Cattle Genetic Resources of India

KANKREJ

- The Finest dual purpose Breed

M. Sodhi, M. Mukesh, R.K. Pundir, B. Prakash, P.K. Singh and S.P.S. Ahlawat

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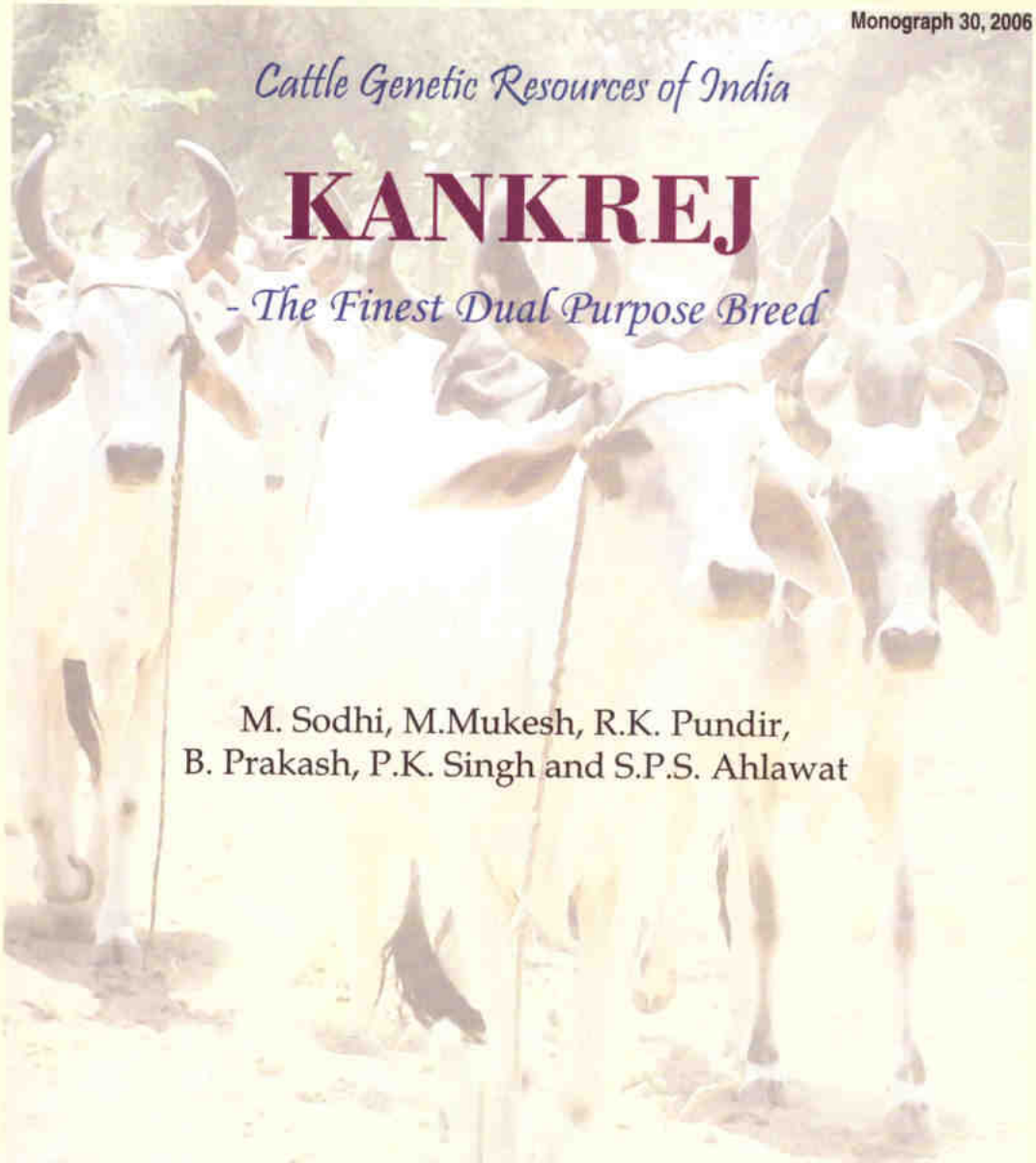

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FOREWORD

The luxuriant reservoir of cattle genetic resources of India refers to the 30 well-recognized breeds of zebu cattle. Besides these descript breeds, many non-descript cattle populations are also spread out in the length and breadth of the country. Each of these indigenous breeds have been evolved over centuries through the intervention of natural and human forces and are locally adapted to their respective agro-climatic and eco-geographical conditions, prevailing in the respective breeding tracts. This has made Indian cattle breeds very well adapted to harsh and extreme climatic conditions with ability to survive in stress and develop special gene combinations such as resistance to the prevalent tropical diseases and better efficiency to utilize coarse feed and fodder, which generally are not found in high producing exotic breeds. Because of all these special traits and their strong contributions as economically important livestock species, cattle genetic resources have a crucial place in the country's agriculture/dairying sector. Indian cattle harboring several advantageous features have also led a continuing upsurge interest worldwide for some of the renowned Indian breeds like Ongole, Gir, Sahiwal, Kankrej *etc.*

However, due to lack of breed associations, herd books and changing production pattern, there has been uncontrolled mixing of cattle breeds and

hence such unique germplasm are getting diluted and becoming endangered at an alarming rate. Therefore, characterization and documentation of our cattle genetic breeds become imperative to understand these valuable resources and to develop their conservation and genetic improvement plans for sustainable utilization. In the regime of patenting and IPR related to animal agriculture also such activities related to our breed characterization becomes pertinent.

Among these few milch breed, Kankrej is now considered as one of the most important breeds of Gujarat and Rajasthan states, gaining much preference by the farming community. The Kankrej cattle are very highly prized as fast, powerful dual purpose cattle. These have a very high genetic potential for milk production and the bullocks of the breed are famous for agricultural work. The breed can survive easily on draught and under scarcity of feeds and fodder. These cattle are resistant to Tick fever and they show little incidence of contagious abortion and tuberculosis

I really appreciate the hard work put by the authors in compiling comprehensive information related to this breed from the research project outcome as well as other available information in the literature in nice manner. I hope that this document will be of immense relevance to the stake holder and researchers involved in betterment of this important breed of our country.

(B. K. Joshi)

CONTENTS

KANKREJ CATTLE

PRIDE OF GUJARAT

Common Name	:	Kankrej
Other names	:	Bannai, Nagar, Talabda, Vaghiyar, Wagad, Waged, Vadhiyar, Wadhiar, Wadhir, Wadial
Scientific Name	:	*Bos indicus*
Group	:	Zebu
Relative Size	:	Large
Category	:	Mammals>> Cattle
Utility	:	Dual purpose

Introduction

India is considered as the goldmine of excellent and diverse germplasm of cattle genetic resources represented by 30 well-defined breeds ranging from good milch animals to extreme draught type, very tall v/s dwarf cattle, highland cattle to those adapted to marshy climate. Most of these indigenous zebu cattle breeds (*Bos indicus*) have evolved over the years for their utility under a certain set of agro-climatic conditions as compared to highly selective *Bos taurus* (exotic) cattle. These Indian zebu cattle breeds have unique features like adaptability to extreme climatic conditions, subsistence on poor feed and fodder and better resistance capabilities to withstand environmental stress and tropical diseases. As a consequence, the diverse Indian cattle germplasm could be a rich source of highly evolved and a vast gene pool comprising many genes of immense economic importance. It is considered that Zebu cattle breeds constitute an interesting resource for genetic studies as they present traits different from those of the taurine breeds *(Bos taurus)*.

Although, cattle in India is the most important livestock species and plays a major role in agricultural economy, yet most of the indigenous breeds have not been exploited to their full genetic potential and population of some of the important cattle breeds is either declining or breed characters are being diluted under the present production system. This depletion of cattle resources would result in loss of important genes/gene combinations responsible for remarkable adaptive traits, further leading to loss in genetic variability vital for selection and improvement. Conservation of these genetic groups is of priority since loss of information will restrict the options available to meet future unknown requirements. However, the selection of breeds for conservation or improvement programs is mostly hampered by an inadequate description of population structure of indigenous cattle breeds existing in India. This bulletin aims to provide descriptive information related to population structure and existing genetic variability in Kankrej cattle- an extremely athletic, useful dairy and draft breed of Gujarat.

Origin and Geographical Distribution

Kankrej is one of the heaviest breeds of cattle in India. The breed has originated from Kank area of Banaskantha district of Gujarat and is maintained by Bharwards and Rabaries communities. The breeding tract of Kankrej cattle mainly lies in southeast Rann of Kutch comprising of Mehsana, Kutch, Ahmedabad, Kaira, Sabarkantha, Banaskantha districts of Gujarat and Barmer, Jodhpur areas of Rajasthan (Fig 1). However, the Kankrej cattle is distributed throughout the state of Gujarat. The breed can survive easily on draught and under scarcity of feeds and fodder.

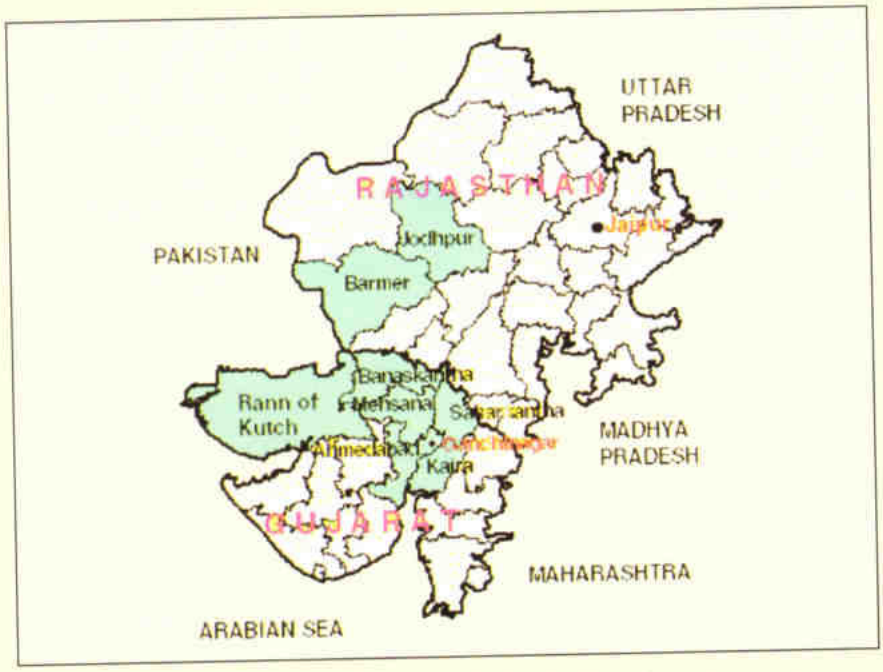

Fig. 1. Breeding tract of Kankrej cattle

Breed Survey

To know breed characteristics, utility, management and performance of the Kankrej cattle, a survey was conducted by National Bureau of Animal Genetic

Resources, Karnal in Kutch and Banaskantha districts of Gujarat. A total of 114 farmers were contacted, 50 from Kutch and 64 Banaskantha districts. Various parameters were recorded from a total of 31 villages ; 17 of Kutch and 14 Banaskantha districts covering 3 tallukas in each of the district. The survey was conducted in Bhuj, Anjar and Bachau tallukas of Kutch district and Thara, Deodar and Deesa tallukas of Banaskantha district.

The morphological parameters i.e. body length, height at wither and heart girths were recorded on 429 animals of different age and sex. Various parameters on production, reproduction and draft capacity of the breed was known by intraction with the farmers in the breeding tract for evaluating breed parameters

Topography of Breeding Tract

The breeding tract of Kankrej covers roughly 18,000 km^2 and lies between 21° and 24° north latitude, and between 75°16 and 78°15 east longitude. The elevation of the tract ranges from 409 to 455 MSL.

Soil

The soil in the southwestern part of breeding tract is sandy loam and heavy black, whereas on the eastern side it is mostly sandy with some sandy loam areas. The sub soil type is yellowish white.

Climate

The climate in the region is tropical to subtropical and dry varying greatly with the distance from the sea. Average annual rainfall is 50 to 76 cm and is usually concentrated during July to October. Temperature of the region varies from 4°C (winter) to 49°C (summer). The range of diurnal temperature (minimum and maximum) in a year is highest in Kutch district. The rainfall and humidity percentage is lower in Kutch district as compared to Banaskantha. The depth of subsoil water is more in Kutch than Banaskantha district.

Feeds and fodder

In the breeding tract Wheat bhusa (*Triticum aestivum*), karavi of Jawar (*Sorghum vulgare*) and Bajara (*Pennisetum typhoides*) are available as dry fodder; Maize (*Zea mays*), Oat (*Avena sativa*), Lucern (*Medicago sativa*), Sorghum and Bajara as green fodders and Cottonseed, Ground nut cake (GNC) and Banas dana are available as concentrates.

Population Status of the Breed

In Gujarat state, the cross bred cattle population has increased by 48.04% and 13.13% from year 1992-1997 and 1997 to 2003 respectively. The proportion of crossbred cattle among the total cattle population in the state was 3.40%, 5.07%, and 9.04% in the year 1992, 1997, and 2003 respectively. It was less by 3.07% as compared to the proportion of crossbred in Indian cattle population in the 2003. So the increase of crossbred cattle in the state was less than that in the country. The indigenous cattle comprises Kankrej, Gir, Dangi and non descript which showed a decline of 2.52% from the year 1992 to 1997, while it increased by 5.92% from 1997 to 2003. Other than West Bengal, Gujarat is the only state in India which has shown an increase (3.26%) in the indigenous cattle population from 1992 to 2003 as compared to an overall decrease of 15.25% in India (Livestock census 2003, Fig. 2). The total and indigenous cattle population in Gujarat in 2003 were 7424000 and 678500 respectively. The buffalo population in Gujarat showed an increase of 19.30% and 11.47% from the year 1992 to 1997 and 1997 to 2003, against the increase of 6.65% in the country from 1997 to 2003. Annon (2000) estimated the proportion of Gir and Kankrej cattle in Sauratra. Out of total cattle population of 25,05,000, the populatin of Kankrej and Gir cattle were 917081 (36.61%) and 846, 941 (33.81%) respectively.

In Gujarat, the proportion of different breeds (Milch animal) was 7.18% exotic/ crossbred , 36.63% Gir, 35.07% Kankrej and 21.11% non descript including Dangi breed in the year 1998-99 (Report 1999). There may be more

than 23.81 lacs of Kankrej cattle in the state (Report 2003). In addition to this Kankrej animals are also available in Rajasthan state.

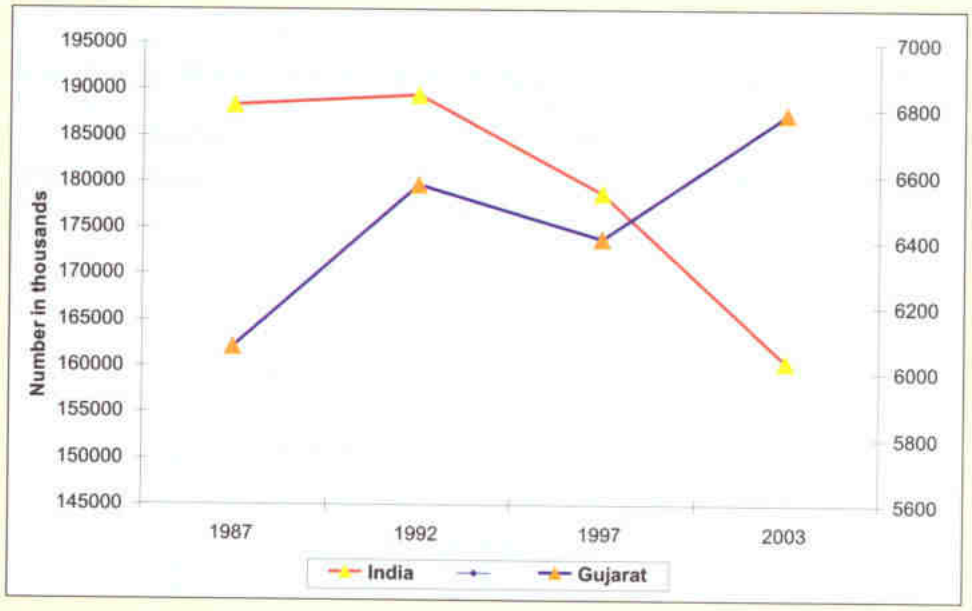

Fig. 2. Number of Indigenous cattle in India and Gujrat

Gujarat State Animal Husbandry Department has also conducted district wise survey regarding the population of Kankrej milch cows in the year 1998-99, (report 1999). Based on number of Kankrej cattle, the major breeding tract of the breed includes Banaskantha (154800), Kutch (178736), Mehsana (75176), Ahemadabad & Gandhinagar (74664) and Sabarkantha (59560) districts. The other districts where Kankrej cows are reported to be present in high number were Vadodara (44688), Kheda (44534), Bharuch (26280), Surat (30733), Valsad & Dang (11022), Sureandranagar (11305) and Panchmahals (7400). The Kankrej cows constituted about 26.85% of the total cattle population in 1998-99 in Gujarat. From 1988-89 to 1998-1999, there was increase in the population of Kankrej cows in all the districts except Ahemadabad, Gandhinagar, Valsad, Dang and Sureandranagar. The population trend from 1988-89 to 1998-99 showed that total as well as

Kankrej cows in particular increased by 25.87% and 26.85%, respectively in Gujarat. The details of the population trend of total cows and the Kankrej milch cows in Gujarat is depicted in Table-1.

Table-1. Population trend of total cows & Kankrej cows in Gujarat

Districts	1988-89			1998-99		
	Total cows (%)	Proportion of Kankrej	Kankrej Population	Total cows (%)	Proportion Kankrej	Kankrej
Ahemadabad/ Gandhinagar	95200	83.67	79653	116100(21.95)	64.31	74664(-6.26)
Banaskantha	119400	93.10	111161	171600(43.71)	90.21	154800(39.25)
Bharuch	52500	39.46	20716	65900(25.52)	39.88	26280(26.85)
Kachchh	125700	99.39	124933	179400(42.72)	99.63	178736(43.06)
Kheda	46900	60.99	28604	69400(48.49)	64.17	44534(55.70)
Mehsana	82400	80.54	66364	101700(23.42)	73.92	75176(13.27)
Sabarkantha	100400	54.32	54537	112400(11.95)	52.99	59560(9.21)
Surat	90700	32.54	29514	99300(9.48)	30.95	30733(4.13)
Vadodara	70600	45.36	32024	94900(34.42)	47.09	44688(39.54)
Panchmahals	171400	1.39	2382	198400(15.75)	3.73	7400(210.66)
Sureandranagar	80000	17.00	13600	111600(39.50)	10.13	11305(-16.67)
Valsad & Dang	107400	15.50	16647	125400(16.76)	8.79	11022(-33.78)
Gujarat	1636200	34.80	569398	2059500(25.87)	35.07	722266(26.85)

Figures in parenthesis depicts trend in percentage among total & Kankrej cows in Gujarat during 1988-89 to 1998-99

Management Practices in the Breeding Tract

Animal housing

Most often, the Kankrej animals are kept in open type of Kutcha houses with Kutcha flooring. The open houses are mostly made up of paddocks of thorny bushes. The animal house is located either in a separate area or

part of the farmer's residence. The percentage of farmers having separate house for the animals varied from 42-76% in Banaskantha and Kutch district, respectively. The animal houses have proper ventilation, drainage and cleaning. The herd size ranged from 2 to 60 with 2-5 breeding bulls.

Grazing, feeding and management

The pastures in the breeding tract of Kankrej are seasonal. These are available from July to October. The animals are tied in night and during the daytime they are taken out for grazing around the whole year. During the rainy season when pastures are available in plenty, they graze in the nearby areas but in the scarcity period they have to cover long distances. Stall-feeding is not very common practice in the region and only few farmers provide

Fig. 2 Grazing herd of Kankrej cattle

feeds & fodder at stall in the evening/night. Stall-feeding is more prevalent in Kutch than the Banaskantha district. As no fodder crops are grown in the area, only stovers and straws are fed to cattle. Cottonseed and Oilcakes are widely used as concentrates. Clusterbean (*Cyamopsis psoraloides or C. tetragonoloba*) is also used as a cattle feed.

The calves are not weaned and are reared through suckling and feeding colostrum to the new born. The male calves are cared better than the female calves. Ladies are also involved in the rearing of animals. Dehorning is not a common practice. In the surveyed area, natural service is a preferred way for breeding of animals. Kankrej Cattle are heat, tick resistant and are tolerant to many of the diseases. The use of wormicide and other health care measures are not adopted by the farmers.

Sale and purchase of animals

Among the farmers surveyed across both the districts, it was observed that all of them get cows either from farm or neighbouring farmers. No businessmen are involved in sale and purchase of the Kankrej cows. The bullocks of Kankrej breed are well reputed for agricultural work and their sale and purchase was also observed in the breeding tract.

Socio-economic status of the farmers

The owners of the Kankrej cattle in Kutch district had larger land holding than the Banaskantha district. Among the surveyed farmers in Banaskantha, 65% farmers had land below 10 acres while the corresponding percentage of farmers in Kutch district was 18%, rest all the farmers had larger land holding. In Kutch, the main income source of the farmers was sale of milk and almost all the milk produced was sold in the market. However in Banaskantha district, 70% of the farmers utilized their milk at home, 8% sell their milk and 22% use it at home and sell as well. Sale of bullocks of the breed is one of the main sources of income.

Utility of the Breed

Kankrej cattle has an important role to play in the economy of the region. The breed is reared for milk as well as agricultural operations. Road transport in village areas is carried out mainly by bullocks of this breed Fig. 3. As the crop farming in Kutch district is dependent on rains, the farmers earn their

Fig. 3 Utility of the breed

livelihood from the sale of milk. Here majority of the farmers (84%) rear this breed for milk purpose. Ten percent of the farmers from this region maintain the animals of this breed for milk as well as agricultural operations and only 6% of farmers rear it for agriculture operation alone. In Banaskantha district, the percentage of farmers rearing the breed for dual purpose (milk and draft) and exclusively for agricultural operations was 64 and 36% respectively.

Physical Characteristics

The animals of the breed have thick skin, broad chest, straight and powerful body. Colour of the animal varies from silver-grey to iron-grey or steel-black or white. In males, forequarters, hindquarters and hump are slightly darker than the rest of the body. Muzzles are grey, white or black whereas hoofs are black, grey or white. Eyelids are grey in colour. Forehead is comparatively broad, slightly dished in the centre. Face of the animal is short and nose slightly upturned. Ears typical to this breed are large and pendulous. Typical Kankrej cow, bull and calves are depicted in Fig. 4, 5 & 6. The Kankrej Cattle have long and strong horns with grey, white or black

Fig. 4 The Kankrej cow

Fig. 5 The Kankrej bull

Fig. 6 The Kankrej calves

color. These are curved outward and upward in a lyre shape. These are covered with skin to a longer distance as compared to other breeds. Hump is large and well developed whereas dewlap is medium, thin and pendulous. Polls, forequarters and hindquarters are rusty red in newborn calves, but the colour disappears later on. The cows have small sized udder with small and cylindrical teats. The milk veins are not prominent. Tail of the animal is moderate in length and has black switch. The Kankrej animals generally have furious temperament.

The gait of the Kankrej known as Sawai chal (11/4 paces) is peculiar to this breed. The action is smooth with head held noticeably high. There is hardly any movement of the body; the stride is long and even, and the hind hoof is placed well ahead of the impression of fore hoof.

Morphometric and Performance Parameters

Body measurements

The body length, height at wither and heart girth recorded on 429 animals of different age and sex from the breeding tract are summarized in Table-2. The average body length, height at wither and heart girth was 126.6±1.6 cm,

134.6±1.4 cm and 161.9±1.8 cm respectively. However Nivsarkar et al (2000) reported the average body length, height at wither and heart girth average to be 148, 158 and 194 cm, respectively, in males and 113.6, 133.6 and 166.2 cm, respectively, in females. In the present study, it was observed that animals in all age groups had more length, height and heart girth in Kutch district than those of Banaskantha district. The average birth weight of the animals, adult body weight of male and female animals was reported to be 23 kg (range 21-26), 500-550 kg and 325-400 kg in females, respectively (Nivsarkar *et al.* 2000). Earlier Pundir and Sahai (1997) reported the body weight of adult male and female as 589.6 and 430.9 kg respectively.

Table-2: Body measurement recorded in different age and sec of animals of Kankrej breed

Age	Sex	Banaskantha District				Kutch District				Pooled			
		N	BL	HT	HG	N	BL	HT	HG	N	BL	HT	HG
2-3	M	4	62	80	85	7	66	88	90	11	64.5	85.0	88.2
	F	6	62	78	82	12	67	84	88	18	65.3	82.0	86.0
3-6	M	3	66	84	90	6	72	92	96	9	70.0	89.3	94.0
	F	8	65	87	94	13	70	88	95	21	68.1	87.6	94.6
6-12	M	2	73	98	106	7	81	110	114	9	79.2	107.3	112.2
	F	8	74	92	102	14	79	106	111	22	77.2	100.9	107.7
12-18	M	1	86	112	120	6	96	121	128	7	94.6	119.7	126.8
	F	10	88	110	124	13	93	118	127	23	90.8	114.5	125/7
18-24	M	2	96	121	134	4	108	130	143	6	104.0	127.0	140.0
	F	7	94	116	128	21	104	127	141	28	101.5	124.2	137.7
24-30	M	4	98	124	136	5	111	136	147	9	105.2	130.6	142.1
	F	6	96	116	132	23	108	127	141	29	105.5	124.7	139.1
>30	F	155	123.1 ±1.6	130.9 ±1.5	158.9 ±1.7	82	133.2 ±1.3	141.7 ±1.4	167.3 ±2.1	237	126.6 ±1.5	134.6 ±1.4	161.9 ±1.8

N- no. of observations, BL-Body length (cms.) HT-Hight at wither (cms.) HG- Heart girth (cms.) M-Male, F- Females

Lactation yield and lactation length

Lactation yield is an important parameter to assess the economic value of cattle. Wide range of lactation yield in Kankrej cattle (800-2196 liters) has been reported by different workers. Pundir and Ahlawat (2004) reported the lactation milk yield of the Kankrej cattle varing from 800-1200 Kg. These values were less in comparison to other available reports (Table-3). The lactation milk yield of 1535.8 kg was recorded by Doodhsagar (Farmers Co-Operative Union); 1807 Kg by Ambatkar (1991); 1589 by Raj Kumar (2002). Highest milk yield (2196 liters) till date has been reported in one of the earlier study by Md-Nur-UL-Islam (1984) in Kankrej herd of Anand institute of Agriculture. Vaious reports indicated lactation length of 287 (Raj Kumar 2002); 321 (Md-Nur-Ul-Islam 1984); 302.1 (Doodhsagar union); 340.7 (Wadhwani et al. 2005); and 240-300 days (Pundir and Ahlawat 2004).

Peak milk yield

From the available literature (Table-3), peak milk yield in Kankrej cattle ranged from 6-11.13 Kg. Pundir and Ahlawat (2004) observed peak yield in the range of 6-8 Kg. Mathur and Uppal (1993) reported slightly higher values of peak yield (7.83-8.17 Kg). However, peak yield as high as 11.3 ± 0.10 Kg in Kankrej cattle has been reported by Bhambure (1986).

Wet average and herd average

Average daily yield and average herd average in Kankrej cattle reported by different workers ranged from 4 to 6.8 liters and from 2.78 to 4.45 liters (Table-3), respectively. Raj Kumar (2002) cited the example of Sardarkrushinagar farm, where in last 25 years, the wet average and herd average has increased more than double fold from 3.17 to 7.44 and from 1.57 to 4.64, respectively.

Dry period

Rajkumar et al. (2002) reported the dry period in Kankrej cattle as 165 ± 6 days after analyzing the data for a long period of time (1984 to 2001) of LRS,

Sardar Krushinagar. However, this figure was quite low when compared the data from other Govt. farm (100-265 days, Raj Kumar et al. (2002) and of Pundir and Ahlawat, (2004) which varied from 180-300 days. The dry period reported by several other workers for Kankrej cattle is mentioned in Table-3.

Service period

The service period recorded for Kankrej cattle by Pundir and Ahlawat (2004) varied from 90-180 days. Ambatkar (1991) and Raj Kumar (2002) also observed the service period within the similar range. Contrary to this, Patel (1988) reported service period of 251 days in this breed (Table 3).

Calving interval

The period between two consecutive calving (calving interval) observed in the study of Pundir and Ahlawat (2004) was 365 to 700 days, which was relatively high when compared with the other available reports. Raj Kumar *et al.* (2002) reported calving interval of 462 ± 7 days for LRS, Sardarkrushinagar herd. Several other workers have mentioned CI (Table-3) in the similar range as that reported by Raj Kumar (2002).

Age at first estrus, conception and calving

Age at first estrus in Kankrej animal of LRS, Sardarkrushinagar, Gujarat was reported to be of 780 days (Gurjar, 1989). In general herd, this varied from 942 days to 1364 days (Raj Kumar, 2002). The age at first conception in Kankrej heifers ranged from 846 to 1125 days (Rak Kumar et al., 2004). As per Pandey and Shukla (1993), age at first calving in Kankrej cattle ranged from 1036 to 1520 days. Raj Kumar (2002) reported age at first calving in Kankrej cattle to be 1407 days, whereas, as per Pandey (1990), it was 1127 days.

Work capacity

Kankrej bullocks are known to have excellent work capacity for different agricultural operations. Pundir and Ahlawat (2004) reported that one pair

of bullock could plough 0.4 to 0.6 hectare of land in a day. They could also record the carrying capacity of a pair of bullock as 1.5 to 1.8 tones of load for 20 to 22 kms in a day.

Table-3 Performance of Kankrej breed revealed from the literature

Trait		Mean+SE	Reference
Birth weight (kg)		23.0	Nivsarkar et.al.2000
		22-24	Livestock Res. Station, SDAU 2007
Body weight (kg)			
	Adult male	589.6	Pundir and Sahai, 1997
		500-550	Nivsarkar et.al.2000
	Adult female	430.9	Pundir and Sahai, 1997
		325-400	Nivsarkar et.al.2000
Production			
Lactation milk yield (kg)		2196	Md-Nur-UL-Islam, 1984
		1875	Patel, 1988
		1123±28	Gujar et. al.1989
		1807	Ambatkar, 1991
		1738.00+8.62	Mathur and Uppal, 1993
		1589	Raj Kumar, 2002
		800-1200	Pundir and Ahlawat, 2004
		1535.8	Doodhsagar (Farmers Union)
		2312	Livestock Res. Station, SDAU 2007
	First	1528-1972	Chaudhary et. al.1994
		1850.0±51.4	Pundir and Sahai, 1997
		1746	Nivsarkar et.al.2000
Lactation length (days)		321.26	Md-Nur-Ul- Islam, 1984
		287.0±4.0	Gujar et. al., 1989
		297.24±0.71	Mathur and Uppal, 1993
		302.1	Doodhsagar farmers union
		287±3.2	Raj Kumar, 2002
		240-300	Pundir and Ahlawat (2004).
		340.72	Wadhwani et al.2005
		290-305	Livestock Res. Station, SDAU 2007
	First	337.0-368.0	Chaudhary et. al.1994
		351.0±8.0	Pundir and Sahai, 1997
		294	Nivsarkar et.al.2000

Trait	Mean+SE	Reference
Peak milk yield (kg)	7.83 - 8.17	Mathur and Uppal, 1993
	11.3 ± 0.10	Bhambure, 1986
	6-8	Pundir and Ahlawat, 2004
Av. daily milk yield (kg)	5.71-5.91	Mathur and Uppal, 1993
	7-9	Livestock Res. Station, SDAU 2007,
Dry period (days)	185.0±7.0	Patel, 1988
	165 ± 6	Rajkumar, 2002
	180-300	Pundir and Ahlawat, 2004
	100-265	Rajkumar, 2002
	120-130	Livestock Res. Station, SDAU 2007,
First	149.61-231.90	Chaudhary et. al.1994
	141.0±9.2	Pundir and Sahai, 1997
Reproduction		
Age at first calving (days)	1127	Pandey, 1990
	1036-1520	Pandey and Shukla, 1993
	1438.1±0.03	Mathur and Uppal, 1993
	1623.68	Chaudhary et. al.1995
	1436±0.8	Pundir and Sahai, 1997
	1438.1+10.95	Nivsarkar et.al.2000
	1407	Raj Kumar, 2002
	1270-1385	Livestock Res. Station, SDAU 2007
Service period (days)	251.0±6.0	Patel, 1988
	163.9±18.8	Ambatkar, 1991
	90-180	Pundir and Ahlawat, 2004
	120-140	Livestock Res. Station, SDAU 2007
Calving interval (days)	483.0	Patel, 1988
	462 ±6.8	Rajkumar, 2002
	458.80.72	Mathur and Uppal, 1993
	365- 700	Pundir and Ahlawat, 2004
	415-440	Livestock Res. Station, SDAU 2007
First	553.29	Chaudhary et. al., 1995
	486±0.4	Pundir and Sahai, 1997
	490.0	Nivsarkar et.al.,2000
Age at first estrus (days)	780±33	Gurjar, 1989
	942 - 1364	Rajkumar, 2002
Age at first conception (days)	846 - 1125	Rajkumar, 2002

Performance recorded under field conditions

Under the field survey conducted by National Bureau of Animal Genetic Resources (NBAGR) team, various performance parameters for Kankrej cattle were recorded in the areas of Banaskantha and Kutch districts of Gujarat (Table 4). The milk yield in a lactation length of 240-300 days ranged from 800-1400 kg. The average values for milk yield and lactation length were 1535.8 kg and 302.1 days respectively. The observed daily milk yield ranged from 3-5 kg with a peak milk yield of 6-8 kg. The age at first fertile service was recorded to be 3 years whereas the age at first calving ranged from 3.5 –4.0 years.

Table-4: Performance of the breed in the surveyed area

SNo	Trait	Banaskantha	Kutch
	Production		
1	Daily Milk yield (Kg)	2-4	3-5
2	Peak milk yield (Kg)	6-8	6-8
3	Lactation milk yield (kg)	800-1200	800-1400
4	Lactation length (days)	240-300	250-300
5	Fat %	4.0	4.0
6	Solid not fat %	8.0	8.0
7	Dry period (days)	180-240	180-300
8	Life span (years)	12-15	12-15
	Reproduction		
9	Age at first fertile service (years)	3.0	3.0
10	Age at first calving (years)	3.5-4.0	3.5-4.0
11	Service period (days)	90-180	90-180
12	Calving interval (days)	365-700	400-750
	Work capacity (Bullocks)		
13	Area ploughed by 1 pair of bullock in a day (hact)	0.4-0.6	0.4-0.6
14	Load carry and distance covered by one pair of bullock in a day	1.5 to 1.8 tones for 20-22 km	1.5 to 1.8tones for 20-22 km

The comparison of the surveyed data with earlier studies (summarized in Table-3) revealed that production parameters like lactation milk yield, daily milk yield, peak milk yield and lactation length were on lower side. While reproductive parameters like age at first calving, service period and calving interval were within the range of different reports available in literature. The performance of cow was recorded to be better in Kutch district as compared to Banaskantha district in terms of daily milk yield and lactation milk yield. This was attributed to the fact that milk is the main source of income and hence animals are relatively better cared in Kutch district.

Draft performance

Dhangar 1998 investigated the draft performance of Kankrej cattle. He observed that the Draft generation of Kankrej cattle was 39.61 kg. The main pulling force was estimated to be 23.56, 36.36, 47.08 and 56.72 kg respectively for 340, 620, 900 and 1180 kg payloads. Kankrej bullocks could tug the cart at the speed of 3.83 km/h, whereas horse power (HP) production at carting was 0.59 $\pm$ 0.01 per bullock. The mean stive lenght was 1.50 $\pm$ 0.02.

The Draft generation and HP produced per pair of bullock were 79.96 kg in 1.07 HP respectively while ploughing and 39.92 kg and 0.52 HP while planking. The performance was also compared with the cross bred bullocks (Table).

The kankrej bullocks can safely be used for 6 hours for medium to heavy work (ploughing) and 3 hours for light work (plan work), to a total of 9 hours of work in a day. Engaging bullocks to work at 7.00 hours or even earlier in the morning, and work during 1600 to 1900 hours in afternoon particularly during summer might result in still bettr perfomance of the bullocks.

Draft generation while carting

Draft generation while caring					
	Pull generated while carting (kg)	39.61			
	Pulling force (kg)	23.56	36.36	47.08	56.72
	(Pay loads (kg))	(340)	(620)	(900)	(1180)
	Speed of carting (km/hr)	3.83			
	Horse Power (hp)	0.59±0.01			
	Stride length (m)	1.50±0.02			
Draft generation while ploughing (per pair of bullock)					
	Draft generation (kg)	79.96			
	Horse Power (hp)	1.07			
Draft generation while planking (per pair of bullock)					
	Draft generation (kg)	32.92			
	Horse Power (hp)	0.52			
Efficiency of performing agricultural operations					
	Area ploughed (hec/day)	0.74			
	Speed ((km/hr)	3.4			

Molecular Genetic Characterization

Molecular genetic characterization of populations allows the assessment of genetic variability, a crucial element in determining breeding strategies and genetic conservation programs. The assessment of genetic variability at neutral as well as functional loci is especially important in Indian indigenous livestock breeds since the indiscriminate use of assisted reproduction techniques, such as artificial insemination and embryo transfer could have reduced the genetic variability of the population. Molecular markers have been widely used to access this variability since they provide information on every region of the genome, regardless of the level of gene expression (Nijman et al.1999; Machugh et al. 1998).

Microsettelite (neutral) marker based analysis

Microsatellites (highly polymorphic simple sequence repeats) are currently the most widely used molecular markers, mainly because of the possibility of combining their analysis with the polymerase chain reaction (PCR). These markers have been used to explain bovine domestication and migration patterns (Tambasco et al.2000) and to characterize cattle populations (MacHugh *et al.*, 1998; Kemenes *et al.*, 1999; Mukesh *et al., 2004 a & b*).

Another application of data generated through molecular markers is in assignment of the individuals to their breed of origin. This is especially important for guaranteeing the accuracy of breeding programs in which the relationship between individuals is used to estimate breeding value. Thus characterization of the breeds has multifold advantages. Several studies on establishing the genetic relationships and differentiation based on microsatellite markers have been reported in different cattle populations from Africa, Europe and Asia (Moazami-Goudarzi et al. 1997; Beja-Pereira et al. 2003; Jordana et al. 2003). However, not many studies have been carried out to reveal the genetic variation and establish the genetic relationship amongst the indigenous Indian cattle breeds. Only few reports available on this aspect are (Kumar et al.2003; Metta et al.2004; Mukesh et al. 2004a; Mukesh et al. 2004b).

In a step towards characterization of the Indian indigenous breeds an attempt was made to characterize and evaluate Kankrej cattle, an important milch breed both phenotypically and at DNA level using FAO recommended simple sequence repeats (SSR)/microsatellites (Litt and Lutty 1989) following the guidelines proposed by FAO (1996) under the global project for the measurement of domestic animal diversity (MoDAD).

Sampling and DNA Isolation

Fresh blood samples (7-8 ml) were collected randomly from 50 genetically unrelated animals of Kankrej cattle from its breeding tract in line with

MoDAD recommendations (FAO, 1998). Genomic DNA was extracted from the whole blood using proteinase-K digestion followed by standard phenol-chloroform extraction procedure of Sambrook *et al.* (1989).

Microsatellite Markers

A panel of 25 bovine specific microsatellite markers (BM1824, CSSM08, CSSM33, CSSM60, CSSM66, ETH3, ETH10, ETH225, HAUT27, HEL01, HEL5, HEL09, ILSTS005, ILSTS006, ILSTS011, ILSTS033, ILSTS034, INRA05, INRA63, INRA35, MM8, MM12, TGLA53, TGLA122 and TGLA227) recommended in MoDAD project of FAO (1996; 1998) for cattle genetic diversity studies was selected. One of the two primers for a given locus was end labeled with one of the four fluorescent dyes viz., 6-FAM™, VIC®, NED™ or PET™ (Table- 1)

PCR Based Genotyping

Polymerase Chain Reaction was carried out in 15 ml reaction volume containing 1.5 mM $MgCl_2$, 200 mM dNTPs, 5 mM of each primer, ~100 ng of template DNA and 1.0 U of Taq DNA Polymerase (Banglore Genei, India) using PTC-200 thermocycler (MJ Research Inc., MA, USA). PCR cycling conditions were: 2 min at 94C, followed by 30 cycles of 1 min at 94C, 1 min at annealing temperature (52-64C) of each primer, 1 min at 72C and final extension of 10 min at 72C. PCR amplified products (0.5ml) were mixed with Hi Di formamide (9.0ml), Liz standard (0.5ml) and analyzed on ABI PRISM® 3100 DNA analyzer. Allele sizing for different DNA fragments was carried out utilizing the GeneScan software.

Different measurements of within breed genetic variations were estimated using POPGENE software package (Yeh *et al.*, 1999). Polymorphism Information Content (PIC) was calculated as per Botstein *et al.* (1980). The tests for departure from Hardy Weinberg proportions and linkage disequilibrium were performed using exact probability tests provided in GENEPOP version

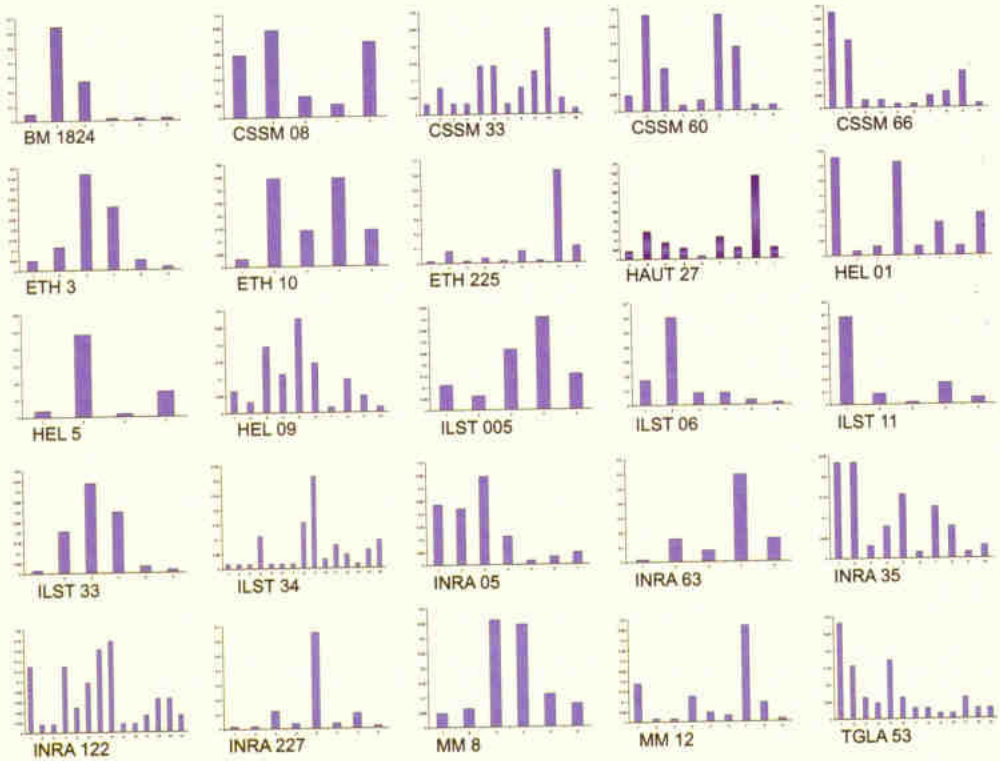

Fig. 8 Allelic frequency distribution across the 25 microsatellite markers in Kankrej cattle

3.1 a. (Raymond and Rousset, 1999). Within-population-inbreeding estimates ($f = F_{IS}$) at each microsatellite loci was estimated using FSTAT version 2.9.3.2 computer programme (Goudet, 2002). The level of significance ($P < 0.05$) was determined from permutation test with the sequential Bonferroni procedure applied over all loci.

To evaluate the bottleneck events in the Kankrej cattle three different approaches were followed; The heterozygosity excess tests developed by Cornuet and Luikart (1996): Sign test, Standardized differences test and Wilcoxon sign-rank test. The probability distribution was established using 1000 simulations under three models– Infinite allele (IAM), Stepwise

mutation (SMM) and Two-phase model of mutation (TPM). The second approach was the graphical representation of the mode-shift indicator originally proposed by Luikart *et al.* (1998). These two approaches were conducted using bottleneck v1.2.02 software (http://www.ensam.inra.fr/URLB). The third approach was the *M*-ratio test conducted by applying the m_p_val.exe program (Garza and Williamson, 2001).

Within breed Genetic Variability

Overall allele diversity considered to be a reasonable indicator of genetic variation within the population (MacHugh *et al.*, 1997), displayed high genetic variation in Kankrej cattle. A total of 205 distinct alleles were detected with a mean of 8.2 alleles (Table-1). These microsatellites exhibited high level of polymorphism as revealed by wide range of alleles, which varied from 5.0 (CSSM08, ILSTS005, ILSTS011, INRA63) to 15 (ILSTS034). The overall effective numbers of alleles was less than the observed values across all the loci and ranged from 2.0 (ILSTS011) to 8.8 (TGLA122) with a mean of 4.2. These values were higher to that of Hariana and Deoni cattle as observed by Mukesh *et al.* (2004a). The allele size range observed in the studied population was in agreement with that of other Indian cattle and exotic breeds (MacHugh *et al.*, 1997; Mukesh *et al.*, 2004b). The number of genotypes per locus varied from 10 to 105.

The observed (0.694) and expected (0.717) heterozygosity averages in Kankrej cattle were relatively similar to other cattle breeds investigated earlier (Mukesh *et al.*, 2004a). The mean observed heterozygosity values, though lower than the expected values, exhibited failure of significant differences using ANOVA test ($p>0.05$) suggesting random mating in Kankrej cattle. The high value of expected heterozygosity indicated that the population has retained the presence of several alleles although at a small frequency. The fairly high PIC values observed for most of the markers (Table 4) are suggestive of the fact that, these microsatellites might prove to be quite useful for biodiversity

Table 4 : Allelic size-range, number of alleles (No - Observed, Ne - Effective), shanon's index (I), heterozygosity (Ho - observed, He - expected), polymorphism information content (PIC), within-population inbreeding estimates (F_{IS}) at each locus in Kankrej cattle

S. No.	Locus	Flourescent label	Size Range	No	Ne	I	Ho	He	PIC	F_{IS}
1	BM1824	VIC	178-198	6.0	2.1	0.98	0.750	0.740	0.455	0.228*
2	CSSM08	PET	180-202	5.0	3.8	1.42	0.936	0.804	0.686	0.005
3	CSSM33	VIC	147-189	12.0	7.3	2.20	0.822	0.875	0.857	0.075
4	CSSM60	NED	80-116	9.0	4.7	1.73	0.717	0.650	0.755	-0.176
5	CSSM66	FAM	177-207	10.0	4.2	1.72	0.663	0.660	0.728	-0.135
6	ETH3	NED	96-122	6.0	3.0	1.32	0.771	0.701	0.617	-0.432
7	ETH10	NED	187-223	5.0	3.6	1.40	0.702	0.622	0.675	-0.151
8	ETH225	VIC	132-158	9.0	2.4	1.32	0.891	0.847	0.554	0.009
9	HAUT27	NED	132-162	9.0	6.0	1.30	0.698	0.719	0.712	0.008
10	HEL01	PET	102-120	8.0	4.2	1.64	0.692	0.712	0.723	0.276*
11	HEL5	VIC	140-170	7.0	3.3	1.47	0.216	0.345	0.665	-0.103
12	HEL09	FAM	137-169	10.0	6.1	2.00	0.723	0.806	0.817	0.152*
13	ILSTS005	NED	156-208	5.0	3.6	1.42	0.745	0.778	0.681	0.024
14	ILSTS006	FAM	276-310	6.0	2.4	1.22	0.447	0.756	0.555	0.209*
15	ILSTS011	NED	249-277	5.0	2.0	0.98	0.896	0.663	0.460	-0.091
16	ILSTS033	PET	131-163	6.0	3.1	1.28	0.689	0.710	0.620	-0.060
17	ILSTS034	VIC	137-199	15.0	6.3	2.19	0.783	0.875	0.834	-0.007
18	INRA05	FAM	120-148	7.0	4.2	1.60	0.745	0.849	0.727	-0.092
19	INRA63	FAM	157-189	5.0	2.5	1.15	0.596	0.648	0.551	-0.069
20	INRA35	PET	91-135	10.0	6.1	1.98	0.750	0.791	0.815	-0.143
21	MM8	PET	116-140	6.0	3.7	1.49	0.563	0.634	0.686	0.013
22	MM12	NED	101-129	9.0	3.5	1.60	0.521	0.516	0.686	0.022
23	TGLA53	NED	146-186	13.0	6.6	2.18	0.875	0.889	0.839	0.033
24	TGLA122	PET	134-166	14.0	8.8	2.34	0.875	0.866	0.886	0.190*
25	TGLA227	FAM	65-115	8.0	2.2	1.21	0.292	0.474	0.517	-0.070
	Mean			**8.2**	**4.2**	**1.57**	**0.694**	**0.717**	**0.684**	**-0.013**

*Mean estimates from Jackknife over loci. *$p < 0.05$*

evaluation in other native Indian cattle breeds (Kemp *et al.*, 1995). All the diversity indices values signify a substantial amount of genetic variability in Kankrej cattle (Fig. 9).

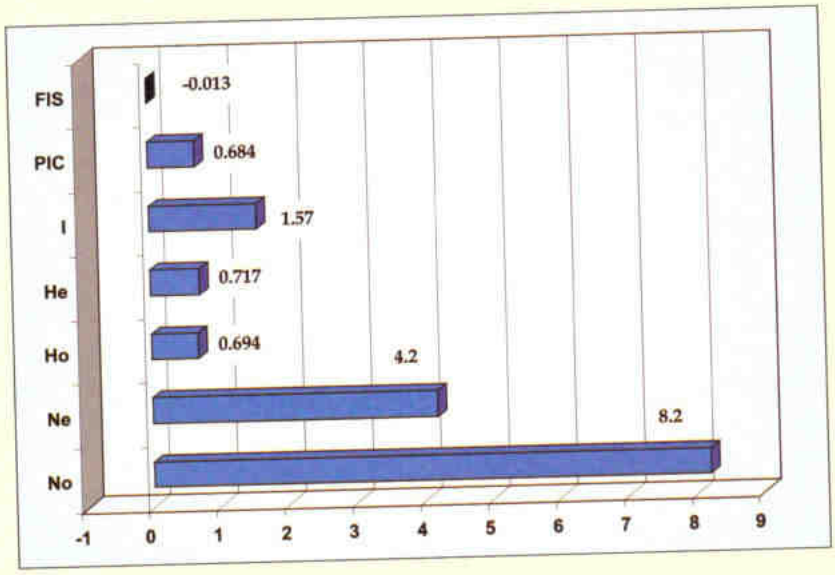

Fig. 9: Mean diversity indices and within population in breeding estimates across 25 microsatellite loci

The negative values of within population inbreeding estimate (F_{IS}= -0.013) in Kankrej population indicated lack of inbreeding. The F_{IS} values for only five of the loci were significantly different from zero ($p<0.05$). The low heterozygote deficiency observed in Kankrej cattle could be attributed to random mating. This lack of inbreeding in Kankrej cattle can also be postulated to the absence of genetic isolation (no barrier to gene flow) between the sub-populations of this breed from the sampling area (absence of Wahlund effect, Barker *et al.*, 2001). The results are in contrast to those reported for Sahiwal, Deoni and Hariana cattle (Mukesh *et al.*, 2004a), wherein significant heterozygotes deficiencies have been observed.

Table 5: Number of loci with heterozygosity excess or deficiency and probabilities obtained from three microsatellite evolution models in Kankrej cattle

TESTS/BREEDS	Exc. H exp	Exc. H obs	Def. H obs	P
1. SIGN TEST				
IAM	14.20	22	3	0.00276
TPM	14.18	17	8	0.29982
SMM	14.24	15	9	0.02544
2. STANDARDIZED DIFFERENCES TEST (T2 values)				
IAM	3.231			0.00062
TPM	0.835			0.20179
SMM	-3.321			0.00045
3. WILCOXON TEST (probabilities for heterozygosity excess)				
IAM				0.00001
TPM				0.07999
SMM				0.98944

Heterozygote deficiency analysis revealed deviations from HWE ($P<0.05$) at some of the loci in Kankrej population. It is, though, difficult to envisage the exact basis of this departure, however, the presence of low frequency null alleles segregating at these loci may be a possible reason. This deviation could also be linked to fairly high positive F_{IS} (within-population-inbreeding estimate, Table-4) for these loci. Exact test for genotypic linkage disequilibrium depicted no significant P values across population, suggesting no evidence of linkage between loci and therefore independent assortment was assumed.

The outcome for IAM, SMM and TPM supported for the absence of any bottleneck in Kankrej cattle. None of the estimated P values were significant ($P> 0.05$), indicating that the null hypothesis of mutation drift equilibrium is accepted in all the population. No Mode shift was detected in the frequency

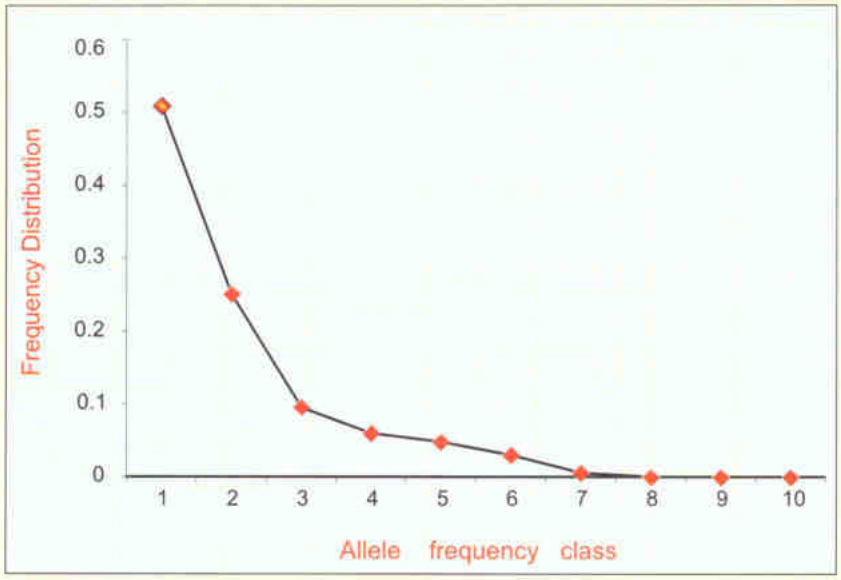

Fig. 10 Mode shift analysis for test of bottleneck in Kankrej Cattle

distribution of alleles and a normal L- shaped curve was observed, where the alleles with the lowest frequencies (0.01-0.1) were found to be most abundant (Fig.10). The M ratio for Kankrej population was 0.8234, which was not statistically significant at the 5% level indicating the absence of bottleneck event. Since the three approaches applied in the study utilize different properties of microsatellite markers, concordance in their results reveal the absence of any past demographic reduction in Kankrej population

Thus the present results contribute to the knowledge of genetic structure of Kankrej cattle and the data derived could be utilized in establishing the relationship with other Indian cattle breeds. This would further help in formulation of rational breeding programmes.

Candidate gene based analysis

To date, several class I polymorphisms (gene based) have been reported in different exotic cattle breeds, but the comparable status (gene frequencies, gene diversity, differences between breeds) is still unknown in the Indian

cattle breeds. Under the ongoing project on "Candidate Gene Analysis of Milk Performance Traits in *Bos Indicus* Breeds" at National Bureau of Animal Genetic Resources, Karnal the polymorphism at different economically important gene loci is being investigated to reveal a comprehensive information on pattern of allelic and genotypic variants in Indian native cattle breeds.

The *Msp* I allelic variation in intron III of bovine growth hormone (bGH) gene was explored using PCR-RFLP in 43 individuals of Kankrej cattle. Restriction digestion analysis of 329 bp PCR fragment of bGH intron III region with *Msp* I restriction enzyme revealed 2 alleles (*Msp* I - and *Msp* I +) and 2 genotypes (-/- and +/-) in Kankrej cattle. The allelic frequencies of *Msp* I (-) and *Msp* I (+) was 0.91 and 0.09 respectively. The observed +/- and -/- genotype frequencies were 0.18 and 0.82 respectively. Interestingly, no animal with (+/+) genotype was detected across the samples analyzed. The allele and genotype frequencies obtained were in sharp contrast to that of *Bos taurus* breeds (Lagziel *et al.*, 2000).

The polymorphism at another important candidate gene locus, pituitary specific transcription factor (*Pit-1*) was analyzed in Kankrej cattle. PCR-RFLP analysis *Pit-1/Hinf*I of 1350 bp fragment of 6th exonic region revealed the predominance of BB genotype and B allele with a mean frequency of 0.940 and 0.970 respectively. AB genotype was the next most frequent with a mean frequency of 0.060. These observed frequencies were similar to the observations of De Mattos *et al.*, (2004) wherein significantly high frequency of *Pit-1/Hinf*I B allele (0.95) and BB genotype (0.90) was observed in Brazilian Gyr and Nellore cattle, with complete absence of AA genotype. Contrary to the present findings, higher frequency of *Pit-1/Hinf*I A allele was reported in some of the European cattle *viz;* Angus cattle (0.45; Moody *et al.*, 1995), Belgian Blue cattle (0.53; Renaville *et al.*, 1997) and synthetic Canchim breed (0.86; Carrijo *et al.*, 2003).

Efforts were also made to reveal the pattern of known variants at Kappa casein (K-CN), Prolactin (PRL) and β-Lactglobulin (β-LG) loci. At K-CN gene locus a 935 bp fragment was PCR amplified from the exon IV region of K-CN gene and digested with *HindIII* and *HaeIII* enzymes. On analysis, it was observed that AA genotype (0.758) and A allele (0.879) were most commonly distributed in Kankrej cattle population, followed by AB genotype (0.242) and B allele (0.121). No animal with homozygous BB genotype was observed in this breed. Kankrej cattle differed significantly with respect to distribution of K-CN genotypes, what has been reported for European *Bos taurus* Jersey and cattle breeds from other countries, where, the preferred BB genotype was more prevalent.

Exon 3 region of Prolactin (PRL) gene was amplified (156 bp) and digested with *Rsa*I enzyme to reveal the genotype and allele patterns in Kankrej cattle. The first pattern with a single band of 156 bp was designated as AA genotype (no digestion), the second pattern with 2 fragments with BB genotype (82 and 74 bp) and third pattern with 3 fragments as AB genotypes (156, 82 and 74 bp). BB genotype was found to be most prevalent in Kankrej cattle (0.424), followed by heterozygous AB genotypes (0.394) and homozygous BB genotypes (0.182) was the least frequent. B allele was predominant with a frequency of 0.621, whereas, A allele had the frequency of 0.379.

Polymorphism at β-lactoglobulin (β-LG) gene which has been known to be well associated with milk yield, milk composition and cheese yield has also been studied. PCR-RFLP analysis of β-LG 4 exonic and 4 intronic region was undertaken to reveal the allelic pattern of A and B variants in Kankrej cattle. A 265 bp of β-LG specific PCR amplified product was digested with *Hae* III enzyme and produced three genotypic patterns. Pattern I corresponds to AA genotype with two bands (166 and 99 bp), pattern II corresponds to BB genotypes with three bands (99, 92 and 74 bp) and pattern III corresponds to AB genotype with four bands (166, 99, 92 and 74 bp) (Fig. 11). BB genotype

was most predominant (0.546) followed by AB (0.33) and AA genotype (0.121) in Kankrej cattle. The allelic and genotypic frequencies at various candidate gene loci is depected in table 6.

Table 6: Polymorphisms in some candiate genes in Kankrej Cattle

Locus	Allelic Frequency		Genotypic Frequency		
	A	B	AA	AB	BB
Kappa-Casein *(k-CN)*	0.758	0.242	–	0.879	0.121
Beta casein *(²-cas)*	0.758	0.242	–	0.879	0.121
Alpha lactalbumin (*a-LA*)	0.063	0.531	0.406	0.328	0.672
β-*lactoglobulin (b-LG)*	0.121	0.333	0.546	0.288	0.712
Prolactin (*PRL*)	0.182	0.394	0.424	0.379	0.621
Growth hormone (*bGH*) (MspI - allele)	0.910	0.090	0.820	0.180	0.000
Pituitary specific transcription factor (*Pit-1*)	–	0.061	0.939	0.030	0.970
Acyl CoA:diacylglycerol acyltransferase (*DGAT1*) (K allele)	1.000	0.00	1.000	0.000	0.000
Butyrophilin (*BTN1*)	0.750	0.250	–	0.875	0.125
Butyrophilin (*BTN3*)	0.281	0.531	0.187	0.546	0.454

allelic and genotypic frequencies at various candidate gene loci in Kankrej

In addition to these efforts, Behl et al. (2006) conducted PCR-RFLP analysis at BoLA II DRB3 (exon 2), another important candidate gene loci. The analysis revealed the presence of 5 different alleles with *Hae* III and 16 alleles with *Rsa* I restriction digestion of the amplicon. This study indicated that BoLA region is highly polymorphic in Kankrej cattle.

Such molecular data once generated for other Indian native cattle breeds as well will provide a basis for comprehensive evaluation of distribution pattern of different variants and thereof, the genetic structuring of native cattle

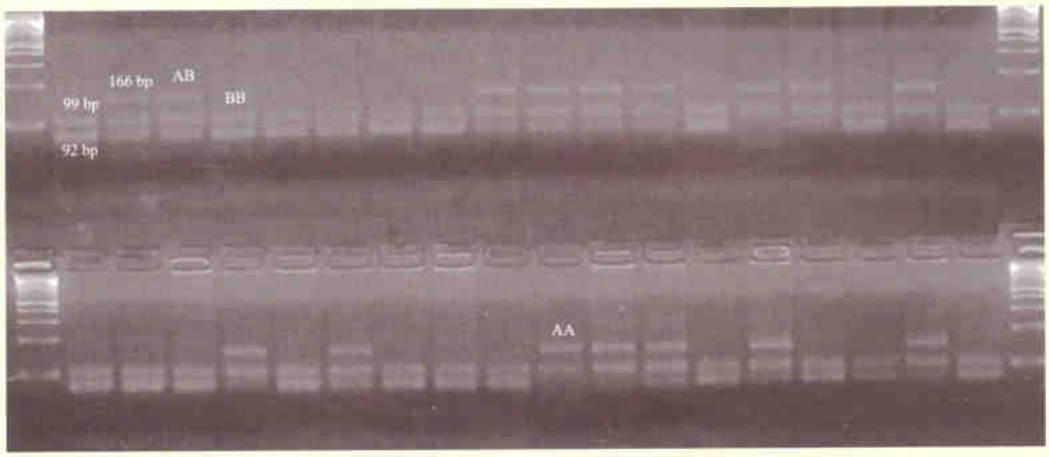

Fig. 11 Genotypic profile at β - LG candidate gene locus in Kankrej Cattle

based on gene based polymorphism. Characterization of allelic variants/ SNPs/ or haplotypic frequencies in and around selected candidate genes of commercial importance across indigenous cattle breeds would improve the comparison of their genetic profile with *Bos taurus* breeds and framing the future strategies for their overall economic exploitation.

Improvement Programs Suggested

There has been a steady increase in population and improvement in the productivity of Kankrej breed in the state, yet for further improvement the following programs are suggested.

Selective breeding

Young male progenies from elite females should be selected from the breeding tract on the basis of dam's milk yield and conformation of breed characteristics. These males after rearing upto maturity should be utilized for natural as well as AI for the improvement and production of superior breeding males from high genetic merit females.

Progeny testing

A herd of 300-350 elite cows should be set-up for producing genetically superior young bulls. Male calves should be selected based on the dam's yield and true breed physical characteristics. They should be reared and trained for artificial semen donation. Preliminary selection of young bulls should be based on semen quality and sufficient numbers of frozen semen doses should be stored for test mating of young bulls. The young bulls should be evaluated based on at least 15 first lactation records of their daughters. High ranked proven bulls should be mated with elite cows to produce young bulls for next generation and the remaining proven bulls should be used in field conditions. Bull calves of less than one year of age should be selected from the native tract based on their pedigree records. They may be reared, trained for artificial semen donation and tested for libido, semen freezing, etc. before their registration in the test batch. About 15 bulls per batch may be put to test and nearly 7000 frozen semen doses from each bull should be prepared out of which about 1500 insemination per bull should be carried out for a period of 1.5-2.0 years, and rest of the semen doses may be stored. Data on the identification of animals, insemination, pregnancy diagnosis results, date of calving, sex of calf and its number, lactation records and management practices may be recorded. A provision to provide incentives to the farmers based on performance in terms of growth of the male calves should also be made. Morning and evening milk production and fat percent of daughters be recorded on monthly basis and standard 305-days lactation milk yield may be estimated.

Open nucleus breeding system (ONBS)

In progeny testing only the bull to bull and bull to cow path is utilized for genetic improvement. However, combination of ONBS with multiple ovulation and embryo transfer (MOET) can help in effective utilization of female for selection purpose. This system also helps in early selection of animals using records of collateral relatives particularly full-sibs and half

sibs. Though the accuracy of selection is lower in ONBS-MOET system but the overall genetic improvement per year will be higher in comparison to progeny testing due to shorter generation interval.

Culling policy

The effect of selection program will be neutralized if unproductive / low producing animals are not culled from the breeding population. The minimum level of production should be decided and animal with lower production than culling level should be eliminated from the herd. The animals that are not true to the breed characteristics should not be used for breeding purpose despite their better production.

Kankrej cattle have high genetic potential for milk production as well as draft capacity. The allelic distribution at economically important candidate gene loci would help in formulation of rational breeding programmes with the goal of increasing output in the production system by perpetuation of the desirable alleles. Furthermore, the genetic characterization using neutral markers should be extended to other cattle breeds.The information thus generated would assist in establishing differences/similarity level among the important Indian cattle breeds which is an essential prerequisite for effective and meaningful conservation programme on the basis of genetic make up and phylogenetic ranking of the breeds.

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