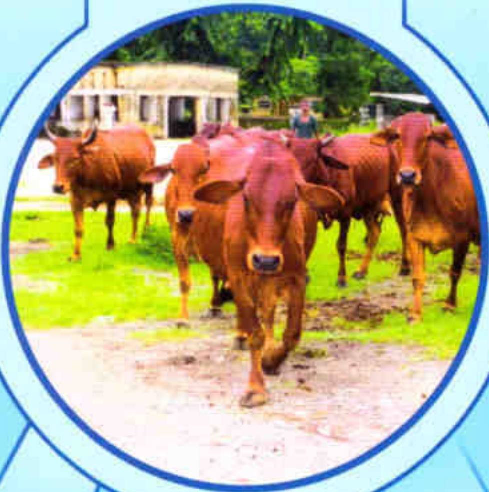
Cattle Genetic Resources of India

RED SINDHI



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PREFACE

Red Sindhi is an important milch breed of Indian cattle. This breed was originated from the Sindh state of Pakistan. The animals of the breed are heavy and heat tolerant. Cows of the breed are good milkers and milk potential of the cows is comparable with Sahiwal breed. The Red Sindhi breed was exported to more than 20 countries including America, Australia, Phillipines, Brazil and Sri Lanka etc. Red Sindhi animals are red in Colour and have good appearance. The females are producing up to 4179 kg of milk in a lactation and calve regularly. In India, breed is facing endangered population status as animals of the breed are not available in field condition. Animals of this breed are available only at few organized herds, there are approximately 1000 Red Sindhi pure animals in the country. In the present document an attempt has been made to detail the characteristics of the breed based on information generated and compiling all the possible available information especially on status of the breed, physical characteristics, morphometric traits, microsatellite genetic studies and production and reproduction performance. This monograph will be useful to researchers, academicians and planners for formulating programmes and strategies for the improvement and conservation of the breed.

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Authors

CONTENTS

1.0 Introduction

Indian cattle population was increased by 6.98% during 1987 to 1997 but subsequently declined by 10.06% during 1997 to 2003. As per Livestock census, 2003 there are 185.18 million cattle heads in the country . There are 30 well defined breeds of cattle (Pundir and Sahai, 1997; Nivsarkar *et al.*, 2000; Pundir and Ahlawat, 2007) used for milk, draft or both the purposes. Among the indigenous cattle breeds Sahiwal, Red Sindhi, Gir, Tharparkar and Rathi are reared mainly for milk production. All the Indian cattle milch breeds are showing decline in their population in the respective breeding tract which may be due to fact that buffalo has largely replaced cows for milk production and also crossbreeding.

Red Sindhi is an important milch breed of cattle. This breed was originated from the Sindh state of Pakistan. The animals of the breed are heavy and heat tolerant. Cows of the breed are good milkers and milk potential of the cows is comparable with Sahiwal breed. The Red Sindhi breed was exported to more than 20 countries including America, Australia, Phillipines, Brazil and Sri Lanka etc. In India, breed is facing endangered population status as animals of the breed are not available in field condition. Breed is presently maintained only in few organised herds of the country. Red Sindhi animals are red in colour and have good appearance. The females are good milkers producing up to 4179 kg of milk in a lactation and calve regularly. In India animals of this breed are available only at few organized herds and almost completely missing in the field conditions. There are approximetly less than 1000 Red Sindhi pure animals in the country.

The crossbreeding of Red Sindhi cattle breed with Jersey was initiated in early seventies to evolve better germplasm for the milk production in the country. Different reports revealed that crossbred cows are not good as per expectation due to segregation effects from F_1 to F_2, and non availability of desired selection pressure in F_1 for selection of future bulls. The breed was used to develop Karan Swiss cattle by crossing with Brown Swiss at National Dairy Research Institute (NDRI), Karnal. In Australia, local breeds were crossed with Red Sindhi to develop a new crossbred Australian Milking Zebu (AMZ).

Red Sindhi is one of the important dairy cattle breeds in Indian sub-continent. Realizing its potential, the Government of India established one Central Cattle Breeding Farm at Chiplima, Orissa in 1968. The original mandate of the farm was to carry out progeny testing for Red Sindhi. In each set, 2 bulls were to be selected from 8 bulls, which were to be used extensively through frozen semen technology. In addition, the farm was also to produce 80 high graded bulls to be distributed to different states. In 1989-90, the mandate was revised to keep 50 elite and best Red Sindhi cows and followers as nucleus herd to conserve the Red Sindhi breed. Total herd strength should not exceed 120 and 50 Red Sindhi cows next in superiority to the above should be kept for production of crossbred bulls and heifers.

2.0 Survey

A survey was conducted in Kalsi (Sahaspur, Hari Singh, Pura, Kalsi, Balwar, Jeevan Nagar, Dak Pathar, Navabagh, Harbatpur, Vikas Nagar, Ambodi villages) Sahiya and Korba teshil of Dehradun district and Nan Bag area (Marod, Pab, Kheirwal) of Tehri district of Uttarakhand to know the breed characteristics and performance. The survey was also conducted in Goudi Tikka, Dugura Manda, Brahmor Tikka, Khaiv Pali and Burla villages of Atarbira taluk of Bargur district of Orissa. The area for survey was selected after discussion with the officials of respective state governments and farm managers of Cattle Breeding Farm (CBF), Kalsi, Dehradun and Central Cattle Breeding Farm (CCBF) Chiplima, Orissa. Two farms of the breed, Cattle Breeding Farm, Kalsi (77 animals) Uttarakhand and Central Cattle Breeding Farm, Chiplima (118 animals) were also studied for breed characterization and its performance. The data comprised of 809 lactation records of 160 Red Sindhi cows, daughters of 24 sires, from 1 to 11^{th} parity and spread over a period of 48 years from 1958 to 2005 maintained at CBF, Kalsi, was analyzed to know the performance of the breed. Physical characteristics were recorded on available animals of different ages and sex at both the farms. Nine different morphometric measurements i.e. body length, height at wither, heart girth, paunch girth, face length, face width, ear length, horn length and tail length without switch were recorded on 97 animals of different age and sex at both of the farms.

3.0 Status of breed

The survey conducted revealed a very gloomy picture about the breed. It was observed that in both of the states Red Sindhi pure animals were not available in field. However, in Orissa, we could locate only two farmers one from Khaiv Pali and other one from Burla villages of Atarbaria taluk of Burgur district having two Red Sindhi cows, each. All the four cows were farm born (CCBF, Chiplima) and farmers got them through auction from the farm. The animals of the breed maintained on different farms spreaded all over the country in India are given in table-1. By considering all the possibilities and means, it may be concluded that breed does not has more than 1000 animals in the country. Breed is facing endangerment and need immediate attention for its conservation. The reasons for non availability of animals of the breed may be that Red Sindhi is a milch breed and had stiffer competition with Sahiwal breed. The choice of farmer between the Red Sindhi and Sahiwal is definitely Sahiwal but Sahiwal is also loosing ground indicating that buffalo is replacing the cattle for milk production. The other reason may be non availability of cow, bull and semen of the breed to the farmers. However, liking of the breed / blood of Red Sindhi by the farmers was noticed during the survey. In Orissa, farmers generating Red Sindhi crosses from local cattle. They are crossing local cattle with Jersey breed and then F_1 with Red Sindhi semen. Theses crosses are well adapted to local climate and performing nicely by producing 6-10 Kg of milk in a day. It was also revealed that farmers had realized the importance of the breed.

Table 1. Strength of animals of Red Sindhi breed of cattle in various farms in India

S.N.	Farm	Total animals	Date of record
1	CBF,Kalsi,Uttaranchal	077	October, 05
2	CBF, Chiplima, Orissa	118	May, 06
3	SAGP, Bidaj, Gujarat	010	August, 05
4	Dhat Moillen, Goa	055	March, 01
5	DLF,Pudukottai,Tamilnadu	016	March, 04
6	DLF,Hosur,Tamilnadu	160	March, 04
7	DLF,Sivagangai,Tamilnadu	010	March, 04

In the surveyed areas major crops grown were wheat (*Triticum aestivum L*), maize (*Zea mays L.*), oat (*Avena sativa*), jowar (*Sorghum bicolor L. Moench*), berseem (Trifolium *alexandrinum L.*). sugarcane *(Saccharum officinarum L.)* and local grasses (Johanson) in Uttarakhand and rice *(Oryza sativa L.)*, maize, jowar, oat and cow pea *(Pisum app.)* in Orissa. Major diseases observed in the area were F.M.D., B.Q. and H.S. Both of the farms followed the proper vaccination schedule. Majority of the farmers had small land holdings i.e. less than one acre of land (Pundir *et al.* 2007d)

4.0 Physical characteristics

Animals of the breed were red in colour showing whitish/gray colour on venteral and medial aspects of the body. Body was large, compact and straight. Face was short and skin was loose. Hump and dewlap were moderate to large in cows and large in bulls/bullocks. Ears were moderate in length and drooping. Eyes were black and shrinking. Hoofs were black. Tail was long touching to ground with black switch. Head was well proportionate. Horns were small to medium (15-22 cm) in length, black in colour, thick at the base and curved outward and then upward. Udder was well developed, capacious and pendulous (Figure 5). In some cases it was bowl type. Teats were long (8-12 cm) and cylindrical shaped (Figure 6). Size of the fore and rear udders were large. Milk veins were large and well developed. Naval flap and penis sheath were large. The temperament of the animals was docile. The calf, group of calves, cows of the breed, elite cows, herds of the breed , bulls of the breed, housing in the area and cows under grazing are shown in figures 1 to 11.

Figure 1. Red Sindhi calf

Figure 2. Herd of Red Sindhi calves

Figure 3. Typical Red Sindhi cow

Figure 4. Typical Red Sindhi cow

Figure 5. Rear view of udder & teats

Figure 6. Shape and size of teats

Figure 7. Herd of Red Sindhi cows

Figure 8. Red Sindhi cows on grazing

5.0 Morphometric characteristics

The mean body measurements at different age, sex and farm are given in table-2. The average body length, height at wither, heart girth, paunch girth, face length, face width, horn length, ear length, tail length without switch and teat length in cows at Kalsi farm were 123, 117, 159, 180, 50, 18, 15, 25, 86 and 11 cm, respectively. The corresponding figures at CCBF Chiplima were 128, 124, 169, 184, 48, 21, 18, 24, 76 and 12 cm. respectively. The cows at CCBF, Chiplima farm had significantly higher height at wither, heart girth and tail length without switch than the Kalsi farm. Higher estimates of body length and similar for height at wither and heart girth were reported by Nivsarkar *et al*. (2000) as compared to the present study. However, Kumar *et al.*(2005) reported lower estimate of body length in cows than the present study.

6.0 Production and reproduction performance

6.1 Performance of the Purebreds

Different production and reproduction performance traits with heritability, available in literature are presented in table 4 for Red Sindhi cattle breed. Pundir *et al*. (2007a) analysed 809 Lactation records of 160 Red Sindhi cows, daughters of 24 sires, from 1 to 11th parity and spread over a period of 48 years from 1958 to 2005 maintained at Uttarakhand State Government Cattle breeding farm, Kalsi, Dehradun. The trait considered in the study were age at first fertile service (days), age at first calving (days), lactation milk yield (kg), lactation length (days), gestation period (days), dry period (days), service period (days) and inter calving period (days). Data was analyzed using least square maximum likelihood program (Harvey, 1990) to estimate the performance of breed and genetic parameters.

Heritabilities and genetic correlations were estimated by paternal half sib correlation method. Age at first fertile service and age at first calving were analyzed using a mixed model incorporating sire as random and sex of calf, birth season and period as fixed effects. All the other traits were analyzed using sire as random and parity, sex of calf, calving season and

Table 2. Means with standard error of different body measurements of red Sindhi cattle breed

Age	Sex	Farm	Body length	Height at wither	Heart girth	Paunch girth	Face length	Face width	Ear length	Horn length	Tail length without switch
Less than 1 year	Male	Kalsi	79.40±3.48 (5)	83.40±0.92 (5)	89.80±2.99 (5)	95.20±3.73 (5)	30.40±0.74 (5)	13.32±0.37 (5)	12.80±0.48 (5)	-	56.60±2.69 (5)
		Chiplima	-	79.54±3.81 (8)	80.01±5.69 (8)	94.92±5.30 (8)	23.68±5.08 (8)	14.0±0.56 (8)	12.87±0.54 (8)	-	47.62±1.83 (8)
		Pooled	79.40±3.48 (5)	81.02±2.37 (13)	83.77±3.83 (13)	95.02±3.45 (13)	20.11±3.85 (13)	16.15±0.76 (13)	12.07±0.47 (13)	-	51.07±1.92 (13)
	Female	Kalsi	73.0 (1)	81.0 (1)	94.0 (1)	100.0 (1)	30.0 (1)	13.0 (1)	12.0 (1)	-	54.0 (1)
		Chiplima	-	82.50±1.68 (6)	90.50±2.37 (6)	92.56±6.49 (6)	28.18±4.96 (6)	14.50±0.0 (6)	14.0±0.77 (6)	-	47.50±2.37 (6)
		Pooled	73.0 (7)	82.28±2.07 (7)	91.0±5.58 (7)	93.62±5.22 (7)	21.29±0.71 (7)	17.28±0.78 (7)	13.57± (7)	-	48.42±2.21 (7)
1-2 years	Male	Kalsi	94.20±2.69 (5)	101.0±2.49 (5)	122.0±3.11 (5)	136.80±3.83 (5)	37.80±0.66 (5)	16.20±0.37 (5)	16.20±0.48 (5)	-	73.20±1.24 (5)
		Chiplima	-	107.0±15.0	127.50±4.5	129.0±9.0	43.50±1.50	16.0±0.0	17.0±0.0	-	55.0±12.0
		Pooled	94.20±2.69 (5)	101.57±4.73 (7)	123.57±2.57 (7)	136.0±3.76 (7)	40.85±0.88 (7)	18.28±0.74 (7)	15.0±0.61 (7)	-	65.14±5.88 (7)
	Female	Kalsi	88.55±3.51 (9)	96.11±3.63 (9)	111.77±5.34 (9)	123.55±7.07 (9)	39.77±1.76 (9)	14.88±0.53 (9)	17.88±0.73 (9)	-	67.33±4.06(9) (9)
		Chiplima	-	102.0 (3)	130.0 (3)	138.0 (3)	40.0 (3)	18.0 (3)	19.0 (3)	-	61.0 (3)
		Pooled	88.55±3.51 (9)	97.58±2.81 (12)	116.33±4.70 (12)	127.16±5.60 (12)	38.33±1.74 (12)	17.16±1.25 (12)	18.16±1.90 (12)	-	65.75±3.12 (12)
2-3 years	Female	Kalsi	105.5 (2)	106.5 (2)	131.5 (2)	148.50 (2)	43.0 (2)	17.50 (2)	23.0 (2)	-	79.50 (2)
		Chiplima	-	109.0 (2)	145.50 (2)	156.50 (2)	49.50 (2)	19.50 (2)	21.0 (2)	-	72.0 (2)
		Pooled	105.50 (2)	112.75 (4)	138.50 (4)	156.50 (4)	46.25 (4)	19.10 (4)	22.0 (4)	-	75.75 (4)
Above 3 years	Female	Kalsi	123.66±0.77 (39)	117.48±0.55 (39)	159.66±1.22 (39)	180.71±1.68 (39)	50.10±0.23 (39)	18.12±0.18 (39)	25.66±0.40 (39)	15.68±1.17 (39)	86.23±0.79 (39)
		Chiplima		124.62±2.52 (15)	169.62±2.36 (15)	184.42±3.87 (15)	48.60±2.55 (15)	21.80±2.52 (15)	21.89±2.55 (15)	18.42±1.56 (15)	76.62±1.47 (15)
		Pooled	123.66±0.77 (39)	119.46±0.90 (54)	162.43±1.24 (54)	181.74±1.62 (54)	49.68±0.71 (54)	19.54±0.73 (54)	24.61±1.32 (54)	16.75±0.95 (39)	83.56±0.91 (54)

Figures in parenthesis are number of observations period as fixed effects. Results of the study are presented in table 3 and 5 for performance and genetic parameters, respectively for various traits.

6.1.1 Body weights

Birth weight of male calves ranged from 18-26 kg and of female 16-25 kg., which were similar to the reports of Nivsarkar *et al.* (2000). Average body weights at 3, 6 and 12 months of age in males were 41.0 kg, 58.0 kg and 110 kg., respectively. The corresponding weights in females were 40.0 kg, 55.0 kg and 95 kg., respectively. The average body weights in females at 18 and 24 months of age were 130 and 170 kg, respectively. Bulls and cows weighed about 450 and 320 kg, respectively (Pundir *et al.* 2007d).

6.1.2 Age at first fertile service and calving

Age at first fertile service ranged from 901 to 1215 days and age at first calving from 982 to 1561 days in various reports (table 4). The pooled estimates of age at first fertile service and calving were 1009.45 and 1382 days based on 659 and 1768 records, respectively. Pundir *et al.* (2007a) obtained least square means of age at first fertile service and age at first calving were 1215±53 and 1500±56 days, respectively. Lower estimates for both of the traits were observed by Ulmek *et al.* (1992) and similar estimates of age at first calving were observed by Jalatge (1986). The effects of sex of calf and birth season were non significant on both of the traits. Chauhan *et al.* (1975) also reported non significant effects of birth season on age at first calving. The birth period affected significantly to age at first calving, similar to the reports of Yazdani and Rakshe (1997). Age at first calving was maximum in first period (2130±189 days) may be due to fact that management of the breed at this farm was in initial stage. Than it was stable (1224 -1391 days) from 2^{nd} to 6^{th} period and then again it was slightly increased from 6^{th} period onwards (1736±947 days) indicating that there was uniform management and environmental conditions from 2 to 6^{th} period and then it got deteriorated. The significant effect of birth period on AFC also indicated that there were differences in the environment and management practices during the growth period.

Table 3. Performance traits of Red Sindhi cattle

Effect/ Trait	No	Lactation milk yield (kg)	Lactation length (days)	Gestation period (days)	Dry period (days)	Service priod (days)	Inter calving period(days)
Overall	809	1532±88	291±5	291±3	195±14	192±14	485±13
Parity			*		*	*	*
1	160	1640±102	317±8	283±42	213±18	242±17	529±17
2	135	1700±102	301±8	287±4	166±18	185±17	467±17
3	115	1616±106	301±8	280±5	164±18	164±18	466±18
4	94	1611±109	278±9	291±5	167±19	166±18	448±19
5	83	1646±115	283±10	285±6	172±21	168±20	457±21
6	76	1559±123	308±11	287±6	178±22	204±22	486±23
7	51	1525±130	286±13	283±7	220±24	206±23	505±25
8	40	1504±153	259±16	291±9	240±29	200±28	494±30
9	26	1434±174	258±19	298±11	234±34	68±33	490±36
10	20	1483±208	300±24	318±13	169±41	192±39	468±44
11	18	1133±273	304±32	297±18	225±55	220±53	530±59
Sex of calf							
1	418	1554±92	296±6	292±3	201±15	201±14	497±14
2	391	1510±93	285±6	289±3	189±15	183±15	474±14
Calving Season				*			
1	258	1532±95	286±6	289±4	184±16	180±15	469±15
2	223	1577±99	289±7	284±4	197±17	191±16	484±16
3	140	1474±106	302±9	289±5	208±19	214±18	509±18
4	186	1546±101	285±8	301±4	193±17	184±17	479±17
Calving Period		**				**	*
1	79	1922±136	281±13	288±7	225±25	204±24	504±26
2	156	1166±113	263±10	285±6	180±20	154±19	442±20
3	127	1341±119	295±11	288±6	194±22	209±21	489±22
4	114	1581±119	307±11	295±6	184±22	201±21	491±22
5	85	1758±129	299±12	301±7	189±24	193±23	488±24
6	68	1524±128	284±12	302±7	164±24	153±23	448±24
7	84	1617±124	285±12	285±6	198±23	189±22	482±23
8	96	1346±146	311±15	283±8	228±28	234±27	539±29

* Significant at 5% level of significance

** Significant at 1% level of significance

6.1.3 Lactation milk yield (LMY)

The LMY ranged from 861 to 2980 kg in various reports. The pooled estimate based on 3120 observations was 1426.67 days. In the study of (Pundir *et al*. 2007a) maximum lacation milk yield was observed as high as 4179 kg. The mean lactation milk yield (LMY) was 1532±88 kg (Pundir *et al*. 2007a). The estimates were lower than the reports of Singh *et al*. (1994) and higher than that of reported by Gupta and Tripathi (1994). Parity, sex of calf and calving season did not influence the LMY. However, Gupta and Tripathi (1994) and Das *et al*. (2003) reported significant effects of parity on LMY. Bhan and Prasad (1985) observed non significant influence of calving season, similar to the reports of (Pundir *et al*. 2007a), but in contrary to this, Prasad *et al*. (1994) and Das *et al*. (2003) reported significant effects of calving season on this trait. Effects of calving period on LMY were significant, similar to the reports of Gupta and Triapthi (1994). No definite trend was observed among LMY due to period effects. It was maximum in period 1 and lowest in period 2. The LMY was increased from 2nd to 7th period and then declined indicating that there were significant differences in environment and management practices over the periods.

The LMY 305 days ranged from 1037 to 1534 kg in different reports. The pooled estime of lactation milk yield in 305 days was 1229.01 kg based on 588 records (table 4).

6.1.4 Lactation length

In the different reports first lactation length ranged from 275 to 345 days with pooled mean of 308 days based on 859 records. The over all lactation length ranged from 242 to 394 days in various reports. The weighted mean based on 3476 records was 285 days (table 4). Pundir *et al*. (2007a) reported mean lactation length (LL) as 291±5 days. The estimate was in close agreement with the reports of Gogoi *et al*. (1993). Lower estimates of LL were reported by D'Souza et al. (1979) and higher by Gupta and Tripathi (1994). The parity effects were significant on this trait as reported by Gupta and Tripathi (1994) and Das *et al*. (2003). All the other effects included in this

Table 4. Various performance traits of Red Sindhi cattle

No. of Obs.	Mean+ S.E.	Heritability	References
Age at first fertile service (days)			
219	982.20	-	D,Souza *et al.*, 1979
40	983.60	-	Kar *et al.*, 1987
240	901.6± 07.42	-	Ulmek *et al.*, 1992
160	1215.0±53.00	0.08±0.13	Pundir *et al.*, 2007a
Pooled 659	**1009.45**		
Age at first calving (days)			
44	0982.70	-	Nair, 1975
	1070.80	-	Basu *et al.*, 1979
219	1174.70	-	D,Souza *et al.*, 1979
16	1468.40	-	Ghose *et al.*, 1980
123	1265.75 (41.5 Months)	-	Malhotra and Singh, 1980
369	1487.70± 14.00	-	Singh *et al.*, 1982
188	1338.66± 15.67	0.46	Patro and Rao, 1983 b
	1147.71-1197.43 (37.63-39.26 Months)	-	Govindaiah *et al., 1984*
369	1561.60 (51.2 Months)	-	Jalatge, 1986
40	1264.50	-	Kar *et al.*, 1987
	1549.40 ± 50.93 (50.8± 1.67 Months)	-	Mishra and Mishra, 1987
240	1183.750.8±7.48	-	Ulmek *et al.*, 1992
		0.21	Rahumathulla *et al.*, 1993 a
160	1577±56	0.12±0.17	Pundir *et al.*, 2007a
Pooled 1768	**1382.07**		
First Lactation milk yield (kg)			
174	1212.0		Chopra *et al.*, 1973
	1431.0		Kumar *et al.* 2005
160	1640±102		Pundir *et al.*, 2007a

Lactation milk yield (kg)				
179		1712.0	0.67	Chopra *et al.*, 1973
144		1386.2	-	Nair, 1975
176		2980.0	-	Kumar and Narain, 1978
118		1700.0±.30.0	-	Taneja and Sikka 1978
62		1817.6±62.6	-	Lalli *et al.*, 1979
		1048.31	.07-.039	Taylor *et al.*, 1979
123		1391.0	-	Malhotra and Singh, 1980
		1080.0	-	Jalatge, 1986
363		1847.6±35.10	-	Tomar, and Sharma 1986
40		1290.9	-	Kar *et al.*, 1987
			0.32	Nigam and Bector, 1991
26		1703± 67.9	0.32	Gogoi *et al.*, 1993 a
			0.24	Rahumutullah *et al.*, 1993
1080		861.40	-	Gupta and Tripathi, 1994
809		1532±88	0.20±0.09	Pundir *et al.*, 2007a
Pooled	**3120**	**1426.67**		
305 days lactation milk yield (kg)				
		1450.07	-	Basu *et al.*, 1979
219		1534.5	-	D,Souza *et al.*, 1979
369		1048.3±30.5 (Ist lact)	-	Singh *et al.*, 1982
		1155.6±36.6 (IInd lact)	-	Singh *et al.*, 1982
		1047±37.5 (IIIrd lact)	-	Singh *et al.*, 1982
		1037.5±40.91 (IVth lact)	-	Singh *et al.*, 1982
			0.22	Rahumutullah *et al.*, 1993 a
Pooled	**588**	**1229.01**		
First Lactation Length (days)				
174		304.0	0.43	Chopra *et al.*, 1973
		275.1± 31.23	-	Taylor *et al.*, 1979
219		283.6	-	D,Souza *et al.*, 1979
118		293.1	-	Taneja and Sikka, 1981

188		345	0.34	Rao and Patro, 1984
160		317.0± 08.0		Pundir *et al.*, 2007a
Pooled	**859**	**308.69**		
Lactation length				
174		304.0	0.43	Chopra *et al.*, 1973
102		275.10± 8.51	-	Johar and Taylor 1973
		296.0	-	Bhatnagar *et al.*, 1973
44		394.5	-	Nair, 1975
		365.5	-	Pattar and Dev, 1977
176		384.0	-	Kumar and Narain, 1978
27		370.20	-	Manickam *et al.*, 1978
363		299.3	0.42	Tomar and Sharma 1986
219		284.1	-	D,Souza *et al.*, 1979
62		318.2± 11.0	-	Lalli *et al.*, 1979
		275.1	0.22-0.58	Taylor *et al.*, 1979
55		303.9	-	Ghose *et al.*, 1980
123		287.0	-	Malhotra and Singh, 1980
118		293.1	-	Taneja and Sikka 1981
		304.0	0.42	Rao and Patro, 1984
		282.0	-	Jalatge, 1986
58		322.4	-	Pereira and Prasad 1986
40		349.6	-	Kar *et al.*, 1987
26		288.4± 12.6	-	Gogoi *et al.*, 1993
			0.01	Rahumutullah *et al.*, 1993 a
1080		242.6	-	Gupta and Tripathi, 1994
809		291.0± 05.0	0.12±0.08	Pundir *et al.*, 2007a
Pooled	**3476**	**285.0**		
Service period (days)				
174		158.0	-	Chopra *et al.*, 1973
		87.0	-	Basu *et al.*, 1979
219		153.8	-	D,Souza *et al.*, 1979

				0.32	Rahumutullah *et al.*, 1993 a
1080		140.1		-	Gupta and Tripathi, 1994
809		192.0± 14.0		0.09±0.04	Pundir *et al.*, 2007a
Pooled	**2282**	**161.17**			
Dry period (days)					
		57.6		-	Basu *et al.*, 1979
		163.4		.07-0.12	Taylor *et al.*, 1979
219		159.5		-	D,Souza *et al.*, 1979
188				0.57	Rao and Patro, 1984
40		119.0		-	Kar *et al.*, 1987
26		35.2± 2.5		0.22	Gogoi *et al.*, 1993
				0.40	Rahumutullah *et al.*, 1993 a
1080		179.80		-	Gupta and Tripathi, 1994
809		195± 14		0.11±0.07	Pundir *et al.*, 2007a
Pooled	**2174**	**181.75**			
Inter calving period (days)					
		612.10		-	Nair, 1975
		350.22		0.23	Basu *et al.*, 1979
		436.1		-	D,Souza *et al.*, 1979
123		447.0		-	Malhotra and Singh, 1980
188		496.91	(Ist lact.)	0.42	Patro and Rao, 1983 a
		453.25	(IInd lact.)	0.53	Patro and Rao, 1983 a
		456.75	(IIIrd lact.)	-	Patro and Rao, 1983 a
		384		-	Jalatge, 1986
40		518.90		-	Kar *et al.*, 1987
26		417		-	Gogoi *et al.*, 1993
				0.37	Rahumutullah *et al.*, 1993
1080		425		-	Gupta and Tripathi, 1994
809		485±13		0.08±0.06	Pundir *et al.*, 2007a
Pooled	**2266**	**455.14**			

study were non significant on this trait. Effects of calving season were similar to the reports of Bhan and Prasad (1985) and Sachan (1987) while, Gupta and Tripathi (1994) and Das *et al.* (2003) reported significant influence of calving season on this trait. The lactation length ranged from 258 to 317 days in different parity but no definite trend was observed among this trait due to its effects (Pundir *et al.* 2007a).

6.1.5 Gestation period

The least square mean of gestation period was 291±3 days (Pundir *et al.* 2007a). D'Souza *et al.* (1979) also reported similar estimates of gestation period. Effects of parity, sex of calf and calving period were non significant on this trait. However, calving season influence this trait significantly as reported by Singh and Prasad (1985) and Das *et al.* (2003). It was higher in cows those calved in winter season as compared to other seasons.

6.1.6 Dry period (DP)

The dry period ranged from 57 to 195 days in different reports. The pooled estimated based on 2174 records was 181.75 days (table 4). The overall mean of dry period (DP) was 195±14 days as reported by Pundir *et al.* (2007a). The estimate was lower than the reports of Gogoi *et al.* (1993) and higher from the Basu *et al.* (1979) and Kar *et al.* (1987). Parity effects were significant on this trait as reported by Das *et al.* (2003). However, calving season, sex of calf and calving period did not influence this trait significantly. In contrary to the reports of (Pundir *et al.* 2007a), Gupta and Tripathi (1994) reported significant influence of calving season and calving period on this trait. The estimates of DP due to parity ranged from 164±18 days (3^{rd}) to 240±29 days (8^{th}), but there was no definite trend among this trait due to the parity.

6.1.7 Service period (SP)

The service period ranged from 87 to 192 days in different reports. The weighted mean based on 2282 records was 161.17 days. Pundir *et al.* (2007 a) reported mean service period (SP) was 192±14 days. Gupta and Tripathi

Figure 9. Elite cow of the breed

Figure 10. Elite cow of the breed

Figure 11. Bull of the breed

(1994) reported lower estimates of SP than the report of Pundir *et al.* (2007 a). Parity and calving period effects were significant on this trait as reported by Gupta and Tripathi (1994). Effects of sex of calf and calving season were non significant on this trait. The estimate of SP due to parity effects ranged from 164±18 (3^{rd}) to 242±17 days (1^{st}). The SP due to calving period ranged from 153±19 days (6^{th}) to 234±27 days (8^{th}). No definite trend among this trait due to parity and calving period was observed.

6.1.8 Inter calving period (ICP)

The inter calving period ranged from 350 to 612 days in various reports. The pooled estimate of inter calving period based on 2266 observations was 455.14 days (table 4). Pundir *et al.* (2007a) observed least square mean of inter calving period (ICP) as 485±13 days. Estimates of similar magnitude were reported by Patro and Rao (1983). Kar *et al.* (1987) reported higher estimates of ICP and Gogoi *et al.* (1993) and Gupta and Tripathi (1994) lower estimate than Pundir *et al.* (2007 a). Sex of calf and calving season effects were non significant. The effects of calving season were similar to the reports of Yazdani and Rakshe (1997) and contrary to the Prasad *et al.* (1994). Effects of parity and calving period were significant, similar to the observations of Gupta and Tripathi (1994). In contrast Pundir *et al.* (2007 a), Yazdani and Rakshe (1997) reported non significant effects of calving period on this trait. The ICP ranged from 466±18 days (3^{rd}) to 530±89 days (11^{th}) due to parity effects. Due to effects of calving period ICP ranged from 442±20 days (2^{nd}) to 539±29 days (8^{th}). No different trend was observed among the ICP due to parity and calving period effects.

6.1.9 Genetic parameters

The genetic parameters of different production and reproduction traits of Red Sindhi cattle are presented in table 5 (Pundir *et al.* 2007a). The h^2 estimates of age at first fertile service (AFFS), age at first calving (AFC), lactation milk yield (LMY), lactation length (LL), gestation period (GP), dry period (DP), service period (SP) and inter calving period (ICP) were 0.08±0.13, 0.12±0.17, 0.20±0.09, 0.12±0.08, 0.02±0.06, 0.11±0.07, 0.09±0.04 and 0.08±0.06, respectively. Higher estimate of h^2 for AFC was reported by Rao and Patro (1984) and Rahumathulla *et al.* (1993 a). The h^2 estimate for LMY was in close agreement with the reports of Taylor *et al.* (1979) and Rahumathulla *et al.* (1993 a) and lower than the Gogoi *et al.* (1992). Higher estimates of h^2 for LL were reported by Rao and Patro (1984). However, Rahumathulla *et al.* (1993 a) observed lower estimate of h^2 for LL than the less than the reports of Pundir *et al.* (2007a). Taylor *et al.* (1979) observed similar estimates of h^2 for DP while, Rahumathulla *et al.* (1993 a) and Rao and Patro (1983) reported higher estimate as compared to report of Pundir *et al.* (2007 a).

Rahumathulla *et al.* (1993 a) observed higher estimate of h^2 for SP as compared to present study. Similar estimates of h^2 for ICP as in the present study were reported by Patro and Rao (1983) and higher by Rahumathulla *et al.* (1993 a). The h^2 estimates express the amount of genetic variation among the trait and suggest the measures to be taken for the its genetic improvement. In the present study production traits like LMY, LL and DP showed moderate amount of genetic variation and can be improved through direct selection while, reproductive traits like SP and ICP needed indirect selection and better management for their improvement. The GP and SP both the traits influenced largely by environmental effects so they may be improved by better management in the herd.

The moderate genetic correlations between LMY and LL were observed. The LMY was negatively genetic correlated with GP, SP and ICP. In contrary to this Chopra *et al.* (1973) observed high genetic correlation of LMY with SP. Similar magnitude of genetic correlation between LMY and LL was observed by Sivarajasingam and Mukherjee (1980). Lactation length also had negative genetic correlation with all traits except LMY. The high genetic correlations of GP with DP and ICP were also observed. The genetic correlation of DP with SP and ICP were high. The SP and ICP had high genetic correlations suggesting the improvement in one trait also lead improvement in other trait too. Low phenotypic correlations among GP, DP,SP and ICP were observed. Moderate genetic correlation among two traits suggested that selection of one trait influence other one up to some extant while low genetic correlations between two traits indicated that improvement in both the traits may be made by selection individually.

Table 5. Genetic parameters of different performance traits of Red Sindhi cattle

Traits	LMY	LL	GP	DP	SP	ICP
LMY	0.20±0.09	0.23	0.02	-0.01	0.11	0.12
LL	0.54±0.16	0.12±0.08	0.10	0.18	0.21	0.17
GP	-0.08±0.88	-.04±0.34	0.02±0.06	0.07	-0.04	0.06
DP	-0.34±0.46	-.24±0.16	0.88±1.29	0.11±0.07	0.73	0.83
SP	-0.41±0.44	-.31±0.14	-0.18±1.06	0.81±0.21	0.09±0.04	0.88
ICP	-0.26±0.56	-.16±0.06	0.88±1.47	0.71±0.14	0.94±0.11	0.08±0.06

Heritabilities are on diagonal and phenotypic and genetic correlations are above and below the diagonal, respectively.

6.2 Performance of the crossbreds of Red Sindhi & Jersey

Pundir *et al.* (2007b) analyzed 801 Lactation records from 1 to 11th parity of 189 Red Sindhi and Jersey crossbred cows, daughters of 29 sires, spread over a period of 28 years from 1977 to 2004 maintained at Uttarakhand State Government Cattle breeding farm, Kalsi, Dehradun. The total duration of study was divided in to 4 periods viz. P1 (1977-1983), P2 (1984 to 1990), P3 (1991 to 1997) and P4 (1998 to 2004). Each year was divided in to 4 seasons i.e season 1 (November to January), season 2 (February to April), season 3 (May to July) and season 4 (August to October). The generation effects f_1 (1) and later generations (2) were also considered to know its effect on the performance. The trait considered in the study were age at first fertile service (days), age at first calving (days), lactation milk yield (kg), lactation length (days), dry period (days), service period (days) and inter calving period (days). Data was analyzed using least square maximum likelihood program (Harvey, 1990) to estimate the performance of breed and genetic parameters. Heritabilities and genetic correlations were estimated by paternal half sib correlation method. Age at first fertile service and age at first calving were analyzed using a mixed model incorporating sire as random and sex of calf, birth season and period as fixed effects. All the other traits were analyzed using sire as random and parity, sex of calf, generation, calving season and calving period as fixed effects. Results of the study are presented in table 6 and 7.

6.2.1 Age at first fertile service (AFFS) and first calving (AFC)

The overall mean of age at first fertile service (AFFS) and age at first calving (AFC) were 1184±187 days and 1439±165 days, respectively. The estimate of AFC was in close agreement with the reports of Nair (1973). While, Yazdani *et al.* (1993) reported lower estimate of AFC as compared to the reports of Pundir *et al.* (2007 b). The estimate of AFFS was higher than the reports of Kar *et al.* (1987). Effects of generation, sex of calf, birth season and birth period were non significant on both of the traits. Similar effects of birth season on AFC were also reported by Chauhan *et al.* (1975). While, Yazdani and Rakshe (1997) reported significant effects of birth period on AFC. The estimates of AFFS and AFC were higher in later generations as compared to F_1 but differences were not significant.

6.2.2 Lactation milk yield (LMY)

The least square means of lactation milk yield (LMY) was 1964±323 kg. Estimates of similar magnitude were reported by Kar *et al.* (1987). Lower estimate of LMY than the present study were observed by Sachan (1987) and higher by Taneja and Chawla (1987). The generation effects were significant on this trait. There was 14% decline in later generations as compared to F_1, may be due to non availability of desired selection pressure for selection of males in F_1 for future bulls and reduction in hybrid vigour. Chopade *et al* (2002) reported 37.5% decline in lactation milk yield in Holstein Friesian crosses with Sahiwal and Hariana breed. Similar results were also observed by Doc and Taneja (1984). The other effects parity, sex of calf, calving season and calving period were non significant. Similar effects of calving season on LMY were also observed by Subramanian and Ulaganathan (1990).

In contrast to this Das *et al*. (2003) reported significant effects of parity and calving season on LMY.

6.2.3 Lactation length (LL)

The mean lactation length (LL) was 287±11 days. Estimates were within the range as observed by Gogoi *et al.* (1993). However, higher estimates for LL as compare to the reports of Pundir *et al*. (2007b) were reported by D'Souza *et al.* (1979). The lactation length was significantly influenced by the generation effects. There was significant decline (13%) in later generations as compared to F_1. Effects of sex of calf and calving season were non significant, similar to the reports of Yasdani and Jagtap (1996). However, Das *et al.* (2003) reported significant influence of calving season on this trait. Effects of calving period on LMY were significant. In the last period it was higher than the earlier breeds, may be due to better climatic and management conditions as LMY was also higher for this period.

6.2.4 Dry period (DP)

The least square mean of dry period (DP) was 140±51 days. Similar estimates were also observed by Mishra and Mishra (1987). However, Kar *et al.* (1987) and Gogoi *et al.* (1993) reported lower estimates of DP as compared to the present study. Effects of parity, calving season and calving period were significant on this trait. Sachan (1987) also observed similar effects of calving season on DP. Das *et al.* (2003) reported similar effects of parity on this trait. The parity effects showed a declining trend as the parity advanced. Cows those calved during June to November had lower dry period than the others may be due to availability of better feeds and fodders in winter seasons. The estimates of DP were higher in period 3 and 4 as compare to 1 and 2.

6.2.5 Service period (SP)

The overall mean of service period (SP) was 144±49 days. Higher estimates of SP were reported by Mishra and Mishra (1987) in RSxJ crossbreds. Effects of generation, sex of calf and calving season were non significant. Sharma and Bhatnagar (1975) reported significant effect of calving season and sex of calf on SP. Pattar and Dev (1977) reported significant effects of calving season on this trait. Effects of parity and calving period were significant on this trait. Trends in service period due to parity and calving period were similar to DP.

6.2.6 Inter calving period (ICP)

The overall mean of inter calving period (ICP) was 427±47 days. The estimates were within the range as reported by Kar *et al.* (1987), Mishra and Mishra (1987) and Gogoi *et al.* (1993). The effects of generation, sex of calf and calving season were non significant. Sharma and Bhatnagar (1975) and Yazdani and Rakshe (1997) also reported non significant effects of calving season on ICP. The effect of parity and calving period were significant. In contrast to this study Yazdani and Rakshe (1997) reported non significant effect of calving period on ICP. The trends in ICP due to parity and calving period were same as in DP and SP.

6.2.7 Genetic parameters

The heritability and phenotypic and genetic correlations among various performance traits of Red Sindhi and Jersey crossbred cows are presented in table 7. The h^2 estimates for age at first fertile service, age at first calving, lactation milk yield, lactation length, dry period, service period and inter calving period were 0.11±0.66, 0.09±0.08, 0.65±0.17, 0.07±0.07, 0.29±0.12 and 0.25±0.11, respectively. Rahumathulla *et al.*(1993 b) reported higher estimates for AFC, DP and ICP, lower estimates for LMY, LL and similar estimates for DP as in the present study. Chopra *et al.* (1993) obtained similar estimates of h^2 for LMY and higher for LL. Gogai *et al.* (1992) reported lower estimates of h^2 for LMY. Low estimates of h^2 for ICP was obtained by Patro and Rao (1983 a). The h^2 estimates of LMY, DP, SP and ICP showed high amount of additive variation and suggested that they can be improve through direct selection.

Table 6. Performance traits of Red Sindhi and Jersey crossbred cattle

Effect/ Trait	No.	Lactation milk yield (kg)	Lactation length (days)	Dry period (days)	Service period (days)	Inter calving period(days)
Overall	801	1964±323	287±11	140±51	144±49	427±47
Generation		*	**			
1	626	2117±320	307±10	130±50	150±48	434±46
2	175	1811±340	267±15	150±57	137±55	420±53
Parity			*	*	**	**
1	189	1920±323	304±11	212±51	232±49	518±47
2	139	1958±324	300±11	176±51	190±49	479±47
3	107	1935±324	286±11	158±51	162±49	446±47
4	91	2064±325	286±11	163±52	166±50	451±48
5	69	1959±327	294±12	142±52	148±50	437±49
6	58	1986±330	278±13	133±53	130±51	413±50
7	45	1952±334	292±14	114±55	125±53	407±51
8	36	1963±340	289±15	106±57	118±55	398±53
9	24	2197±347	289±15	108±59	121±57	401±56
10	18	1671±359	246±19	118±63	92±61	371±60
11	25	2000±362	294±19	109±64	97±62	378±61
Sex of calf						
1	402	1968±324	289±11	144±51	150±49	433±47
2	399	1960±324	285±11	136±51	138±49	421±47
Calving Season				**		
1	248	1958±325	283±11	161±51	156±50	443±48
2	206	1893±325	281±11	150±51	146±50	430±48
3	180	2025±325	295±11	125±51	138±50	420±48
4	167	1980±325	290±11	124±51	135±50	415±48
Calving Period			**	*	**	**
1	163	1832±340	270±15	100±57	96±55	371±53
2	284	1869±331	271±13	116±53	106±52	389±50
3	158	2074±326	275±12	172±52	165±50	451±48
4	196	2082±326	332±11	172±52	209±50	497±48

* Significant at 5% level of significance ** Significant at 1% level of significance

The genetic correlations of LMY with LL was 0.52, suggesting that direct selection of LMY will also lead some improvement in this traits too. The negative genetic correlations of LL with DP, SP and ICP were obtained. The high and significant genetic correlations among DP, SP and ICP indicated that improvement in one trait also bring improvement in other traits too. The LMY had low phenotypic correlation with all other traits under study. High phenotypic correlations among DP, SP and ICP were also obtained. The high genetic correlations between two traits suggesting the improvement in one trait also lead improvement in other trait too. Moderate genetic correlation among two traits suggest that selection of one trait influence other one up to some extent while low genetic correlations between two traits indicated that improvement in both the traits may be made by selection independently.

Table 7. Genetic parameters of different performance traits of Red Sindhi and Jersey cattle

Traits	LMY	LL	DP	SP	ICP
LMY	0.65±0.17	0.33	0.05	0.16	0.17
LL	0.52±0.44	0.07±0.07	-0.19	0.21	0.21
DP	0.21±0.31	-0.44±0.65	0.29±0.12	0.87	0.91
SP	0.29±0.30	-0.27±0.56	0.81±0.03	0.28±0.12	0.95
ICP	0.30±0.31	-.32±0.57	0.95±0.02	0.83±0.02	0.25±0.11

Heritabilities are on diagonal and phenotypic and genetic correlations are above and below the diagonal, respectively.

6.3 Genetic and phenotypic trends

The genetic, phenotypic and environmental trends were estimated from 809 Lactation records of 160 Red Sindhi cows, daughters of 24 sires and spread over a period of 48 years from 1958 to 2005 maintained at Uttaranchal State Government Cattle breeding farm, Kalsi, Dehradun by Pundir *et al.* (2007c). The trends were estimated for pooled lactation traits. The trait considered in the study were lactation milk yield (Kg), lactation length (days), dry period (days), service period (days) and inter calving period (days). The phenotypic trend (DP) was estimated as the linear regression of the population performance on the year of calving and genetic trend (DG) was estimated as described by Smith (1962). Genetic trend, equal to negative twice of the pooled intra sire regression of the records of sire progeny on time, each record being expressed as deviation from the contemporary average. The contemporary was defined as the progeny of the same sire born during the two months earlier or later. The environmental trend (DE) was computed by subtracting genetic trend from the phenotypic trend.

The estimates of phenotypic, genetic and environmental trends for lactation milk yield were significant (table 8). The lactation milk yield increased by 0.72% of herd average may be due to better management practices and availability of feed and fodders while sire did not contribute favorably. In contrast to this Acharya and Lush (1969), Tomar and Singh (1981), Gupta and Tripathi (1994) and Pundir (1999) obtained positive estimates of genetic trend for this trait. While Chaudhary *et al.*, (1994) obtained negative estimates of genetic trend for lactation milk yield. Narian and Garg (1972) reported non significant genetic trends in Red Sindhi cattle

Table 8. Genetic, Phenotypic and Environmental trends in various economic traits of Red Sindhi cattle.

S.N.	Traits	Herd Av.	Phenotypic trend	Genetic trends	Environmental trend
1	Lactation milk yield (kg)	1532±88	10.97±2.88	-42.34±3.47(2.76)	53.31±4.50(3.48)
2	Lactation length (days)	291±5	12.27±3.17(4.22)	-5.37±2.71(1.84)	17.64±4.17(6.06)
3	Dry Period (days)	195±14	-9.31±3.45(4.77)	6.72±3.12(3.44)	-16.03±4.65(8.22)
4	Service period (days)	192±14	-7.47±3.63(3.89)	14.73±3.12(7.67)	-22.20±4.78(11.56)
5	Inter calving period (days)	485±13	-5.48±3.11(1.13)	15.71±3.42(3.24)	-21.19±4.62(4.37)

Note : Figures in parenthesis are percentage to the herd average.

for this trait. Negative and significant estimates of genetic trend for lactation milk yield indicated that deterioration in the genetic worth (sire) might have been neutralized by the better managemental conditions in this herd. The estimate of genetic trend was higher then the reports of Amble *et al.,* (1958) and Pundir (1999) and similar to the reports of Singh *et al.,* (2003). The estimate of genetic trend for lactation length was non-significant while it was significant for estimates of phenotypic and environmental trends. Negative estimates of genetic trend for this trait were reported by Chaudhary *et al.,* (1994). While Gupta and Tripathi (1994) and Pundir (1999) obtained this estimate as positive. Narian and Garg (1972) also reported positive estimates of phenotypic trends and non significant estimates of genetic trend in Red Sindhi cattle for this trait. Singh *et al.,* (2003) reported higher estimates for all the three estimates of trends as compared to the present study. The lactation length increased by 4.22 percent to the herd average in spite of negative contribution of sires in this herd.

All the estimates of trends of dry period, service period and inter calving period were significant except estimate of phenotypic trend for inter calving period. All the three estimates of trends for dry period, service period and inter calving period have shown similar pattern i.e. positive estimates of genetic trend and negative for phenotypic and environmental trends. It may be concluded that the sires contributed positively for all the three traits but due to environmental effects all of them declined phenotypically as desired by an animal breeder. All these estimates were within the range as reported by Pundir (1999) in magnitude and similar to the change in direction. In contrast to this Narian and Garg (1972) reported non significant estimates of genetic trend in Red Sindhi cattle for inter calving period. Pundir and Singh (2007 c) observed that used sires were favorable for dry period, service period and inter calving period while lactation milk yield and lactation length improved due to better environmental conditions. This herd (Kalsi farm) needed more efforts to bring improvement in the productivity by desired change in the genetic architecture of the population and management.

7.0 Molecular genetic studies

The admixture genetic analysis of microsatelite variation in seven Bos indicus cattle breeds was studied by Kumar *et al.* (2003). DNA samples were screened with 20 microsatellite loci. Allele frequencies for all loci were determined directly by counting. Unbiased estimates of gene diversity (expected heterozygosity) with associated standard errors were computed for all locus / population combinations. The mean number of alleles per locus (MNA) was also calculated as an index of sample diversity. A size-adjusted MNA value was calculated using 1000 iterations of a resampling method. The number of blood sample for Red Sindhi, Tharparkar, Hariana, Sahiwal, Desi, Nellore and Ongole were 39, 35, 10, 26, 27, 20 and 32 respectively. The observed heterozygosity, expected heterozygosity, mean number of allele and sample size adjusted number of allele were 0.68 ,0.03, 6.35 and 4.72 in Red Sindhi, 0.61, 0.03, 5.20 and 3.95 in Tharparkar, 0.71, 0.03, 5.15 and 5.01 in Hariana, 0.60, 0.05, 4.40 and 4.27 in Sahiwal, 0.72, 0.02, 6.55 and 5.11 in Desi, 0.65, 0.03, 5.45 and 4.13 in Nellore and 0.65, 0.03, 5.05 and 4.12 in Ongole, respectively. The diversity analysis indicated that within the South Asian breeds, neither gene diversity nor MNA showed a discernible geographical pattern. Gene diversity varied from 0.61 (Sahiwal) to 0.72 (Desi). In the five samples of comparable size, MNA values are lower in the two breeds of southern provienance, Ongole and Nellore than the Desi, Tharparkar, and Red Sindhi. These measures may reflect differences in historical population size but may also be a result of higher levels of taurine admixture in the more northern samples. These analyses revealed a *B. taurus* influence in the Indian subcontinent; part of a gradation which stretches from Europe through the Near East towards Indian and which may be of ancient origin

Kumar *et al.* (2004 b) studied the genetic variability within and between breeds in indigenous cattle viz. Hariana (n=20), Red Sindhi (n=20) and Tharparkar (n=20) by using random amplified polymorphic DNA (RAPD) fingerprinting. The intrabreed divergence pattern in terms of band sharing frequency was highest in Red Sindhi (0.86±0.04) followed by Tharparkar (0.76±0.02) and Hariana (0.75±0.04). The interbreed genetic distance, mean average percentage difference between 2 breeds was highest (37.39) in Red Sindhi-Hariana pair followed by Red Sindhi-Tharparkar (34.11) and Hariana-Tharparkar pair (33.31). The Kuhnlein's genetic distance also indicated the same trend. The modified Roger's distance also indicated the highest magnitude of differences between Hariana and Red Sindhi pair (1.08) followed by Red Sindhi-Tharparkar (1.06) and Hariana-Tharparkar (1.05).

Kumar et al (2004a) determine the frequencies of k-casein genetic variants in three Indian zebu cattle breeds (Hariana,, Tharparkar and Red Sindhi). Blood samples were collected from 20 cattle of each breed. The *Hind* III restriction site polymorphism of k-casein gene indicated the presence of two alleles, A and B, in the zebu population. The frequencies of the B allele in Hariana, Tharparkar and Red Sindhi population were 0.30±0.07, 0.33±0.07 and 0.35±0.08, respectively. The chi-square test indicated a significant ($P<0.05$) segregation of the gene in the Hariana population and an insignificant result in the other populations. The genetic divergence study depicted that the distances among these 3 populations were 0.004, 0.010 and 0.002 in Hariana-Tharparkar, Hariana-Red Sindhi and Tharparkar-Red Sindhi, respectively.

Lacorte *et al.* (2006) studied *DGAT1 K232A* polymorphism in Brazilian cattle breeds. They identified *DGAT1* (EC 2.3.1.20) harboring a lysine to alanine substitution (*K232A*) as a candidate gene with a strong effect on milk production traits. Their objective was to estimate the frequency of the *DGAT1 K232A* polymorphism in the main zebu and taurine breeds in Brazil as well as in zebu x taurine crossbreds as a potential QTL for marker-assisted selection. Samples of 331 animals from the main Brazilian breeds, Nellore, Guzerat, Red Sindhi, Gyr, Holstein, and Gyr x Holstein F_1 were genotyped for *DGAT1 K232A* polymorphism (A and K alleles) using the PCR-RFLP technique. The highest frequency of the A allele was found in the Holstein sample (73%) followed by Gyr x Holstein F_1 (39%). Gyr and Red Sindhi showed low frequencies of A alleles (4 and 2.5%, respectively). The A allele was not found in the Nellore and Guzerat samples. They concluded that these results could be used to guide association studies between this locus and milk traits in these breeds.

8.0 Red Sindhi breed in abroad

8.1 Red Sindhi in Pakistan

The Red Sindhi breed originated in the Sind state of Pakistani and due to its hardiness, heat resistance and high milk yields they have spread into many parts at least in 33 countries of Asia, Africa, Oceania and the Americas. Under good management conditions the Red Sindhi averages over 1700 kg of milk after suckling their calves but under optimum conditions there have been milk yields of over 3400 kg per lactation. The average height of a Red Sindhi cow is 116 cm with a body weight of 340 kg. Bulls average 134 cm in height and a body weight of 420 kg. They are normally a deep, rich red color but this can vary from a yellowish brown to dark brown. Males are darker than females and when mature may be almost black on the extremities, such as the head, feet and tail.

In early fifties a scheme for breed improvement was launched by the government. Under this project pure cow and buffalo bulls were given to the recognized farmers who were maintaining the pure herds of Red Sindhi, Bhag Nari and Tharparkar cattle breeds. The records were maintained at the farmers level and were checked by the stock man and livestock overseers appointed by the department of Animal Husbandry. The project was launched on left and right banks of Indus river. The aim of the project was to upgrade the breeds to improve the milk yield.

In sixties another project was launched in which farmer maintaining pure bulls of cattle and buffalo breeds (Red Sindhi, Bhag Nari, Tharparkar and Kundhi buffaloes) were identified and documented and approved after certification from the Veterinary Officer (Vety. Assistant Surgeon) for breeding the pure bred as well as non descript cows in herds for upgrading the them for purity and improving their milk yields. The owners were paid Rs 30 per month as subsidy for maintaining the bulls. The record were kept at the farmer level by the Stock Assistants and verified by the Veterinary Assistant Surgeons now designated as Veterinary Officers.

There are two Red Sindhi cattle breeding stations in public sectors one each at Korangi, Karachi and Tando Muhammad Khan. The aim of these experiment stations was to produce progeny tested bulls for the breed improvement in the province. These stations were established in 1921 at Karachi and was named Breeding Farm. At Tando Muhammad Khan another Red Sindhi cattle breeding farm was established in 1954. These experiment stations did not produce the progeny tested bulls for distribution to the breeders for breed improvement, however, they produced pure bred Red Sindhi bulls for distribution to the private sector.

To propagate superior indigenous pure breeds of cattle and buffaloes, progeny testing programs for Red Sindhi cattle and Kundhi buffalo breeds and milk recording systems bull testing centers were started at Livestock Experiment Station at Tando Muhammad and Livestock Experiment Station Rohri for Red Sindhi and Kundhi buffalo bulls, respectively.

The semen production units one each at Karachi and Rohri produced frozen semen. The unit at Karachi produces frozen semen of Red Sindhi, Holstein Friesian and Kundhi buffalo.

(Source, www.ansi.ok state.edu.breeds/cattle/Red Sindhi and www.wis.cgiar.org/rwc/shared/asp/project/summary)

8.2 Red Sindhi in Australia

Red Sindhi cattle arrived in Australia in 1954 from Pakistan, as a gift to the Australian Government. While traditionally considered a milking breed they have been successfully used in crossing systems with British breeds to produce tropical beef types. In Australia, they have been an adaptable, hardy breed, good foragers and have a high degree of resistance to heat and ticks.

8.3 Red Sindhi in Ceylon

The Tamankaduwa district in the dry zone of Ceylon has long been engaged in breeding cattle. The Tamankaduwa is now the home of a large herd of Red Sindhi cattle that has been built up by regular importations from India and Pakistan since 1937–38. These cattle are used primarily for milk production, though the bullocks are sometimes used for agricultural operations as carting (Mahadevan, 1955).

8.4 Red Sindhi in Bangladesh

Sahiwal and Red Sindhi bulls were imported from Pakistan in 1950 for the improvement of Bangladeshi local breeds through artificial insemination. Hossain *et al.* (2002) studied the performance of Red Sindhi breed by analyzing 756 lactation records maintained at Central Cattle Breeding Station (CCBS), Dhaka from 1961 to 1997. The average lactation milk yield, lactation length and daily milk yield were 1023 kg, 287 days and 3.49 kg, respectively. The performance of Red Sindhi cattle breed in Bangladesh is comparable with Sahiwal breed and higher than the local cattle.

The Red Sindhi breed has a very high genetic potential for milk production and comparable with Sahiwal. Breed is facing endangerment in the country and needs immediate attention for conservation. The germplasm available at different farms should be multiply at a faster rate and must be distributed in the field as demand of breed is there. All the organised herds of breed throught the country should be declared as conservation units. An Associated Herd Progeny Testing Program incorporating all the organised herds may be plan on priority for the improvement and conservation of breed.

9.0 Recommendations

1. Red Sindhi is a promising dairy breed of Indian continent. All possible efforts should be made for its conservation and propagation at farmers herd. Immediate attention of Government of India & State Animal Husbandry Depatment is needed in this regard.
2. All the cattle farms maintaining Red Sindhi breed of the country may be associated for multiplication and improvement of the germplasm.

3. Availability of Red Sindhi bull semen should be ensured atleast in the vicinity of organized herds of Red Sindhi breeds in initial stage and expansion of this area in later stage.

4. An improvement program in the shape of open nucles breeding scheme (ONBS) should be initiated in the associated herds.

5. Molecular genetic studies on QTL marker for milk production & quality traits should be iniatiated.

6. Multiplication of germplasm may be made faster and attempts should be made to distribute animals of the breed in the field.

7. Crossbreeding of Red Sindhi breed with others should be stooped immediately. All the crossbreds of Red Sindhi should be graded up to Red Sindhi by using semen of Red Sindhi bulls.

8. Farmers should be made aware about the milk production ability and better adaptability of the breed.

9. Frozen semen from at least 15 to 20 proven bulls of Red Sindhi breed should be preserved (2,000 doses from each bull). These doses should

10. Efforts should also be made to collect and preserve the embryos and other genetic material at national animal gene bank.

10.0 References

Acharya, R M and Lush, J L 1969. Genetic progress through selection in a closed herd of Indian cattle. *Indian Journal of Dairy Sciences* **51** : 1059-1064

Amble, V N, Krishna, K S and Srivastava, J S 1958. Statistical studies on breeding data of Indian herds of dairy cattle. *Indian Journal of Veerinary Sciences and Animal Husb.andry* **28** : 33.

Basu, S B, Bhatnagar, D S, Taneja, V K and Rao, V P 1979. Comparative performance of Indian dairy breeds. *Indian Journal of Dairy Sciences* 32 (4) : 497-499

Bhan, C and Prasad, J 1985. Effect of season of calving on milk yield, fat production, lactation length and dry period of some crossbred cow of AAI farm. *Livestock Advisor* **10** (2) : 13-16

Bhatanagar D S, Nagarcenkar R, Gurnani M, Sharma R C andBhoserekar M R 1973. Cross breeding of Zebu (Red Sindhi and Sahiwal) with Brown Swiss. *Annual Report, NDRI, Karnal 97-99.*

Chaudhary, C S, Tripathi V N and Gupta A K 1994. Performance trends in production traits of Kankrej cattle. *Indian Journal of Dairy Sciences* **77** : 1027-1030

Chauhan, R S, Mishra, R R and Bhatnagar, D S 1975. *Annual Report, NDRI, Karnal*, 156-157

Chopade, M M ,Ali, S Z and Kurlkar, S V 2002. Comprative study of F_1 and F_2 crossbred cows with reference to production traits. *Indian Journal of Animal Sciences* **72** (10) : 916-917

Chopra, R C, Bhatnagar, D S and Gurnani, M 1973. Influence of service period on lactation length and lactation yield in Sahiwal, Red Sindhi and Brown Swiss crossbred cows. *Indian Journal of Dairy Sciences* **26** (4) : 263-269

Das, G C, Das, D, Goswami, R N, Roy, T C and Nahardeka, N 2003. Factors affecting some production traits in Jersey, Red Sindhi and their crosses in Assam. *Indian Veterinary Journal* **80** (2) : 126-127

Doc, N V and Taneja, V K 1984. Comprative performance of purebred and crossbred grades in India. *Indian Journal of Animal Sciences* **54** : 1023-1028.

D, Souza, C, Bhat, P N and Mukundan, G 1979. Genetic studies on some important economic tritas in Red Sindhi and its crosses. *Indian Journal of Animal Sciences* **49** (4) : 247-250

Ghose, S C, Haque, M, Rahman, M and Saddhullah, M 1980. A comparative study of lactation period and milk yield of different breeds of cattle. *Indian Veterinary Journal* **57** (12) : 1009-1014

Gogoi, D N, Goswami, R N and Das, D 1992. Performance of Jersey, Red Sindhi and their F_1 Crossbred cattle in Assam. *Journal of the Assam Veterinary Council* **2** : 15-22

Gogoi, D N, Goswami, R N and Das, D 1993. First lactation performance of Jersey, Red Sindhi and their F1 cross under the farm condition of Assam. *Indian Journal of Animal Sciences* **63** (5) : 569-572

Govindaiah, M G, Sharma, K N S and Nagaarcankar, R 1984. Certain reproductive parameters in crossbred dairy cattle. *Livestock Advisor* **9** (7) : 59-64

Gupta, A K and Tripathi, V N 1994. Effect of parity, season and period on performance of Red Sindhi cattle. *Indian Journal of Dairy Sciences* **47** (11) : 976-978

Gupta, K 1979. Season, age and lactation day correction factors for Indian breeds of cattle. Thesis submitted to *Haryana Agricultural University* **5** (1) : 22-23

Harvey, W R (1990). *User's guide for LSML-PC-VERSION-2, mixed model least square maximum likelihood program,* Mine graph, Columbus, Ohio, USA.

Hossain K B, Takayanagi S, Miyake T, Bhuiyan A K F H and Sasaki Y 2002. Statistical genetic studies on cattle breeding for dairy productivity in Bangaladesh : I Genetic improvement for milk performance of local cattle populations. *Asian- Australian Journal of Animal. Scieences*. **15** : 627-632.

Jalatge, E F A 1986. Crossbreeding of cattle in Sri Lanka. In: *3rd World Congress on Genetics Applied to Livestock Production*, Lincoin, Nebraska, USA held during 16-22 July, 1986

Johar, K S and Taylor, C M 1973. Variation in lactation period of Sahiwal and Red Sindhi cows. *Indian Veterinary Journal* **50** (9) : 882-885

Kale, A M, Chavan, I G and Patil, N A 1982. Studies on the live weight and sex ratio of Red Sindhi cows. *Livestock Advisor* **7** (10) : 27-30

Kar, B K, Mohanty, A and Mishra, M 1987. Relative economic efficiency of Jersey, its crosses with Red Sindhi and Hariana and Red Sindhi cows and Murrah buffaloes. *Indian Journal of Animal Production and Management* **3** (2) : 72-77

Kumar, D and Narain, P 1978. Effect of season of calving on lactation yield and length in Red Sindhi, Jersey and their crosses. *Cheiron* **7** (1-2) : 190-194

Kumar, P, Bbanga R K and Chauhan R S 2005. Red Sindhi : Important dairy breed of the Indian subcontinent. The Indian Cow (Jan- March) : 40-42

Kumar P, Bhattacharya, T K and Joshi, J D 2004a. Restriction site polymorphism of k-casein gene in three Indian zebu cattle. *Indian Veterinary Journal* **81** (3): 280-282

Kumar, P, Bhattacharya, T K and Joshi, J D 2004b. Use of RAPD markers for genetic divergence study in cattle. *Indian Journal of Animal Sciences* **74** (2) :220-222

Kumar P, Freeman, A R, Loftus, R T, Gaillard, C, Fuller, D Q and Bradley, D G 2003. Admixture analysis of South Asian cattle. *Heredity* **91**: 43–50.

Lacorte, G A, Machado, M A, Martinez, M L, Campos, A L, Maciel, R P, Verneque, R S, Teodoro, R L, Peixoto, M G C D, Carvalho, M R S and Fonseca, C G 2006. *DGAT1 K232A* polymorphism in Brazilian cattle breeds. *Genetic Molecular Research* **5** (3): 475-482

Lalli, A H, Rai, V and Siddappa, L 1979. Effect of season of calving on lactation parameters in dairy cattle. *Mysore Journal of Agricultural Sciences* **13** (3) : 324-329

Mahadevan P 1955. Population and Production Characteristics of Red Sindhi Cattle in Ceylon. *Journal of Dairy Science* **38** (11): 1231-1241

Malhotra, P K and Singh, R P 1980. Estimation of life time production in Red Sindhi cattle using ridgetrace criterion. *Indian Journal of Animal Sciences* **50** (3) : 215-218

Manickam, R, Kathaperumal, V and Sadasivam, P 1978. A comparative study of the some economic traits in Red Sindhi and ½ Jersey -½ Sindhi crossbreds. *Indian Veterinary Journal* **55** (6) : 462-465

Mehla, R K, Kumar, S, Tripathi, V N, Gajbhiye, P U and Patel, R K 1988. A conceptual model for inter se mating of cows in India. *Agricultural Systems* **28** (1) : 47-55

Mishra, L and Mishra, M 1987. Lactation and reproduction performance of crossbred jersey cows in humid condition: a note. *Indian Journal of Animal Production and management* **3** (2) : 68-69

Nair, B R K 1973. A preliminary report on the performance of Jersey crossbred and Jersey grades in Kerala. *Kerala Journal of Veterinary Science* **4** (2) : 99-105

Nair, B R K 1975. Effect of season of calving on laction yield and lactation period in Red Sindhi and Red Sindhi x Jersey crossbred cows. *Kerla Journal of Veterinary Science* **6** (1-2) : 20-28

Narian, P and Garg, L K 1972. Estimation of genetic changes in Indian herds of cattle. *Indian Journal of Animal Production* **3**: 143-150.

Nigam, S and Bector, B S 1991. Effect of milking and stage of lactation on the composition of milk of crossbred (Karan Swiss and Karan Fries) and Sahiwal cattle. *Indian Journal of Dairy Sciences* **44** (7) : 431-436

Nivsarkar A E, Vij P K and Tantia M S 2000. *Animal Genetic Resources of India-Cattle and Buffalo.* DIPA, ICAR, Krishi Anusandhan Bhavan, New Delhi.

Patro, B N and Rao, A S 1983. Genetic, phenotypic and environmental correlations between some production characters in first two lactations of Red Sindhi cattle. *Indian Journal of Dairy Sciences* **36** (1) : 107-110

Patro, B N and Rao, A S 1983. Inheritance of age at first calving, calving interval and breeding efficiency in different locations of Red Sindhi cows. *Indian Journal of Animal Sciences* **53** (7): 750-752

Pattar, A S and Dev, D S 1977. A comparison of Red Dane x Red Sindhi with Holstein Friesian x Red Sindhi crossbred cows. *Indian Journal of Dairy Sciences* **30** (2) : 150

Pereira, M B and Prasad, J 1986. Effect of month of calving on the subsequent lactation milk yield and length of Red Sindhi cows. *Livestock Advisor* **11** (7) : 5-6

Prsaed J, Sushobhan M, Prsaed J and Maji S 1994. Effect of season of calving, first lacation length, milk yield, age and body weiht at first calving on first calving interval of Red Sindhi cows. *Livestock Adviosr* **19** (6) : 76

Pundir R K 1999. Trends in economic traits of Hariana cattle. *Indian Journal of Dairy Sciences* 52 (1): 51-54

Pundir R K and Ahlawat S P S 2007. Indigenous Breeds of Cattle and Buffalo, *Dairy India, Yearbook, 6th edition* pp 261-271

Pundir R K and Sahai R 1997. Conservation of Indigenous cattle breeds. *Dairy India, Yearbook,1997,* page 267-281

Pundir R K, Kailla O P, Mishra S K and Singh K 2007a. Genetic analysis of performance traits of Red Sindhi cattle. *Indian Veterinary Journal* **84** (6) : 590-595.

Pundir R K, Kailla O P, Mishra S K and K Singh. 2007b. Genetic analysis of performance traits of Red Sindhi and Jersey Crossbreds. *Indian Veterinary Journal* **84** (7) : 705-709

Pundir R K and Singh K 2007c. Trends in various economic traits of Red Sindhi cattle. *Indian Veterinary Journal (Accepted, Indian Veterinary Journal)*

Pundir, R K, Singh, P K, Upadhaya, S N and Ahlawat S P S 2007d. Status, characteristics and performance of Red Sindhi cattle breed. *Indian Journal of Animal Sciences* **77** (8): 755-758

Rahumathulla, P S, Natarajan, N, Edwin, M J, Sivselvam, S N and Thangaraju, P 1993 a. Heritability of production and reproduction traits in Jersey crossbred cattle. *Cheiron,* **22** (3) : 111-115

Rahumathulla, P S, Natarajan, N, Edwin, M J, Sivselvam, S N and Thangaraju, P 1993 b. Repetability estimates for economic traits in Jersey crossbred cattle. *Cheiron* **22** (3) : 98-102

Rao, A S and Patro, B N 1984. Inheritance of average daily milk yield, lactation length and dry period in different locations of Red Sindhi cattle. *Indian Veterinary Journal* **61** (2) : 132-136

Rao, A V N 1983. Incidence of calf mortality among different cattle breeds maintain in states farm of Andhra Pradesh. *Livestock Advisor* **8** (2) : 43-45

Reddy, A O and Sampath, S R 1979. Note on the performance of crossbred and pure bred Zebu cattle with respect to prenatal and early postnatal mortality characteristics. *Indian Journal of Animal Sciences* **51** (10) : 973-974

Sachan, C B 1987. Effect of season of calving on milk yield, fat production, lactation length and dry period of crossbred cows: a note. *Indian Journal of Animal Production and management* **3** (4) : 180-183

Sharma, K N S and Jain, D K 1976. Mortality in crossbred calves vis-à-vis Zebu calves. *Indian Journal of Dairy Sciences* **29** (1) : 53-58

Sharma, R C and Bhatnagar, D S 1975. Influnce of sex of the calf and order of lactation on reproductive efficiency of dairy animals. *Indian Veterinary Journal* **52**:11, 813-822.

Singh, C S P Singh,D K, Mishra, H R and Kumar, P 1982. Note on some milch characters in Red Sindhi cows. *Indian Journal of Animal Sciences* **52** (8) : 683-685

Singh, M K, Gurnani, M and Singh, D V 2003. Trends in first lactation traits of Karan Swiss cattle. *Indian Journal of Dairy Sciences* **56** : 336.

Singh, R K and Prsaed, J 1985. A study on the influence of age at first calving, sex and weight of calf born and season of calving on some economic traits of Red Sindhi herd of Allahabad Agriculture Institute, Allahabad. *Livestock Advisor* **10** (1) : 5-8

Singh, S, Katoch, S, Thakur, Y P, Manujia, N K and Gupta, K 1985. Inheritance of reproductive efficiency in Jersey and Red Sindhi X Jersey cows in Himachal Pradesh. *Himachal Journal of Agricylture Research* **20** (1-2) : 68-71.

Sivarajasingam, S and Mukherjee, T K 1980. Genetic, phenotypic and environmental correlation coefficients between milk yield and other economic traits. *Malaysian Agricultural Journal* **52** (3) : 254-262

Smith, C 1962. Estimation of genetic changes in farm livestock using field records. *Animal Production* **4**: 239 251.

Subramanian, A. and Ulaganathan, V 1990. Effect of parity and environment on milk yield in crossbred cows. *Cheiron* **19** (4) : 153-155.

Taneja, V.K. and Chawla, D.S. 1987. Comparative study of economic traits of Brown Swiss X Zebu crosssbreds *Indian Journal of Dairy Sciences* **31** (2) : 188-190.

Taneja, V K and Sikka, A K 1981. Factors affecting some economic traits in Indian dairy breeds. *Indian Journal of Dairy Sciences* **34** (3) : 347-349

Taylor, C M, Singh, B N, Gurung, B S and Srivatstava, A K 1979. Cattle breeding in Madhya Pradesh: a genetic appraisal. *Indian Veterinary Medical Journal* **3** (4) : 242-247

Tomar, N S and Singh, B P 1981. Genetic trends of some economic traits in Hariana cows. *Indian Veterinary Journal* **58**: 701 709.

Tomar, S S and Sharma, A 1986. Significance of service sire in the post partum performance of mates in ensuring lactation. *Indian Journal of Dairy Sciences* **39** (4) : 506-508

Ulmek, B R, Gosavi, S B and Belhe, N D 1992. Factors affecting reproduction traits in Red Sindhi cattle. *Indian Veterinary Journal* **69** (11) : 998-1000

Yasdani, A R and Jagtap, D Z 1996. Production traits of halfbreds. *Livestock Advisor* **21** (4) : 3-8

Yazdani, A R and Rakshe, P T 1997. Reproductive traits of halfbred friesian X Red Sindhi and Jersey X Red Sindhi. *Journal of Dairying Food and Home Sciences* **16** (1) : 8-12.

Yazdani, A R, Rakehe, P T and Jagtap, D Z 1993. Reproduction traits of Red Sindhi half breds. *Indian Journal of Animal Reproduction* **14** (2) : 112-113

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