	0.982	Hariana	Mathura, Madhurikund & Babugarh
"	1959	Fist lactation period & 1st.lactation milk yield	"	0.745** 0.688**	0.740	"	"

** - Significant at 1% level of probability. * - Significant at 5% level of probability.

two traits mentioned above has been reported by Asker et al (1958); Mahadevan (1955); Robertson (1950); Sikka (1931) and Singh and Prasad (1966).

5. DRY PERIOD:

(a) Average:-

An optimum dry period or period of rest is essential for the maximum production of milk in the subsequent lactation. The average dry period for various Indian breeds of cattle is given in Table 12.

The average dry period reported by various authors for milch breeds of Indian cattle varied from 84 to 170 days. The average dry period for Hariana cattle has been reported by Singh (1959) as 162 days. Sharma et al (1951) recorded an average dry period of 258 days for Hariana cattle, a figure much higher than all other published reports.

(b) Heritability:-

No effort appears to have been made in estimating heritability of dry period for Indian

TABLE 12. AVERAGE DRY PERIOD IN SOME BREEDS OF CATTLE

Author	Year	Amount of data	Breed of Cattle	Average ± S.E. Dry Period (days)	S.D.	C.V (%)	Remarks
Batra & Desai	1964	160	Sahiwal	121.2±3.8		47.3	Military Farms
Biswal & Rao	1960	87	Red Sindhi	139			Orissa
"	1960	87	"	84			"
"	1960	87	"	133			"
"	1960	87	"	119			"
"	1960	87	"	122			"
"	1960	87	"	126			"
Dutt & Desai	1965	50	Gangatiri	143±4.7			Arazilines
Jha & Biswas	1964	158	Tharparkar	140.3±0.85			Patna
Mahadevan	1958		Sahiwal	130-153			India
"	1958		Red Sindhi	114-160			"
"	1958		Tharparkar	138-169			"
"	1958		Gir	133			"
"	1958		Kenkrej	153			"
"	1958		Hariana	194			"
Sharma *et al*	1951		Hariana	258			Hissar
Sikka	1931	1844	Sahiwal	119±1.83			Militiry Farms
Singh	1959	286	Hariana	162.09±4.7	101.01	62.21	Mathura, Madhrikund, Babugarh, Bharari
"	1959	286	Hariana	169 1st. dry period			"
"	1959	188	"	158.6 2nd. "			"
"	1959	112	"	150 3rd. "			"

animals. In Swedish cattle the repeatability of the dry period was found 0.22 (Johansson and Hansson, 1940); 0.18 a nd 0.20 (Johansson, 1949). Singh (1959) estimated repeatability of dry period on the basis of 336 records of 112 Hariana cows. The repeatability estimate obtained was -0.14, indicating that the heritability of this trait was essentially zero.

(c) Correlation:-

The phenotypic correlation between preceding dry period and milk yield in subsequent lactation was reported to be -0.051 by Asker et al (1958) and -0.355 by Singh (1959). The estimate reported by the latter author was significant at 1 per cent level of probability. On the other hand, Jha and Biswas (1964) reported a highly significant (0.12) positive correlation between preceding dry period and subsequent lactation. Sikka (1931) reported a phenotypic correlation value of 0.076±0.019 between service period and dry period on the basis of 1,844 records of Sahiwal cows maintained at Military Farms in India. Dutt and Desai (1965) estimated correlation between service period and dry period on the basis of records of 50 cows. The correlation coefficient

reported by Dutt and Desai was 0.54.

6. SERVICE PERIOD:

The milk yield during the lactation period is influenced by the length of the current and by the length of preceding calving interval or service period. The cal ving interval has two components - gestation period and service period. Since the variation for the gestation length is very small the intercalving period is mostly dependent upon the length of service period.

(a) Average:-

The average service period for various breeds is given in Table 13.

TABLE 13. AVERAGE SERVICE PERIOD

Author	Year	Amount of data	Breed of Cattle	Average ± S.E. Service Period	S.D.	C.V. (%)	Remarks
1	2	3	4	5	6	7	8
Dave & Singh	1934		Red Sindhi	118			I.D.R.I. Bangalore
Dutt and Desai	1965	50	Gangatiri	118.0±1.3			Araziline

Table Contd....

TABLE 13. (Contd.....)

1	2	3	4	5	6	7	8
Kohli *et al*	1961	230	Hariana	314			
Kohli and Acharya	1961	247	Hariana	288±5.11			
Prasad	1958	365	Tharparkar	131	79.8	60.7	
Sharma *et al*	1951	230	Hariana	233			Hissar
Sikka	1931	1844	Sahiwal	123.8±1.7			
Singh & Dutt	1963		Sahiwal	126±6.0			
Venkayya and Anantakrishnan	1958		Red Sindhi	156		63.4	

The service period reported in the literature has varied from 118-314 days. For profitable milk production, a cow calving after 12-13 months is considered satisfactory. Considering this the service period reported in the literature for Indian breeds of cattle is much higher.

(b) Heritability:-

The estimates of heritability of service period are given in Table 14. The estimates reported by various authors reveal that the service period

has very little genetic variability. Estimates cited ranged from zero heritability to 0.27.

TABLE 14. HERITABILITY OF SERVICE PERIOD OF SOME BREEDS OF CATTLE.

Author	Year	Method of Estimation	Amount of data	Breed of Cattle	Heritability Estimates
Carman	1955		1646		0.06
"	1955		1646		0.15
Kohli *et al*	1961	Intrasire Regression	230	Hariana	0.10±0.17
Olds & Sheath	1953	"	472		27%
Prasad	1958	Paternal Halfsib Correlation		Tharparkar	-0.016
		Intrasire Regression		"	-0.12

(c) Correlation:-

The estimates for genetic and phenotypic correlations between service period and other economic traits as reported in the literature are given in Table 15.

Very few attempts appear to have been made for finding the genetic association of service period with other traits. The phenotypic correlation

between milk yield and service period reported in the literature has ranged from 0.03 to 0.53. All the published reports indicate a positive association between milk yield and service period and some of these estimates are also statistically significant. The length of lactation is reported to be positively correlated with service period. The estimate of phenotypic correlation between preceding dry period and service period have ranged from 0.08 - 0.54. The age at first calving is reported to be significantly negatively correlated with the service period (Sikka, 1931).

TABLE 15. PHENOTYPIC AND GENETIC CORRELATION BETWEEN SERVICE PERIOD AND OTHER TRAITS OF CATTLE

Author	Year	Correlated Traits	Amount of data	Phenotypic Correlation	Genetic Correlation	Breed	Remarks
1	2	3	4	5	6	7	8
Dutt & Desai	1965	Preceding dry period & following service period	50	0.5366		Gangatiri	Arazilines Varanasi
Gaines	1927	Between milk production for the first month of lactation and service period	4671	0.039±0.01		Guernsey	

Table Contd.....

TABLE 15. (Contd....)

1	2	3	4	5	6	7	8
Pajalic	1952	Lactation Period		0.895			Monta Farm
"	1952	Milk yield		0.532			
"	1952	Dry period		0.427			
Ragab et al	1956	Milk yield	294	0.089		Egyptian cows	U.A.R.
Sanders	1927	Milk yield		0.401		British cattle	
Sikka	1931	Preceding dry period	1844	0.076±0.019		Sahiwal	
"	1931	Age at first calving	"	-0.067±0.017		"	
"	1931	Milk yield	"	0.339±0.015**		"	
"	1931	Lactation period	"	0.524		"	
Venkayya & Anantakrishnan	1958	First Lactation Milk Yield	147	0.313**		Red Sindhi	
" "	1958	Second "	131	0.085		"	
" "	1958	Third "	124	0.130		"	
" "	1958	Fourth "	72	0.095		"	
" "	1958	Fith "	79	0.260*		"	
" "	1958	Sixth "	73	0.100		"	
" "	1958	All "	626	0.179**			

* - Significant at 5% leve of probability.

** - Significant at 1% level of probability.

7. INTERCALVING PERIOD:

(a) Average:-

The average calving interval of some breeds of cattle is given in Table 16.

TABLE 16. AVERAGE CALVING INTERVAL OF SOME BREEDS OF CATTLE.

Author	Year	Amount of data	Breed	Average ± S.E Calving Interval	S.D.	C.V. %	Rrmarks
1	2	3	4	5	6	7	8
Amble et al	1958	261	Red Sindhi	18±0.3 month		30	
"		317	Kangayam	16.7±0.3 "		28	
Bhasin & Desai	1967	51	Sahiwal	478.82±15.87			
"	1967	59	Red Sindhi	429.85±15.65			
"	1967	67	Hariana X Sahiwal	431.38±12.87			
"	1967	6	Hariana X Sindhi	440.25±43.95			
"	1967	35	Friesian X Sahiwal	403.66±15.12			
"	1967	27	Friesian X Red Sindhi	411.63±14.63			
"	1967	49	Friesian X Hariana	396.82±22.19			
"	1967	75	Hariana	418.58±21.74			Bassi

Table Contd.....

TABLE 16. (Contd.....)

1	2	3	4	5	6	7	8
Biswal & Rao	1960	104	Red Sindhi	525 days Ist.C.P.			Orissa
"	1960	104	"	467 days 2nd. C.P.			"
"	1960	104	"	454 days 3rd.C.P.	Unweaned		"
"	1960	104	"	445 days 4th.C.P.			"
"	1960	104	"	433 days 5th.C.P.			"
"	1960	104	"	464 days 6th.C.P.			"
"	1960	112	"	413 days 1st.C.P.			"
"	1960	112	"	396 days 2nd.C.P.			"
"	1960	112	"	407 days 3rd.C.P.	Weaned		"
"	1960	112	"	417 days 4th.C.P.			"
"	1960	112	"	393 days 5th.C.P.			"
"	1960	112	"	406 days 6th.C.P.			"
Dhandapani	1962	131	Jersey	13 months			Madras
"	1962	131	Jersey X Sindhi	13.5 "			"

Table contd.....

TABLE 16. (Contd.....)

1	2	3	4	5	6	7	8
Dutt & Desai	1965	50	Gangatiri	411.5 days			Arazilines
Joseph & Dave	1931	369	Montgomery	448 " Weaned			Pusa
"	1931	369	"	559 " Unweaned			"
Kohli et al	1961	230	Hariana	614.2 days			Hissar
Legates	1954	1016		406 "			
Mahadevan	1953	600	Black Sinhala	355 "			Ceylon
Robertson	1950		White Fulani	365 "			Nigeria
Scot	1953		A.I.S.	453 "			
"	1953		Friesi an	534 "			
Sharma et al	1951	230	Hariana	523 "			Hissar
Singh	1957	209	Tharparkar	433.9±7.3 "			Patna
Singh et al	1958	738	Hariana	484±4.8 " Overall averages			Mathura
"	1958	738	Hariana	499±4.93 " Ist.Calving period			"
"	1958	738	Hariana	475±4.93 " 2nd. "	"		"
"	1958	738	Hariana	478±7.82 " 3rd. "	"		"
Singh	1959	164	Hariana	528.6±12.2 Ist. calving interval for dams	156.9	29.6	Mathura Madhurikund, Bharari
"	1959	164	Hariana	486.8±10.1 For daughters in 1st.calving interval	128.1	26.3	"

Table 16 Contd....

TABLE 16. (Contd.....)

1	2	3	4	5	6	7	8
Singh	1959	45	Hariana	449.6 Ist.calving interval			Mathura
"	1959	68	Hariana	440.8 2nd. "			"
"	1959	44	Hariana	465.8 3rd. "			"
"	1959	207	Hariana	452.5±7.8 Overall three calving interval	113.1	25%	"

The optimum length of calving interval seems to be somewhere between 12-15 months. Johansson and Hansson (1940) reported that the shorter calving interval than 320 days caused a decrease of 9 per cent in the 300 day lactation record for the current lactation and, for the following lactation, 3.7 per cent, whereas when the calving interval increased to 450 days, the current lactation yield increased 3.5 per cent, and the yield during the following lactation also increased about 3.5 per cent. On an average, the loss of milk yield per day which accompanies an increasing length of current calving interval is at least partly compensated for by the

favourable effect on the yield during the following lactation.

(b) Heritability:-

Heritability estimates of calving interval are given in Table 17.

TABLE 17. HERITABILITY ESTIMATES OF CALVING INTERVAL IN SOME BREEDS OF CATTLE.

Author	Year	Method of Estimation	Amount of data	Breed	Heritability Estimates	Source of data
1	2	3	4	5	6	7
Amble et al	1958	Intrasire Regression	155	Red Sindhi at Hosur	-0.08±0.20	
"	1958	"	125	Red Sindhi at Bangalore	0.13±0.20	
"	1958	"	223	Kangayam at Hosur	0.11±0.19	
"	1958	"	23	Gir at Bangalore	-0.37±0.48	
"	1958	"	25	Kankrej at Anand	-0.31±0.40	
"	1958	"	204	Tharparkar at Patna	-0.01±0.16	
Brown et al	1954	Half-sib Correlation	251	Angus	0	
Dunbar & Henderson	1953		1015	Holstein Friesian	0.004	
Legates	1954		1016		0	

Table 17. Contd....

TABLE 17. (Contd....)

1	2	3	4	5	6	7
Mishra	1965			Dual purpose cattle	-0.04	U.S.A.
Singh	1958	Intrasire Regression	59	Tharparkar	-0.180. ±0.145	Patna
"	1958	"	59	"	-0.164±0.132	"
"	1959	"	164	Hariana	0.022±0.058	Mathura, Madhurikund, Bharari
Stonaker	1953	"	41	Red Sindh	0.88	Agri.Inst. Allahabad.

From the estimates reported in the literature it can be inferred that the heritability of calving interval is essentially zero. The only exception to this in the cited literature is the estimate of calving interval by Stonaker (1953), who reported an estimate of heritability of calving interval as 0.88.

(c) Correlation:-

The phenotypic correlation between calving interval and milk yield in first lactation was

reported to be significantly positive (0.257) by Asker et al (1958). Lecky (1951) estimated positive phenotypic relationship between calving interval and total milk yield (0.184) and between calving interval and lactation period (0.309). The non-significantly negative (-0.03) relationship between lactation period and previous calving interval has been reported by Thompson et al (1957). No attempt appear to have been made for estimating the genetic correlation between traits involving calving interval.

CHAPTER - III

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

/ CHAPTER - III /

MATERIAL AND METHOD

1. MATERIAL :

Source and Collection of Data:-

The data maintained at the District Dairy Demonstration Farm, Mathura (India), attached to the U.P. College of Veterinary Science and Animal Husbandry, Mathura, were utilized for this study. The farm was established in 1947. The foundation stock was comprised of Hariana animals, transferred from the State Livestock-cum-Agricultural Farms, located at Bharari (District Jhansi) and Madhurikund (District Mathura). Some of the Hariana animals were also purchased and included in the herd.

The Hariana is an Indian dual purpose breed of cattle. This breed is called a dual purpose breed, because it is kept for milk production as well as for getting male calves which are subsequently used for artificial insemination, ploughing and carting. The home of this breed is the area covered by the

districts of Rohtak, Hissar, Gurgaon, part of Karnal and the Delhi Province. Large numbers of the pure Hariana are available in Jhajjar and Rohtak Tehsils of the Rohtak District. The cattle found in Hissar District with loose-thick skin, long sheath, large dewlap, long and thick horns and big drooping ears should be differentiated from the pure Hariana met within the Tehsils of Jhajjar and Rohtak of the Rohtak District, which have a long and narrow face with flat forehead and a well marked bony prominence at the centre of the poll; they have short horns, small ears, fine thin skin close to the body and a small dewlap and a small sheath. This breed is also found in the States of Jind, Nabha, Patiala, Jaipur, Jodhpur, Lahore, Uttar Pradesh, Alwar and Bharatpur.

Hariana cattle are proportionately built and are compact in appearance. The head is carried high and gives them a graceful appearance. The popular colour is white or light grey. In some of the males the head, neck, hump and quarters are dark grey which change to white after castration. The long and narrow face with a flat forehead and a well marked bony prominence at the centre of the poll are the indications of the purity of breed. The horns are

never heavy in true Hariana and are often small, somewhat stumpy. In typical females they emerge from the poll in an outward direction and then curve upwards, slightly forwards and inwards with rather blunt points. They have long narrow face and flat forehead, short curved horns emerging laterally from the outer angles of the poll and curving upwards and inwards in aged animals, narrow poll with its small bony prominence in the centre, small sharp ears which should not droop, moderately long body with short strong neck carried horizontally and a small hump placed well in front of the withers, white skin particularly in the cows should be of very fine texture and close to the body, small dewlap and sheath, compact well formed udder, flat mascular limbs with good feet and fine tail with a black switch reaching to about half-way between hock and the ground.
The Hariana bullocks are good work-animals, particularly for fast ploughing and road transport. The cows are good milkers with an average lactation milk yield 2000-3000 lbs. Kaura (1961). This breed is well adapted to tropical climatic conditions and the available literature indicate every possibility for further improvement in the production of this breed.

The data for the period of last twenty years i.e. from 1947 till April, 1967 were used for this study. The records that considered abnormal due to clerical mistakes, abortions, systematic disorders, death of the calf during lactation or incomplete records due to culling of the cow or cow produced milk only sufficient for the calf, were not considered.

Only farm bred cows have been used for comparing the daughters with their dams because the birth date of the purchased dams could not be traced. Every sire having less than five daughters has been discarded from the analysis.

Weaning is not practised and the calf share was not measured. The test yield was carried out for each cow every fortnight during lactation. The cows are milked twice within twenty four hours.

Only Hariana bulls were used for breeding purposes. The selected males from this herd or from outside have been used for breeding the cows artificially. The selection of female stock was time to time carried on the basis of individual performance and pedigree information. More or less

uniform feeding and management practices were followed at the farm. The ration schedule followed presently is given in the Appendix. The green fodder mostly available at the farm composed of Jwar, Oats, Barley, Berseem etc. according to the season. Grazing is limitted to rainy and post rainy seasons, but in dry seasons there is no grazing and the herd usually go to field for exercise.

The data on following quantitative characters were analysed.

1. Age at First Calving.
2. Gestation Period.
3. Lactation Milk Yield.
4. Lactation Period.
5. Dry Period.
6. Service Period.
7. Intercalving Period.

II. METHODS:

(a) Estimation of Heritability:-

Estimates of heritability were obtained from the regression of offspring on parents.

Intrasire regression of offspring on dam procedure was used. The dam's record was repeated in cases where more than one daughters were available from each dam. The estimate of heritability is obtained by doubling the coefficient of regression of phenotype of the offspring on phenotype for the same trait in the dam. In case of parent-offspring covariance estimate, bias is introduced if there is contribution to the estimate that is not due to the effects of the individual's genes on its own phenotype. The regression estimate gives a more reliable estimate from this point of view. Dickerson (1959) pointed out that the regression of offspring on dam estimate will be biased upward on account of maternal effect, interaction involving additive effects and the correlation of environmental effects of the dam with the direct maternal influences on her offsprings.

It may be pointed out here that in the data used in this study the phenotypic variance of dam might have been reduced by selection practised in the choice of dams. However, Falconer (1960) has pointed out that the expectation of regression of offspring on parent is not changed by such selection. This is because expectation of parent offspring

covariance is reduced in the same proportion as phenotypic variance of the parents. Therefore, the regression of offspring on one parent is a valid measure of half of heritability. However, the parent offspring covariance may not be a valid measure of one half of the additive genetic covariance.

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

$$V_b = \frac{\left[\Sigma Y^2 - \frac{(\Sigma X\ Y)^2}{\Sigma X^2}\right] / N-2}{\Sigma X^2}$$

Where ΣY^2 = Corrected sum of squares for Y, the dependent variable.

ΣX^2 = Corrected sum of squares for X, the independent variable.

ΣXY = Corrected sum of products for X and Y.

N = Total number of dam-daughter pairs.

The standard error ($\sqrt{V_b}$) was multiplied by two to obtain the standard error of the heritability estimate. The significance of the heritability estimate was tested by 't' test (Snedecor, 1956).

(b) Estimates of Genetic and Phenotypic Correlations:-

The estimates of components of covariance used in the estimate of genetic correlation were drived from the expectations of mean cross products, by analysis of covariance as described by Hazel (1943). Hazel (1943) suggested use of either of geometric or arithmetic average of the reciprocal regression (b's) are covariance ($Cov._{IJ}$) of offspring (I_2 or J_2) on parent (I_1 or J_1) for traits I and J.

$$\hat{r}_G = \sqrt{\frac{b_{IJ} \cdot b_{JI}}{b_{I_2I_1} \cdot b_{J_2J_1}}} = \sqrt{\frac{Cov_{I_2J_1} \cdot Cov_{J_2I_1}}{Cov_{I_2I_1} \cdot Cov_{J_2J_1}}}$$

Where $\hat{r}_G$ = Genetic correlation coefficient.

Cov., σ I_2J_1 = Covariance between i^{th} trait in the offspring and j^{th} trait in the dam.

Cov., σ J_2I_1 = Covariance of jth trait in the offspring with i^{th} trait in the dam.

Cov., σ I_2I_1 = Covariance of ith trait in the osspring with i^{th} trait in the dam.

Cov., σ J_2J_1 = Covariance of jth trait in offspring with j^{th} trait in the dam.

These symbols are representative anywhere mentioned in this work.

The exact procedure for the estimation of variance of genetic correlation coefficient is not known.

The phenotypic correlation between two characters was estimated as a ratio of the appropriate covariance or cross products to the product of the phenotypic standard deviations for the two characters (Snedecor, 1956). Symbolically:

$$r = \frac{\Sigma XY}{\sqrt{\Sigma X^2 . \Sigma Y^2}}$$

Where r = Phenotypic correlation coefficient.

ΣX^2 = Corrected sum of squares of character X

ΣY^2 = Corrected sum of squares of character Y

ΣXY = Corrected sum of cross products of the character X with the character Y in the same animal.

The standard error of the phenotypic correlation was determined by the procedure described by Snedecor (1956) as given below:

$$r_{SE} = \frac{1 - r^2}{\sqrt{N - 2}}$$

Where r_{SE} = Standard error of phenotypic correlation coefficient.

r^2 = Square of the phenotypic correlation coefficient.

N-2 = The number of observations minus two.

The phenotypic correlation coefficient was also tested for its significance by the correlation table at N-2 degree of freedom.

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CHAPTER - IV

RESULTS & DISCUSSION

/ CHAPTER - IV /

RESULTS AND DISCUSSION

1. AGE AT FIRST CALVING:

The age at first calving data were available for 120 dam-daughter pairs.

(a) Average:-

The average age at first calving for dams and their daughters was found to be 1256.3±26.9 and 1168.85±19.6 days respectively (Table 18). The figures for dam and daughter's average age at first calving is approximately 42 and 39 months. There appears to be a decline in age at first calving in Hariana cows at the farm. This could be due to some selection practised for reducing the age at first calving and/ or due to improvement in feeding and management conditions. The average age at first calving reported by Amble *et al* (1958), Bhasin and Desai (1967), Dutt and Desai (1965), Johari and Talapatra (1957) and Singh and Desai (1961) are relatively higher

than the present estimate.

TABLE 18. AVERAGE AGE AT FIRST CALVING IN HARIANA CATTLE.

	No.of Animals	Average age at first calving (days)	S.E.	S.D.	C.V. (%)
Dams	120	1256.32 (41.9)	26.9	295.5	23
Daughters	120	1168.85 (39.0)	19.6	215.03	18.39
Both	240	1212.58 (40.4)	23.25	255.26	20.69

The figures in parentheses indicate average age at first calving in months.

(b) Heritability:-

The heritability of age at first calving has been estimated as 0.36±0.12, by intrasire regression of daughter on dam procedure. The variance and covariance components needed for estimating heritability are given in Table 19. The estimate of heritability indicates that the trait is moderately heritable and there can be a reduction in age at first calving through selection and breeding. The estimate of heritability obtained in the present

study compares well with the ones reported by Singh and Desai (1961) and Stonaker (1959).

TABLE 19. ANALYSIS OF VARIANCE AND COVARIANCE FOR ESTIMATING HERITABILITY OF AGE AT FIRST CALVING IN HARIANA COWS.

Source of variation and covariation	d.f.	Mean sum of Squares	Mean sum of cross products	Heritability estimate
Total	119			
Between sires	10	70124.13 N.S.	-51754.85	
Within sires	109	88941.40	16268.30	0.36±0.12**

** - Significant at 1% level of probability.

N.S.- Non-significant.

2. GESTATION PERIOD:

The gestation period data for the first three gestations were analysed. The available number of dam-daughter pairs for the first, second and third gestations were 35, 70 and 46 respectively.

(a) Average:-

The average gestation period for the first,

second and third gestation for the dams and daughters along with measures of dispersion is presented in Table 20. The average gestation period pooled over gestations for dams and daughters separately and also on overall basis is given in the same table. The average gestation period for different gestations have varied very little, averages ranging from 289-295 days. The overall average gestation period as observed in the present study was 291 days. The average gestation period as reported by Sharma et al (1951) and Goswami et al (1963) is of the same order. On the basis of the present study as well as published reports it can be inferred that there is very little variability in the length of gestation.

TABLE 20. AVERAGE GESTATION PERIOD OF HARIANA CATTLE.

	No. of Animals	Av. gestation period (days)	S.E.	S.D.	C.V. (%)
1	2	3	4	5	6
FIRST GESTATION PERIOD:					
Dams	35	289	2.60	15.42	5.32
Daughters	35	295	2.95	17.49	5.92

Table Contd.....

TABLE 20. (Contd...)

1	2	3	4	5	6
SECOND GESTATION PERIOD:					
Dams	70	289	1.68	14.10	7.44
Daughters	70	289	1.55	13.02	4.49
THIRD GESTATION PERIOD:					
Dams	46	293	2.84	19.31	6.57
Daughters	46	291	2.35	15.96	5.47
POOLED THREE GESTATION PERIODS:					
Dams	151	290	1.30	16.03	5.51
Daughters	151	291	1.21	14.93	5.12
Both	302	291	1.25	15.48	5.31

(b) Heritability:-

The heritability of gestation period was analysed on the basis of intrasire regression of daughters on dams. The variance and covariance estimated need for the estimation of heritability of gestation period along with the heritability estimates are given in Table 21. The estimates of heritability for the three gestation periods as well as the pooled

estimate of heritability as obtained in the present study was not significantly different from zero as all the estimates were associated with relatively large standard errors. On the basis of this genetic parameter it can be said that there is little scope for reducing or increasing the gestation period through selection. The heritability of gestation period was reported by Singh *et al* (1958) for Tharparkar cows. The estimates as reported by Singh *et al* was 0.002±0.084.

TABLE 21. ANALYSIS OF VARIANCE AND COVARIANCE FOR ESTIMATING THE HERITABILITY OF GESTATION PERIODS IN HARIANA COWS.

Source of Variation and Covariation	d.f.	M.S.S.	M.S.P.	Heritability
1	2	3	4	5
		FIRST GESTATION PERIOD		
Total	34			
		NS		
Between sires	5	359.446	385.138	
Within sires	29	217.102	9.023	0.08±0.39
		SECOND GESTATION PERIOD		
Total	69			
		NS		
Between sires	8	229.786	47.185	
Within sires	61	194.0378	21.2381	0.210±0.24

Table contd.....

TABLE 21. (Contd.....)

1	2	3	4	5
		THIRD GESTATION PERIOD		
Total	45			
Between sires	4	176.762 NS	167.150	
Within sires	41	392.2670	3.656	0.010±0.24
		POOLED THREE GESTATION PERIODS		
Total	148			
Between sires	17	255.445 NS	51.741	
Within sires	131	261.1857	13.0317	0.09±0.15

NS - Non-significant.

3. LACTATION MILK YIELD:

(a) Average:-

The total lactation milk yields for the first three lactations have been analysed. The average lactation milk yield for the first three lactations as well as the pooled averages for dams and their daughters are given in Table 22. The average total lactation milk yield for first three lactations reveal

that the daughters have on an average given less milk than their dams. This indicates that there has been a decline in the performance of the animals over years. The overall average milk yield for Hariana cows based on the yields in three lactations was found to be 1126.4±26.2 Kgs. Similar observations are obtained in Hariana herds at different farms by various authors. Bhasin and Desai (1967); Kohli and Acharya (1961); Kohli et al (1961); Sharma et al (1951); Singh and Prasad (1967) and Singh (1959) as shown in Table 6.

Various workers have reported higher averages in other Indian dairy breeds and crossbreds than those for Hariana cattle. Bhasin and Desai (1967) in Sahiwal, Red Sindhi, Hariana X Sahiwal, Hariana X Red Sindh, Friesian X Sahiwal, Friesian X Red Sindhi and Friesian X Hariana; Dutt and Desai (1965) in Gangatiri; Mishra and Biswas (1963) in Tharparkar; Sikka (1931) in Sahiwal; Singh and Dutt (1963) in Sahiwal; Venkayya and Anantakrishnan (1956) in Red Sindhi, Gir, and Ayrshire X Red Sindhi as reviewed in Table 7.

TABLE 22. THE AVERAGES OF TOTAL LACTATION MILK YIELD IN HARIANA CATTLE.

	No.of cows	Average of Total Lactation Milk Yield (Kg.)	S.E.	S.D.	C.V. (%)
FIRST TOTAL LACTATION MILK YIELD:					
Dams	202	1243.45	48.12	683.9	55
Daughters	202	1011.04	39.86	566.5	56.03
Both	404	1127.24	43.99	625.2	55.51
SECOND TOTAL LACTATION MILK YIELD:					
Dams	161	1240.95	35.43	449.3	36.20
Daughters	161	971.88	37.66	477.6	49.14
Both	322	1106.41	36.54	463.45	42.67
THIRD TOTAL LACTATION MILK YIELD:					
Dams	87	1252.11	55.96	521.6	41.65
Daughters	87	1070.45	60.87	567.4	53.00
Both	174	1161.28	58.41	544.5	47.32
POOLED THREE TOTAL LACTATION MILK YIELD:					
Dams	450	1244.23	27.22	577.4	46.40
Daughters	450	1008.52	25.24	535.4	53.08
Both	900	1126.37	26.23	556.4	49.74

(b) Heritability:-

The estimates of heritability for the first, second and third lactation milk yield are given in Table 23. Heritability was estimated by intrasire regression of daughter on dam procedure. The sum of squares and cross products needed for the estimation of heritability are also given in the table.

For estimation of heritability of first lactation milk yield, the dams' and their daughters' first lactation milk yields were considered. Similarly for the estimation of heritability of second and third lactation milk yield, the dams and daughters second and third lactation records were paired. The heritability estimate for the first lactation milk yield was 0.50±0.16. The estimate was statistically highly significant. The heritability of second lactation milk yield and that of third lactation milk yield was associated with large standard errors and the estimates were not significantly different from zero. The number of pairs available for estimation of heritability also declined with the increase in the lactation. The pooled estimate of heritability, pooled over all three lactations was

0.26±0.08 being statistically highly significant. The pooled estimate of heritability was based on sufficiently large number of dam-daughter pairs. The estimate was in conformity with the majority of published reports, by Bhasin and Desai (1967) in Hariana; Carneiro (1953) and Gowen (1934) for foreign breeds; Johansson (1954) in Red Sindhi; Kohli et al (1961) in Hariana; Laben and Herman (1950) and Lush et al (1941) in Holstein Friesian; Madden (1954) in Holstein Friesian; Mahadevan (1951) in Ayrshire; Midtlid and Berge (1950) in Norweign cows; Mason and Robertson (1958) in Red Sindhi; Mishra et al (1964) in Tharparkar; Rendel and Robertson (1950); Rognoni and Pasti (1955) in Simmetal and Friesian; Seath (1940) in Iowa and Kansas herds; Shanker (1951) in Michigan herds; Singh et al (1964) in Hariana; Singh et al (1967) in Hariana; Singh and Prasad (1966) in Hariana; Singh and Prasad (1967) in Hariana; Singh (1959) in Hariana; Tabler and Touchberry (1955) in Jersey; Taylor (1955) in Guernsey, Holstein and Jersey; Touchberry (1951); Tyler and Hyatt (1947) in Ayrshire and Yao et al (1954) in Short horn. But the majority of the heritability estimates are not accompanied by standard errors. Although there was a decline in

the estimate of heritability with the advancement of lactation, but since the estimation for second and third lactation milk yield were not significantly different from zero, no inference to the fact that there is a decline in the heritability estimates with the advancement of lactation could be drawn from this study, as has been suggested. Sufficiently large amount of data need to be analyzed before such inference could be drawn.

TABLE 23. ANALYSIS OF VARIANCE AND COVARIANCE FOR ESTIMATING THE HERITABILITIES OF TOTAL LACTATION MILK YIELD IN HARIANA COWS.

Source of Variance and Covariance	d.f.	M. S. S.	M. S. P.	Heritability
1	2	3	4	5
	FIRST TOTAL LACTATION MILK YIELD			
Total	201			
Between sires	17	1271995.25 NS	764724.52	
Within sires	84	861796.68	218237.444	0.50±0.16 **
	SECOND TOTAL LACTATION MILK YIELD			
Total	160			
Between sires	14	187486.98 NS	124548.100	
Within sires	146	203275.430	2997.497	0.020±0.15

Table Contd.....

TABLE 23. (Contd.....)

1	2	3	4	5
	THIRD TOTAL LACTATION MILK YIELD			
Total	86			
Between sires	7	316766.79 NS	25616.005	
Within sires	79	268136.119	-20334.165	-0.15±0.22
	POOLED FIRST THREE TOTAL LACTATION MILK YIELDS			
Total	447			
Between sires	38	696476.43 **	383281.005	
Within sires	409	301349.35	39909.97	0.26±0.08 **

** - Highly significant at 1% level of probability.

NS - Non-significant.

4. LACTATION PERIOD:

(a) Average:-

The average lactation period for Hariana cattle for the different lactations as well as pooled over lactations is presented in Table 24. The overall average lactation period was 285±6.36 days. The length of lactation for all the 3 lactations for the dams

was constantly higher than for their daughters. The published reports on the average lactation period for Hariana breed of cows indicate that the average lactation period is around 300 days (refer Table 10). Somewhat similar averages have been obtained in the present study.

TABLE 24. THE AVERAGE LACTATION PERIOD IN HARIANA CATTLE.

	No. of Cows	Av. Lactation Period (days)	S.E.	S.D.	C.V. (%)
1	2	3	4	5	6
FIRST LACTATION PERIOD:					
Dams	209	324	17.74	256.4	79.04
Daughters	209	265	6.51	94.13	35.51
Both	418	294	12.12	175.26	57.27
SECOND LACTATION PERIOD:					
Dams	153	314	7.54	93.29	29.69
Daughters	153	236	5.21	64.47	27.30
Both	306	275	6.37	78.88	28.49
THIRD LACTATION PERIOD:					
Dams	89	332	12.5	117.9	35.47
Daughters	89	235	7.52	70.92	30.15
Both	178	283	10.01	94.41	32.81

Table Contd.....

TABLE 24. (Contd....)

1	2	3	4	5	6
POOLED THREE LACTATION PERIODS:					
Dams	451	322	8.93	189.7	58.83
Daughters	451	249	3.79	80.51	32.21
Both	902	285	6.36	135.10	45.52

(b) Heritability:-

The analysis of variance and covariance components needed for estimation of heritability of lactation period for the first, second and third lactation as well as for the pooled three lactation periods is given in Table 25. Except for the pooled estimate of heritability (0.06±0.007) all other estimates were statistically not significant and were low. The heritability of lactation period as observed in the present study was relatively lower than those reported by Singh (1959) and Singh and Prasad (1956). Lush and Shultz (1936) reported that the variability in lactation period in foreign breeds is about 10%.

Looking at the estimate of heritability

it appears that there is little genetic variability for this trait in the herd and the lower duration of lactation for the daughters in various lactations as compared to the corresponding lactations of the dams may be a reflection on the managemental conditions provided to the animals.

TABLE 25. THE ANALYSIS OF VARIANCE AND COVARIANCE FOR THE HERITABILITY ESTIMATES OF LACTATION PERIODS IN HARIANA CATTLE.

Source of Variance & Covariance	d.f	M. S. S.	M. S. P.	Heritability
1	2	3	4	5
		FIRST LACTATION PERIOD		
Total	208			
		NS		
Between sires	17	13074.255	13346.836	
Within sires	191	70447.47	1957.99	0.050±0.030
		SECOND LACTATION PERIOD		
Total	152			
		**		
Between sires	13	20930.298	7907.702	
Within sires	139	7561.240	498.04	0.170±0.070

Table Contd.....

TABLE 25. (Contd.....)

1	2	3	4	5
THIRD LACTATION PERIOD				
Total	88			
Between sires	7	31891.232 *	17645.873	
Within sires	81	12139.102	384.681	0.060±0.120
POOLED THREE LACTATION PERIODS				
Total	448			
Between sires	37	19394.455 NS	12249.120	
Within sires	411	37687.940	1154.17	0.060±0.007 **

** - Highly significant at 1% level of probability

* - Significant at 5% level of probability

NS - Non-significant.

5. DRY PERIOD:

(a) Average:-

The averages for the first three dry periods along with measures of dispersion are presented in Table 26. The averages have been calculated for dams

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and their daughters separately and were then pooled for each dry period. The average dry period for dams has ranged from 130-134 days and for daughters it has ranged from 161-181 days. The overall average dry period for dams, daughters and pooled average over dams and daughters was 132, 172 and 152 days respectively. The average dry period as obtained in this study indicates that the cows remained unproductive for long period which is undesirable from economic point of view. Similar averages have been found in Hariana cows by Mahadevan (1958) and Singh (1959). However, Sharma et al (1951) reported the higher average dry period for Hariana cows.

Singh (1959) indicated that there would be no advantage if a dry period of more than 90 days is given. He further cited that a dry period of more than 150 days may be disadvantageous for milk production and suggested that the optimum dry period should be between 60 and 90 days.

The average dry period for other breeds of cattle as reported by Biswal and Rao (1960) in Red Sindhi; Dutt and Desai (1965) in Gangatiri; Jha and Biswas (1964) in Tharparkar; Mahadevan (1958) in

Sahiwal, Red Sindhi, Tharparkar, Gir and Kankrej as in Table 12 was lower than in the present study.

TABLE 26. THE AVERAGE DRY PERIOD IN HARIANA COWS.

	No.of cows	Average dry period (days)	S.E.	S.D.	C.V. (%)
FIRST DRY PERIOD:					
Dams	168	133	7.07	91.70	68.69
Daughters	168	181	11.04	143.10	78.73
Both	336	157	9.5	117.4	73.71
SECOND DRY PERIOD:					
Dams	104	130	8.59	87.56	66.88
Daughters	104	165	9.17	93.04	56.37
Both	208	147	8.88	90.3	61.62
THIRD DRY PERIOD:					
Dams	64	134	12.15	97.27	72.10
Daughters	64	161	11.47	91.80	56.76
Both	128	147	11.81	94.53	64.43
POOLED THREE DRY PERIODS:					
Dams	336	132	4.79	91.26	68.63
Daughters	336	172	6.55	120.2	69.57
Both	672	152	5.67	80.60	69.10

(b) Heritability:-

The variance and covariance components needed for the estimation of heritability for dry period are given in Table 27. The estimates for first, second and third dry period as well as the pooled estimates of heritability were of low magnitude and were not different from zero. From the low heritability it may be concluded that the genetic make-up has a minor role, if any, to control the dry period and it is mainly dependent upon environmental factors. Similar findings have been reported by Mahadevan (1958), who concluded that in order to reduce the length of dry period the managemental technique is to be improved.

The repeatability estimates for dry period have been reported by Johansson and Hansson (1940); Johansson (1949); Singh (1959). The estimates were of low magnitude. Since the repeatability may be taken as upper limit of heritability, the heritability estimates obtained in the present investigation are in conformity with the reports cited.

TABLE 27. ANALYSIS OF VARIANCE AND COVARIANCE FOR THE HERITABILITY ESTIMATES OF DRY PERIOD.

Source of Variance & Covariance	d.f.	M.S.S.	M.S.P.	Heritability
		FIRST DRY PERIOD		
Total	167			
Between sires	13	15248.41*	13571.88	
Within sires	154	7833.01	632.19	0.160±0.220
		SECOND DRY PERIOD		
Total	103			
Between sires	9	8186.20 NS	250.54	
Within sires	94	7618.50	281.72	0.070±0.210
		THIRD DRY PERIOD		
Total	63			
Between sires	6	14494.56 NS	9802.36	
Within sires	57	8933.19	-851.55	-0.190±0.250
		POOLED THREE DRY PERIODS		
Total	333			
Between sires	28	12816.87 NS	4281.25	
Within sires	305	7972.51	246.88	0.060±0.130

* - Significant at 5% level of probability.

NS - Non-significant.

6. SERVICE PERIOD:

(a) Average:-

The averagesfor first, second, third and pooled three service periods based on 74, 41, 16 and 131 dam-daughter pairs are presented in Table 28. The average service period ranged from 117 to 188 days with coefficient of variation ranging from 58.06 per cent to 86.38 per cent. The overall average service period was 160 days for dams, 148 days for daughters and 154 days for both with coefficient of variation of 72.69 per cent, 65.56 per cent and 69.12 per cent respectively.

Similar and even longer service periods have been reported by Dave and Singh (1934) in Red Sindhi, Dutt and Desai (1965) in Gangatiri, Kohli et al (1961) in Hariana, Kohli and Acharya (1961) in Hariana, Prasad (1958) in Tharparkar, Sharma et al (1951) in Hariana, Sikka (1931) in Sahiwal, Singh and Dutt (1963) in Sahiwal, and Venkayya and Anantakrishnan (1958) in Red Sindhi (Table 13).

The length of service period is mainly controlled by environment i.e. better feeding and

management, especially looking-after the cows at post-parturition to see that the normal cows get sexual rest of two months after which they become pregnant. Any negligence may result in long service period and consequently a long calving interval which is undesirable from economic point of view.

TABLE 28. AVERAGE OF SERVICE PERIOD IN HARIANA CATTLE.

	No. of Cows	Average Service Period (days)	S. E.	S. D.	C.V. (%)
1	2	3	4	5	6
FIRST SERVICE PERIOD:					
Dams	74	160	14.07	121.07	75.37
Daughters	74	159	12.44	107.03	67.08
Both	148	159	13.25	114.05	71.22
SECOND SERVICE PERIOD:					
Dams	41	148	13.45	86.12	58.06
Daughters	41	141	13.08	83.76	59.14
Both	82	144	13.26	84.94	58.6
THIRD SERVICE PERIOD:					
Dams	16	188	40.62	162.5	86.38
Daughters	16	117	19.49	77.99	66.34
Both	32	152	30.05	120.24	76.36

Table Contd.....

TABLE 28. (Contd....)

1	2	3	4	5	6
POOLED THREE SERVICE PERIODS:					
Dams	131	160	10.17	116.4	72.69
Daughters	131	148	8.51	97.03	65.56
Both	262	154	9.34	106.71	69.12

(b) Heritability:-

The heritability estimates (Table 29) of first, second, third and pooled three service periods were 0.05±0.19, -0.20±0.30, -0.09±0.04 and -0.02±0.14.

The essentially zero heritability estimates indicate that environment plays a major role in controlling the service period. Similar narrow genetic variability in service period has been reported by Carman (1955), Kohli *et al* (1961), Olds and Seath (1953) and Prasad (1958) as reviewed in Table 14.

TABLE 29. THE ANALYSIS OF VARIANCE AND COVARIANCE FOR THE HERITABILITY ESTIMATES OF SERVICE PERIODS IN HARIANA COWS.

Source of Variance and Covariance	d.f.	M.S.S.	M.S.P.	Heritability
FIRST SERVICE PERIOD				
Total	73			
Between sires	9	6344.57 NS	5913.27	
Within sires	64	15827.56	412.20	0.05±0.19
SECOND SERVICE PERIOD				
Total	40			
Between sires	4	1451.07 NS	224.67	
Within sires	36	8080.40	-816.13	-0.20±0.30
THIRD SERVICE PERIOD				
Total	15			
Between sires	1	81302.8 NS	13350.2	
Within sires	14	22519.37	-1067.37	-0.09±0.04 *
POOLED THREE SERVICE PERIODS				
Total	128			
Between sires	14	10300.59 NS	4819.16	
Within sires	114	14202.89	-157.39	-0.02±0.14

* - Significant at 5% level of probability

NS - Non-significant.

7. INTERCALVING PERIOD:

(a) Average:-

The average of intercalving period for dams, daughters and for both based on 163, 95, 55 and 313 dam-daughter pairs are presented in Table 30. The average intercalving period ranged from 437 to 472 days for dams, while that of daughters ranged from 394 to 440 days. The overall average intercalving period was 460 days for dams, 424 days for daughters and 442 days for both.

The intercalving period is mainly affected by service period because the gestation period is generally constant. In this study it can be seen that the daughters in the third lactation got a minimum service period 117 days with a minimum lactation period of 235 days and a minimum dry period of 161 days and have produced the maximum milk yield of 1070 Kgs., with shortest intercalving period of 394 days. Whereas with longest intercalving period of 440 days in first lactation they produced 1011 Kgs. of milk with a dry period of 181 days and lactation period of 265 days and service period of 159 days. The above position indicates that lengthening the

dry period and service period more than optimum has no advantages but it is disadvantageous because they increase the intercalving period.

Similar and longer intercalving periods in Hariana cows have been reported by Bhasin and Desai (1967), Kohli et al (1961), Sharma et al (1951) Singh et al (1958), and Singh (1959).

Somewhat similar or lesser intercalving periods have been reported by Amble et al (1958) Asker et al (1958), Bhasin and Desai (1967), Biswal and Rao (1960), Dhandapani (1962), Dutt and Desai (1965), Joseph and Dave (1931), Legates (1954), Mahadevan (1953), Robertson (1950), Scot (1953) and Singh (1957) for other breeds of cattle and the crossbreds, reviewed in Table 13 .

TABLE 30. THE AVERAGE INTERCALVING PERIOD IN HARIANA CATTLE.

	No. of Cows	Av. of Intercalving period (days)	S. E.	S. D.	C.V. (%)
1	2	3	4	5	6
		FIRST INTERCALVING PERIOD			
Dams	163	472	10.57	134.9	28.54
Daughters	163	440	9.46	120.8	27.39
Both	326	456	10.01	127.8	27.96

Table Contd.....

TABLE 30. (Contd.....)

1	2	3	4	5	6
SECOND INTERCALVING PERIOD:					
Dams	95	437	9.17	89.4	20.43
Daughters	95	414	8.79	85.71	20.68
Both	190	425	8.98	87.55	20.55
THIRD INTERCALVING PERIOD:					
Dams	55	463	18.39	136.3	29.39
Daughters	55	394	11.80	87.46	22.18
Both	110	433	15.09	111.88	25.78
POOLED THREE INTERCALVING PERIODS:					
Dams	313	460	6.93	122.7	26.65
Daughters	313	424	5.95	105.42	24.82
Both	626	442	6.44	114.06	25.73

(b) Heritability:-

The heritability estimates of first, second, third and pooled three intercalving periods based on

163, 95, 55 and 313 dam-daughter pairs were 0.05± 0.14, -0.21±0.18, 0.17±0.19 and 0.03±0.005 respectively (Table 31). The pooled estimate of heritability was low but highly significant. All the heritability estimates were essentially nearly zero. The variance and covariance components needed for the estimation of heritability of intercalving periods are presented in Table 31.

Stonaker (1953) has reported a very high heritability (0.88) of calving interval in Red Sindhi but the other authors, Amble et al (1958); Brown et al (1954); Dunbar and Henderson (1953), Legates (1954); Mishra (1965); Singh (1958); and Singh (1959), as in Table 17 have reported values in aggrement with the present study.

The intercalving period in this herd showed little genetic variability, so selection to improve this trait will not be beneficial. Improving the environment will be of major effect. The ability to conceive and detection of heat may be the most important factors influencing the intercalving period.

TABLE 31. THE ANALYSIS OF VARIANCE AND COVARIANCE FOR THE HERITABILITY ESTIMATES OF INTER-CALVING PERIOD IN HARIANA COWS.

Source of Variance and Covariance	No. of Cows	M.S.S.	M.S.P.	Heritability
		FIRST INTERCALVING PERIOD		
Total	162			
Between sires	13	23663.24 NS	7059.15	
Within sires	149	17726.57	494.47	0.05±0.14
		SECOND INTERCALVING PERIOD		
Total	94			
Between sires	8	6243.63 NS	1392.29	
Within sires	86	8167.37	-892.75	-0.21±0.18
		THIRD INTERCALVING PERIOD		
Total	54			
Between sires	5	38368.18 NS	7800.40	
Within sires	49	16568.10	1463.75	0.17±0.19
		POOLED THREE INTERCALVING PERIODS		
Total	310			
Between sires	26	21131.23 NS	5458.05	
Within sires	284	14632.01	241.63	0.03±0.005 **

** - Highly significant at 1% level of probability.

NS - Non-significant.

8. INTERRELATIONSHIP:

The estimates of phenotypic and genetic correlations of age at first calving with milk yield in different lactations, lactation period in different lactations and service period are presented in Table 32.

TABLE NO. 32. ESTIMATES OF PHENOTYPIC AND GENETIC CORRELATIONS OF AGE AT FIRST CALVING WITH MILK YIELD, LACTATION PERIOD AND SERVICE PERIOD IN HARIANA COWS.

Correlation	Correlation Between Age At First Calving and:								
	Milk Yield in different Lactations				Lactation Period				Service Period
	1st.	2nd.	3rd.	Pooled	1st.	2nd.	3rd.	Pooled	Pooled 3
Phenotypic	0.17* ± 0.06	0.12 ± 0.08	0.21 ± 0.13	0.16** ± 0.04	0.13 ± 0.07	0.26** ± 0.07	0.41** ± 0.09	0.16** ± 0.04	0.02 ± 0.06
	(107)	(73)	(27)	(207)	(110)	(72)	(38)	(220)	(105)
Genetic	0.23	-0.36	0.21	0.23	0.43	0.76	0.46	0.45	-0.14
	(107)	(73)	(27)	(207)	(110)	(72)	(38)	(220)	(105)

* - Significant at 5% level of probability.

** - Significant at 1% level of probability.

( ) - Figures in parentheses indicate the number of cows in pairs.

The phenotypic correlation between age at first calving and milk yield for the three lactations

was positive. The pooled estimate (0.16±0.04) was significant at 1% level of probability, indicating that on an average the milk yield increases with the increase in age at first calving. The genetic correlation between the two traits was also positive for first, third and for the pooled three lactations. The estimate for the second lactation milk yield was negative. Since the estimates were different in sign for various lactations, no definite conclusion could be drawn. From the pooled estimate it appears that there is some positive genetic association between age at first calving and milk yield.

In the literature the phenotypic association between age at first calving and milk yield has been reported to be varying from low (Bhasin & Desai, 1967; Ragab et al, 1954; Sundaresan et al, 1954) to high (Batra and Desai, 1964; Singh, 1961; and Venkayya, and Anantakrishnan, 1956) values, as it is reviewed in Table No. 4.

The estimate of phenotypic correlation between age at first calving and lactation period in various lactations has revealed that as the age at first calving increases, the lactation period in various lactations increases significantly.

The estimates of genetic correlation between age at first calving and lactation period indicate a moderately high genetic association between the two traits. The estimate of genetic correlation of age at first calving with milk yield and lactation period suggests that it may not be desirable to reduce the age at first calving beyond the optimum level.

In order to know the association between milk yield and lactation period, the genetic and phenotypic correlations between the two traits have been calculated. The phenotypic correlation between first lactation milk yield and first lactation period was 0.61±0.03 and for second lactation milk yield and second lactation period 0.08±0.05. The estimates of phenotypic correlation between first lactation milk yield and first lactation period were significant at 1% level of probability. The genetic correlation between milk yield and lactation period for the first and second lactations was, however, low. The estimates of genetic correlation between first lactation milk yield and first lactation period and for second lactation milk yield and second lactation period were 0.012 and -0.07 respectively. The estimates of genetic and phenotypic

correlation indicate that the length of lactation is dependent mainly upon the management practices.

Since the number of observations for each service period was small, estimates of genetic and phenotypic correlations between age at first calving and pooled first three service periods were made and are also presented in Table No. 32. Both the genetic and phenotypic correlations were of low magnitude. Sikka (1951) has reported a phenotypic correlation between age at first calving and service period to be -0.07±0.02. From the estimate reported in the present study as well as from the published report it appears that the service period is independent of age at first calving.

CHAPTER - V

S U M M A R Y

CHAPTER - V

S U M M A R Y

The data for the last 20 years, maintained at the District Dairy Demonstration Farm, Mathura were utilized for this study. The records of age at first calving, gestation period, milk yield, lactation period, dry period, service period and intercalving period for the Hariana herd were analysed. The averages for above mentioned traits were 40.4 months, 291 days, 1126.4 Kg., 285 days, 152 days, 154 days and 442 days respectively. The heritability estimates on the basis of intra-sire regression of daughter on dam for the above traits were 0.36±0.12, 0.09±0.15, 0.26±0.08, 0.06±0.007, 0.06±0.13, -0.02±0.14 and 0.03±0.005 respectively. The heritability estimates for age at first calving, milk yield, lactation period and intercalving period were significantly different from zero, indicating that genetic improvement with respect to above traits is possible through proper breeding and selection procedure.

The phenotypic and genetic correlation of age at first calving with milk yield, lactation period and service period were also estimated. There was significantly positive correlation of age at first calving with milk yield and lactation period. Overall estimate of genetic correlation of age at first calving with milk yield and lactation period was 0.23 and 0.45 respectively. There was significantly positive phenotypic correlation between milk yield and lactation period and low genetic correlation between the two traits. The service period was found to be independent of the age at first calving.

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LITERATURE CITED

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A P P E N D I X

A P P E N D I X

TABLE (i) THE AVERAGES OF AGE AT FIRST CALVING, GESTATION PERIOD, MILK YIELD, LACTATION PERIOD, DRY PERIOD, SERVICE PERIOD AND INTERCALVING PERIOD IN HARIANA COWS.

Traits	No. of Cows	Average	S.E.	S.D.	C.V. (%)
1	2	3	4	5	6
AGE AT FIRST CALVING:					
Dams	120	1256.32	26.9	295.5	23
Daughters	120	1168.85	19.6	215.03	18.39
Both	240	1212.58	23.25	255.26	20.69
FIRST GESTATION PERIOD:					
Dams	35	289	2.60	15.42	5.32
Daughters	35	295	2.95	17.49	5.92
SECOND GESTATION PERIOD:					
Dams	70	289	1.68	14.10	7.44
Daughters	70	289	1.55	13.02	4.49
THIRD GESTATION PERIOD:					
Dams	46	293	2.84	19.31	6,57
Daughters	46	291	2.35	15.96	5.47
POOLED THREE GESTATION PERIODS:					
Dams	151	290	1.30	16.03	5.51
Daughters	151	291	1.21	14.93	5.12
Both	302	291	1.25	15.48	5.31

Table contd.....

TABLE (i) Contd....

1		2	3	4	5	6
FIRST TOTAL LACTATION MILK YIELD:						
	Dams	202	1243.45	48.12	683.9	55
	Daughters	202	1011.04	39.86	566.5	56.03
	Both	404	1127.24	43.99	625.2	55.51
SECOND TOTAL LACTATION MILK YIELD:						
	Dams	161	1240.95	35.43	449.3	36.20
	Daughters	161	971.88	37.66	477.6	49.14
	Both	322	1106.41	36.54	463.45	42.67
THIRD TOTAL LACTATION MILK YIELD:						
	Dams	87	1252.11	55.96	521.6	41.65
	Daughters	87	1070.45	60.87	567.4	53.00
	Both	174	1161.28	58.41	544.5	47.32
POOLED THREE TOTAL LACTATION MILK YIELDS:						
	Dams	450	1244.23	27.22	577.4	46.40
	Daughters	450	1008.52	25.24	535.4	53.08
	Both	900	1126.37	26.23	556.4	49.74
FIRST LACTATION PERIOD:						
	Dams	209	324	17.74	256.4	79.04
	Daughters	209	265	6.51	94.13	35.51
	Both	418	294	12.12	175.26	57.27

Table Contd.....

TABLE (i) Contd.....

1	2	3	4	5	6
SECOND LACTATION PERIOD:					
Dams	153	314	7.54	93.29	29.69
Daughters	153	236	5.21	64.47	27.30
Both	306	275	6.37	78.88	28.49
THIRD LACTATION PERIOD:					
Dams	89	332	12.5	117.9	35.47
Daughters	89	235	7.52	70.92	30.15
Both	178	283	10.01	94.41	32.81
POOLED THREE LACTATION PERIODS:					
Dams	451	322	8.93	189.7	58.83
Daughters	451	249	3.79	80.51	32.21
Both	902	285	6.36	135.10	45.52
FIRST DRY PERIOD:					
Dams	168	133	7.07	91.70	68.69
Daughters	168	181	11.04	143.10	78.73
Both	336	157	9.5	117.4	73.71
SECOND DRY PERIOD:					
Dams	104	130	8.59	87.56	66.88
Daughters	104	165	9.17	93.04	56.37
Both	208	147	8.88	90.3	61.62
THIRD DRY PERIOD:					
Dams	64	134	12.15	97.27	72.10
Daughters	64	161	11.47	91.80	56.76
Both	128	147	11.81	94.53	64,43

Table Contd....

TABLE (i) Contd.....

1	2	3	4	5	6
POOLED THREE DRY PERIODS:					
Dams	336	132	4.79	91.26	68.63
Daughters	336	172	6.55	120.2	69.57
Both	672	152	5.67	80.60	69.10
FIRST SERVICE PERIOD:					
Dams	74	160	14.07	121.07	75.37
Daughters	74	159	12.44	107.03	67.08
Both	148	159	13.25	114.05	71.22
SECOND SERVICE PERIOD:					
Dams	41	148	13.45	86.12	58.06
Daughters	41	141	13.08	83.76	59.14
Both	82	144	13.26	84.94	58.6
THIRD SERVICE PERIOD					
Dams	16	188	40.62	162.5	86.38
Daughters	16	117	19.49	77.99	66.34
Both	32	152	30.05	120.24	76.36
POOLED THREE SERVICE PERIOD:					
Dams	131	160	10.17	116.4	72.69
Daughters	131	148	8.51	97.03	65.56
Both	262	154	9.34	106.71	69.12

Table Contd.....

TABLE NO. (i) Contd.....

*1	2	3	4	5	6
FIRST INTERCALVING PERIOD:					
Dams	163	472	10.57	134.9	28.54
Daughters	163	440	9,46	120.8	27.39
Both	326	456	10.01	127.8	27.96
SECOND INTERCALVING PERIOD:					
Dams	95	437	19.17	89.4	20.43
Daughters	95	414	8.79	85.71	20.68
Both	190	425	8.98	87.55	20.55
THIRD INTERCALVING PERIOD:					
Dams	55	463	18.39	136.3	29.39
Daughters	55	394	11.80	87.46	22.18
Both	110	433	15.09	111.83	25.78
POOLED THREE INTERCALVING PERIODS:					
Dams	313	460	6.93	122.7	26.65
Daughters	313	424	5.95	105.42	24.82
Both	626	442	6.44	114.06	25.73

TABLE (ii) THE GENETIC AND PHENOTYPIC CORRELATIONS BETWEEN AGE AT FIRST CALVING AND OTHER TRAITS IN HARIANA COWS:

Correlated Traits	Genetic Correlation	No. of cows in pairs	Phenotypic Correlation Coefficients			
			Dams	Daughters	Pooled	No. of Cows
Age at first calving and first lactation milk yield	0.23	107	0.14*±0.09	0.25**±0.09	0.17*±0.06	214
" " & 2nd. "	-0.36	73	-0.11±0.11	0.13±0.11	0.12±0.08	146
" " & 3rd. "	0.21	27	0.08±0.19	0.11±0.19	0.21±0.13	54
" " & pooled three "	0.23	207	0.07±0.06	0.09±0.06	0.16**±0.04	414
" " & 1st. lactation period	0.43	110	0.01±0.09	0.01±0.09	0.13±0.07	220
" " & 2nd. "	0.76	72	0.15±0.11	0.25*±0.11	0.26**±0.07	144
" " & 3rd. "	0.46	38	0.18±0.16	0.71**±0.08	0.41**±0.09	76
" " & pooled 3"	0.45	220	0.0±0.06	0.33**±0.06	0.16**±0.04	440
" " & " 3 Service periods	-0.14	105	0.06±0.09	0.01±0.09	0.02±0.06	210
. . . . .			. . . . .	. . . . .	. . . . .	. . . . .
First lactation milk yield & 1st. lactation period	0.12	196	0.68**±0.03	0.53**±0.05	0.61**±0.03	392
Second " " & 2nd. "	-0.07	152	0.01±0.08	0.06±0.08	0.08±0.05	304

* - Significant at 5% level of probability.

** - Significant at 1% level of probability.

TABLE (iii) COMMONLY USED CONCENTRATE AND MINERAL MIXTURES AT THE DISTRICT DAIRY DEMONSTRATION FARM, MATHURA, INDIA.

(A)

Composition of Concentrate Mixture:		Composition of Mineral Mixture:	
Gram crushed ...	... 30%	Steamed bone meal ...	75 parts
Barley " ...	... 25%	Common salt ...	... 25 "
Wheat bran ...	... 25%	Copper sulphate	... 0.5 "
Ground nut cake ..	... 20%	Lime stone ...	... 5 "
Bhusa (Straw)	ad lib	Manganese sulphate	... 0.5 "
		Cobalt chloride	... 0.05"
		Pot. Iodide	... 0.05"

N.B. This mixture is added to the concentrate mixture in the ratio of 3%.

RATION SCHEDULE

Class of Animals	Maintenance Ration	Production Ration
Hariana cows in milk	3 lb./head	1/3rd.of milk yield
Dry cows (non pregnant)	3 lb./ "	-
Dry cows (pregnant) over 6 months	5-6 lb./ "	-
Pregnant heifers over 6 mth.	6 lb./ "	-
Suckling calves upto 6 "	2 lb./ "	-
Growing calves 6-9 months	3 lb./ "	-
" "over 9 "	4 lb./ "	-

Contd.....

TABLE (iii) Contd....

(B) Composition of Concentrate Mixture:

Gram ...	15% or	30%
Barley ...	15% or	25%
Wheat bran	50% or	25%
Ground nut cake	20% or	20%
Bhusa (Straw)	ad lib	ad lib

Composition of Mineral Mixture:

Steamed bone meal ...	70 parts
Common salt ...	25 "
Chalk ...	5 "
Pot. iodide ...	0.05"
Manganese sulphate ..	0.5 "
Cobalt sulphate ...	0.5 "

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(C) Bran ... 40%

Barley ... 20%

Ground nut cake ... 20%

Gram ... 20%

I.C.I. Churan Mixture is given at the rate of 3% of the concentrate mixture

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RATION SCHEDULE

Class of Animals	Maintenance Ration	Production Ration
Hariana cows in milk	1-1/4 Kg./head	2/5 Kg./head of M.Y.
Pregnant cows above 3 mth.	3 Kg./ "	2/5 Kg./ " "
Pregnant cows " 6 "	4 Kg./ " (steaming ration)	2/5 Kg./ " "
Calves above 3 months & below 1 year	1 Kg./ "	-
Calves above 1 year & below 3 years	2 Kg./ "	-
Bulls	3 Kg./ "	-

Contd.....

Table (iii) Contd.....

(D)

Composition of Concentrate Mixture:			Composition of Mineral Mixture:		
Wheat bran	...	65%	Supermendif	...	1%
G.N.cake	...	20%	Common salt	...	1%
Barley	...	15%			

RATION SCHEDULE

Class of Animals	Maintenance Ration	Roughage (Straw)	Production Ration
Hariana cows in milk	1.25 Kg./head	10 Kg.	1/3 of M.Y.
	+1.00 Kg./ "for 22 1st. calvers	5 Kg.(Barseem)	
" dry	1.5 Kg./head	"	-
" steaming	2.5 Kg./ "	"	-
Hariana heifers 1-2 yrs.	1.5 Kg. / "	5 Kg.	-
" " above 2 yrs.	2 Kg. / "	7 Kg.	-
Male calves 1-2 yrs.	2.00 Kg./ "	5 Kg.	-
" above 2 yrs.	2.5 Kg./ "	7 Kg.	-
Hariana calves both sex	1.0 Kg./ "	3 Kg.	-
Hariana bulls	2.5 Kg./ "	10 Kg.	-
" bullocks	2.0 Kg./ "	10 Kg.	

Contd.....

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