Goat Genetic Resources of India

GOHILWADI

A Multipurpose Goat of Gujrat

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Contents

SOME FACTS ABOUT GOATS

Extracted from

Gary, P. Goat Facts – Goats & Health
(www.goatworld.com)

- Goat has been the first animal among ruminants to be reared by human being.
- There are over 210 breeds of goat in the world.
- Goats occur in varied colours. Indiscriminate breeding has led to mixing of colours resulting in more number of colour combinations within the same breed.
- Goats can survive under varied agro climatic conditions and eat whatever vegetation is available.
- Goats are intelligent animals and can learn how to open latches of farm gates. They can climb, run, crawl under fences and jump upto over 5 feet. They can also stand on their hind legs to reach tree branches and shurbs.
- In a mixed herd, goat prefer to live with goats of same breed. Kids prefer to remain nearby their mother even if separated for years and reintroduced.
- Goat kids have eight small, sharp teeth in their lower front Jaw which fallout and are replaced by permanent teeth. The age of a goat can be closely determined by their teeth.
- Like males, females also grow beard in some breeds of goats.
- The pupil of a goat's eye is rectangular in shape. The animals can see sharply in the night.
- Unlike other animals, goat's tail is upright.
- Goats are ruminants having four stomach compartments namely the rumen (paunch), the reticulum (huney comb), the omasum (maniply) and the abomasum (true stomach). The elementry canal is about 25 times the body length of a goat. The total blood volume is about 1/12 of animals body weight. It takes 14 seconds for goat blood to complete one circulation. The Red blood cells are smaller in size.
- Goats can encounter the same diseases as cattle and sheep. Coccidiosis and pneumonia can bring sudden death to the animals.
- Goats of some breeds (Jamnapari, Jakhrana) may yield upto 5 litres of milk per day. The goat milk has more medicinal value than that of cow and buffalo.
- Goaty odour of milk is produced by the presence of the buck at the time of milking whose scent glands are adoriferous. Milk produced in the absence of buck does not bear the goaty odour.
- Goat generally lives upto 10-12 years.

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FOREWORD

Gujarat is bestowed with the sizable amount of genetic diversity in indigenous Animal Genetic Resources. The state provides a model of Dairy industry for other states of the country. The Government of Gujarat provides animal health care up to the village level with the network of primary institutions. The conservation of milch animal scheme is implemented in order to control illegal export of cattle outside the state. The share of Agriculture and Livestock in state domestic products (GSDP) is 13.63% and that of livestock sector is 4.5 to 5.0% (Animal Husbandry and Dairying statistics, 2004-05).

Gujarat state is having the maximum number (five) of descript goat breeds as compared to other states of the country. The total goat population in the state is 42.3.lakh and the main breeds are Kutchi, Mehsani, Surti, Zalawadi and Gohilwadi. Gohilwadi is an important breed yielding milk, meat, hair, manure etc. to support the livelihood of the poor people. The animals of this breed are found in Junagarh, Amreli and Bhavnagar districts. In the absence of breedwise census the population estimates for Gohilwadi goats is not available. Further, due to nonavailability of good breeding bucks in the tract and unplanned matings with the available bucks, the breed purity is getting diluted. To have an insight of the current population status, distribution of animals, morphological and genetic characterization of Gohilwadi breed of goat a systematic survey was conducted by the scientists of NBAGR and information were gathered from the actual breeding tract of this breed. The information generated in respect of body measurements, phenotypic traits, performance traits, managemental practices, social status of the goat keepers and genetic diversity within the breed have been compiled and presented in the form of this bulletin. I hope that the bulletin "Gohilwadi – a multipurpose goat of Gujarat" will be useful to the researchers, surveyors and policy planners for taking up the research programmes for the improvement of this breed. I congratulate the authors for their efforts to bring out this bulletin on the present ststus of Gohilwadi breed of goat.

(Gurmej Singh)

Gohilwadi

PREFACE

Livestock sector has progressed remarkably in recent past which had a noticeable impact on the lives of small, marginal farmers and landless labourers. Among the livestock species goat and sheep had a significant contribution in improving the social and economic conditions of these farmers and labourers. This species has served the mankind earlier and longer than cattle and sheep. In pestoral and agricultural subsistence the goats are reared as a source of additional income. They also serve as an insurance against the disaster when farmers lose their crops. Unlike other animals both male and female goats have equal value. About 120 millions of total livestock population (482.77millions) of India are goats (Livestock Census, 2003). There are 20 well defined breeds of Indian goats inhabiting the various regions of the country. In addition to this, some more strains of goats like John puri, Chaugarakha, Shingari, Khagni, Feral goat, Kanni Adu, Salem black etc. inhabiting different regions have also been reported. These goats having variable features are claimed to be the local breeds of their respective region.

Goat farming is practiced at large scale by people in the rural areas. The reasons are obvious because the goat can survive under harsh conditions on the available feed resources. Almost zero input resources make these animals cent-percent profitable. further, small generation interval and higher prolificacy add to its demand among the small and marginal farmers. Due to the small body size of animal and their docile nature the requirement in terms of feed, housing etc. is very less. Inspite of the less requirement goats are prolific breeders and achieve sexual maturity at the age of 10-12 months. Due to short gestation period goat starts giving milk at the age of 16-17 months. An elite animal of milch breeds like Jamnapari, Jakhrana, Beetal can yield upto 4-5 litres of milk per day which is sufficient for a family and the cost of milk production is less than that of a cow yielding the same amount of milk. Goat milk is nutritious and has more medicinal value. Due to small fat globulets goat milk is easy to digest than the cow milk. Goat is also termed as a walking refrigerator for the storage of milk because the animal can be milked number of times a day. Apart from this, goats are also used in ceremonial feastings. The goats reared for meat purpose though give less milk but fetch a very good price at the festival/ceremonial occasions. Further, there is no religious taboo against the goat slaughter. Goat slaughtering can be carried out without much environmental problems.

Gohilwadi is one of the twenty descript goat breeds of India, which inhabits the Southern Kathiawar region of Gujarat state. It is a multipurpose breed yielding meat, milk and fiber. As a part of the mandated activity of NBAGR the characterization of Gohilwadi goats was undertaken through systematic survey in its own breeding tract.

N. K. Verma

Gohilwadi

Introduction

Gujarat state possesses a remarkable position in the country as far as livestock wealth and development is concerned. Animal Husbandry and Dairying sector contributes an average 4.5 – 5.0 % share to the Gross State Domestic Products (GSDP) of the state (22nd Survey Report, 2006). According to the livestock census (2003) goats formed 20.95% (45.40 lakhs) of the total livestock of Gujarat state. There was an increase of 3.53% in goat population over the previous years (1997-2003). As compared to other states of the country Gujarat has maximum number of goat breeds viz. Gohilwadi, Zalawadi, Mehsana, Surti and Kutchi. Each breed has its own importance in its native tract and perform their best in view of available resources. Inspite of the ecological and economic importance Gohilwadi breed of goat is inadequately characterised as compared to the other descript breeds of Gujarat state. A systematic survey, therefore, was undertaken to collect information on various aspects of this breed. Two survey visits were made in the breeding tract and data on morphometrics of 621 animals were collected from 36 villages belonging to 18 talukas of four districts. Information on production, reproduction of animals and socio-economic status of the farmers were collected through personal interviews with the goat keepers /farmers. Performance was measured under nomadic conditions with no housing and stall feeding but with totally extensive managemental conditions.

Breeding Tract

Distribution

The main location of Gohilwadi breed is Southern Kathiawar region of Gujarat state of India. This breed of goat has derived its name from the Gohilwad which was a part of the Kathiawar region and was also the old

Breeding tract of Gohilwadi goats

name for Bhavnagar district of Gujarat state. The animals are spreaded mainly in Junagarh, Amreli and Bhavnagar districts, however, some animals were seen in the villages of Rajkot and Porbundur districts too. The information was collected on the animals from Junagarh, Mangrol and Keshod of Junagarh district; Visavadar, Babra, Amreli, Khambha, Rajula, Liliya of Amreli district; Mauva, Talaja, Palitana, Shihor, Umrala, Gadhda, Bhavnagar of Bhavnagr district; Jasdan of Rajkot and Veraval of Porbandar district.

Topography

Gujarat state is situated in the western part of India surrounding by Arabian sea in west and south and by Rajasthan, Madhya Pardesh and

Maharashtra states in north, east and south respectively. The eastern & southern state boundry is woodland, northern area is hilly and semi arid, western is arid whereas middle state is plain area washed by the large rivers such as Sabarmati, Narmada and Mahi. The geograpghic area of Gujarat state is 196024 sq km and comprises of 25 districts, 242 towns and 25 cities and 18539 villages. The soil is sandy and black. The overall climatic condition is monsoonal. The rainfall ranges from 25 cm in Kachchh to 1250 cm in Dang (22nd survey report). The minimum temperature (°C) ranged from 11.1 to 27.1 with average temperature of 21.1 whereas maximum temperature ranged from 27.6 to 39.6 with average 33.4. The average monthly relative humidity (%) varied from 39–77 in morning (average 56) and 21– 64 in evening (average 39). Annual rainfall (cm) is 60.01 (http://www.awbi.org/pamp3.htm). The main crops of the state includes Sugarcane, Paddy, Cotton, Jowar, Bajra, Pulses, Legumes and millets.

Utilization

The Gohilwadi goats are multipurpose animals and are reared for milk, meat and fibre production. The tradional keepers of goats are Rabbari and Bharwar communities (also called Maldharis). The goats meet the nutritional demands of the poor people. They support the economy of the poor farmers. These animals are in great demand for the religious and ritualistic purposes. Goat feaces and urine are richer in Nitrogen and Potash and hence used as a manure for fields. Besides this, the horns and hoofs are used for preparing horn and hoof meals, decorative articles etc. Night foldings in the cultivatable fields is a common practice and goat keepers charge Rs. 25/- per 100 animals per

A flock of goats kept in the cultivatable field for foldings

night in cash or in kinds like 5.0 kgs Bajra/ 100 animals/night for staying at field. This is done at the request of the field owner for manuring the fields.

Phenotypic Characterization

Information on average body biometric characters was generated by measuring different traits like body length(BL) Chest girth (CG), Paunch girth (PG), Height at withers (HT), Face length (FL), Ear length (EL), Horn length (HL) and Tail length (TL) of 621 young as well as adult animals of both sexes. Qualitative conformation attributes and body weights of these animals were also recorded. The data generated so was subjected to statistical analysis using SPSS 11.5 for windows software.

The average body measurements of Gohilwadi goats of different age groups have been given in table 1. An attempt has been made to study the body metrics of the goats in different districts of the breeding tract. The average measurements for different traits in Amreli, Bhavnagar, Junagarh, Porbundar and Rajkot districts have been presented in table 2. It has been observed that Amreli and Bhavnagar have better animals than the Junagarh district. Although the animals of Rajkot and Porbundar have better physique than the animals of other districts but it is not proper to draw this conclusion because the number of animals in Porbundar and Rajkot districts were small. The superiority in body dimensions might be due to the fact that selected animals have been brought by the farmers from the adjacent areas of the real breeding tract.

Farmers with Gohilwadi goats

Body Size

The Gohilwadi goats are medium to large sized, having the average measurements 81.04 ± 2.20, 79.78±0.31, 79.23±2.35, 82.76 ± 2.88 cm for height at wither, body length, heart girth and paunch girth respectively.

A Gohilwadi doe

Colour

The coat colour is uniformly black covered with long coarse hair. Skin colour is pinkish, muzzle is black, eye ball is brown, eye lids are black and hoofs are grayish in colour.

Head

Head is proportionate to the body. Nose is slightly roman type. Face line is convex and the average length of the face measures 20.93±1.24 cms. Animals of both the sexes have beard and wattles.

Head profile of gohilwadi goat

Ears

Ears are tubular and drooping. In many cases pendulous and leaf shaped ears were also observed. The average length of ear is 17.30± 2.41cm in female and 19.81±2.77cm in males whereas the overall length measured 17.49± 2.86 cm. As a part of management the ears were cut short in majority of animals having pendulus ears . Cutting of long hanging ears is a common practice in other breeds of goats also(Verma *et al* 2005, 2006). This is to protect the

ears from entagling in the bushes while browsing and dipping in the water while drinking.

Short and tublar ear

Flat and Pendulous ears

Horns

Horns were observed in both the sexes. They are medium in length of average size 12.32± 2.07 cm in females and 15.11± 2.82cm in males with overall length 12.53± 2.17 cm. The orientation is that they are slightly twisted type projecting upward, outward or backward. The screwing of the horns are lesser than that of Zalawadi goats existing in the same region. Polled goats were also noticed in the Bhavnagar district.

Twisted and backward oriented horns

Body weights

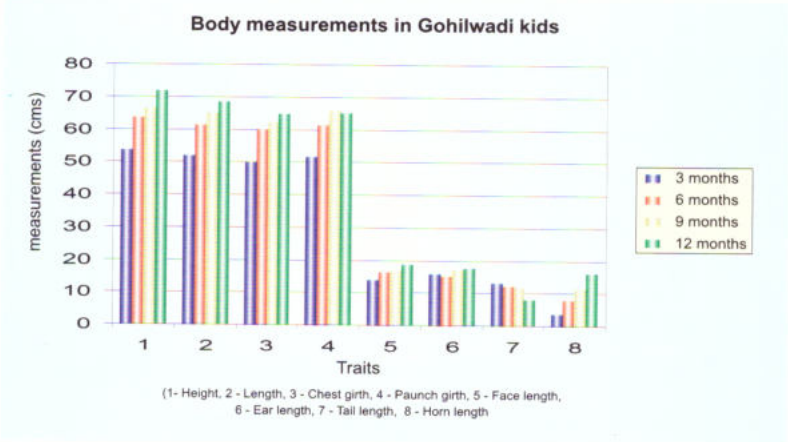
Body weights of 3, 6, 9 and 12 months old and of the adult goats in Amreli, Bhavnagar, Junagarh, and Rajkot district have been given in table 3. The average body weights of of 3, 6, 9, 12 month age group animals were

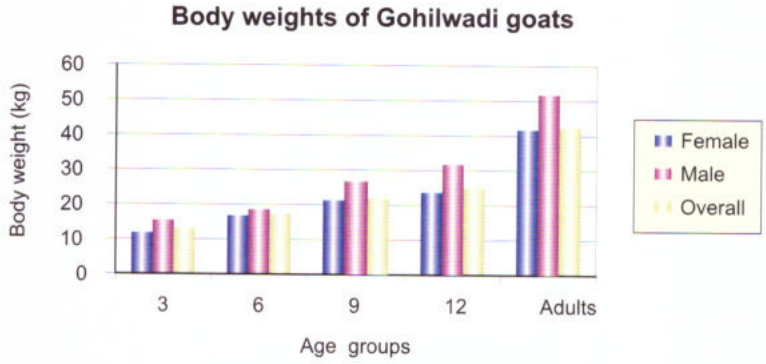
Table 1: Average body measurements (cm) of Gohilwadi goats of different age groups

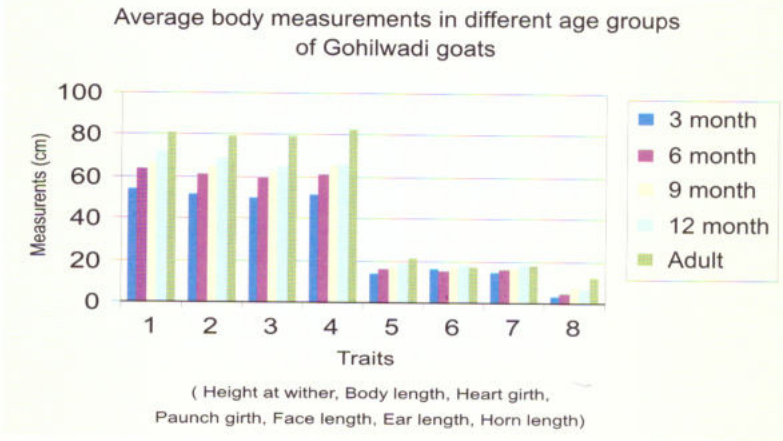
Age (months)	N	Sex	Trait							
			HT	BL	CG	PG	FL	EL	TL	HL
3	12	F	56.00 ±2.04	54.17 ±2.04	53.25 ±1.86	54.67 ±2.23	14.33 ±1.03	15.83 ±1.85	14.67 ±1.64	3.25 ±2.06
	6	M	53.80 ±2.27	51.40 ±2.71	48.00 ±2.25	49.80 ±2.22	14.80 ±1.21	17.00 ±2.11	15.40 ±1.55	2.20 ±1.38
	18	Overall	55.35 ±2.10	53.35 ±2.28	51.70 ±2.13	53.23 ±2.31	14.47 ±1.08	16.17 ±1.91	14.8 ±1.47	2.94 ±1.91
6	45	F	63.47 ±2.25	61.36 ±2.07	59.84 ±2.26	60.89 ±2.64	16.36 ±1.54	14.78 ±2.47	16.29 ±1.51	4.42 ±2.09
	8	M	65.50 ±2.23	63.00 ±2.35	61.38 ±2.12	65.25 ±2.35	17.00 ±1.03	18.00 ±1.68	16.50 ±1.43	6.00 ±1.54
	53	Overall	63.77 ±2.25	61.60 ±2.11	60.08 ±2.24	61.55 ±2.62	16.45 ±1.49	15.26 ±2.41	16.32 ±1.50	4.66 ±2.04
9	21	F	65.81 ±2.01	64.24 ±1.86	62.10 ±1.59	65.38 ±1.85	16.62 ±1.60	17.05 ±2.46	16.86 ±1.27	6.95 ±2.42
	3	M	71.67 ±1.74	71.00 ±1.00	65.33 ±1.74	67.33 ±2.58	19.00 ±1.00	19.00 ±1.89	15.33 ±2.34	7.33 ±1.23
	24	Overall	66.54 ±2.08	65.08 ±1.99	62.50 ±1.66	65.63 ±1.95	16.92 ±1.59	17.29 ±2.41	16.67 ±1.50	7.00 ±2.35
12	24	F	70.92 ±1.74	67.96 ±1.93	64.38 ±1.96	64.17 ±2.28	18.54 ±0.96	16.92 ±2.50	17.46 ±1.14	6.92 ±1.71
	4	M	76.75 ±2.17	72.25 ±3.20	68.75 ±2.61	72.00 ±3.22	20.00 ±1.35	22.50 ±1.73	19.00 ±1.27	7.00 ±2.36
	28	Overall	71.75 ±1.95	68.57 ±2.25	65.00 ±2.12	65.29 ±2.56	18.75 ±1.08	17.71 ±2.49	17.68 ±1.20	6.93 ±1.71
Adult(>18)	460	F	80.45 ±2.04	79.29 ±2.18	78.85 ±2.25	82.48 ±2.87	20.77 ±1.17	17.30 ±2.41	18.04 ±1.42	12.32 ±2.07
	37	M	88.43 ±2.61	85.97 ±2.77	83.86 ±2.86	86.24 ±2.90	22.86 ±1.48	19.81 ±2.77	19.95 ±1.73	15.11 ±2.82
	497	overall	81.04 ±2.20	79.78 ±0.31	79.23 ±2.35	82.76 ±2.88	20.93 ±1.24	17.49 ±2.86	18.18 ±1.47	12.53 ±2.17

Table 2: Average body measurements (cm) of Adult Gohilwadi goats in different districts

Districts	Sex	N	Trait							
			HT	BL	CG	PG	FL	EL	TL	HL
Amreli	F	134	79.31 ±1.86	79.08 ±2.11	78.93 ±2.22	83.65 ±2.61	2.054 ±1.23	15.79 ±2.78	17.28 ±1.36	11.80 ±2.15
	M	15	88.47 ±2.67	87.93 ±2.83	85.13 ±2.88	88.00 ±2.86	23.27 ±1.40	18.27 ±2.82	21.73 ±1.54	18.13 ±2.46
	Overall	149	80.23 ±2.19	79.97 ±2.36	79.55 ±2.38	84.09 ±2.66	20.81 ±1.32	16.04 ±2.79	17.73 ±1.52	12.43 ±2.26
Bhavnagar	F	234	81.27 ±1.96	79.47 ±2.06	78.43 ±2.17	81.46 ±2.73	21.05 ±1.08	18.46 ±2.96	18.75 ±1.34	12.96 ±1.87
	M	11	90.36 ±2.48	86.82 ±2.48	84.45 ±2.56	87.09 ±2.71	24.09 ±1.72	25.00 ±1.77	17.81 ±1.87	15.45 ±2.91
	Overall	245	81.68 ±2.10	79.80 ±2.14	78.70 ±2.22	81.71 ±2.74	21.19 ±1.15	18.75 ±2.95	18.71 ±1.38	13.08 ±1.96
Junagarh	F	72	79.42 ±2.16	78.96 ±2.43	80.67 ±2.22	84.18 ±3.40	20.36 ±1.19	16.32 ±2.36	17.16 ±1.41	11.41 ±2.17
	M	3	79.00 ±2.49	74.33 ±3.04	78.67 ±3.64	81.67 ±3.26	19.00 ±1.00	19.67 ±1.79	19.00 ±0.00	6.33 ±2.34
	Overall	75	79.40 ±2.16	78.77 ±2.46	80.59 ±2.31	84.08 ±3.39	20.31 ±1.20	16.45 ±2.34	17.24 ±1.40	11.21 ±2.19
Porbundar	F	5	82.60 ±1.89	80.60 ±2.60	81.40 ±2.24	83.80 ±2.20	19.40 ±1.06	-	17.60 ±0.74	2.60 ±2.41
	M	4	92.25 ±1.30	90.00 ±1.71	89.50 ±1.84	91.25 ±2.43	21.50 ±1.54	10.00 ±3.40	19.50 ±1.31	10.50 ±3.51
	Overall	9	86.89 ±2.40	84.78 ±2.67	85.00 ±2.43	87.11 ±2.52	20.33 ±1.41	-	18.44 ±1.22	6.11 ±3.09
Rajkot	F	16	82.37 ±2.67	79.56 ±2.78	75.69 ±2.95	80.00 ±3.28	20.94 ±1.34	23.50 ±2.70	18.06 ±1.73	14.43 ±2.21
	M	4	86.25 ±2.43	81.00 ±1.64	75.75 ±2.58	75.75 ±2.38	22.25 ±1.30	21.25 ±1.22	20.25 ±1.43	14.00 ±2.22
	Overall	20	83.15 ±2.64	79.85 ±2.36	75.70 ±2.86	79.15 ±3.15	21.20 ±1.35	23.05 ±1.99	18.50 ±1.71	14.35 ±2.18


Body measurements in Gohilwadi kids
measurements (cms)
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
Traits
3 months
6 months
9 months
12 months
(1- Height, 2 - Length, 3 - Chest girth, 4 - Paunch girth, 5 - Face length,
6 - Ear length, 7 - Tail length, 8 - Horn length


Body weights of Gohilwadi goats
Body weight (kg)
60
50
40
30
20
10
0
3
6
9
12
Adults
Age groups
Female
Male
Overall


Average body measurements in different age groups
of Gohilwadi goats
Measurents (cm)
100
80
60
40
20
0
1
2
3
4
5
6
7
8
Traits
3 month
6 month
9 month
12 month
Adult
(Height at wither, Body length, Heart girth,
Paunch girth, Face length, Ear length, Horn length)

13.0±0.71, 17.11±0.52, 21.80±0.55 and 24.88± 1.01kg respectively whereas that of adult goats was 42.47±0.47 kg. The males were generally heavier than the females. The breeding bucks of more than 60 kg body weight were seen in Amreli district. A comparision of body measurements of male and female goats in different age groups and in different districts have been shown through histograms also.

Table 3: Body weights (kg) in different age group of Gohilwadi goats in different districts

S.N.	AGE (months)	SEX	N	Amreli	Bhavnagar	Junagarh	Rajkot	Mean	SE(±)
1	3	F	7	11.50	12.00	14.00	-	12	0.65
		M	3	15.33	-	-	-	15.33	0.88
	Total		**10**	**13.14**	**12.00**	**14.00**	**-**	**13**	**0.71**
2	6	F	25	17.00	16.75	19.00	-	17	0.51
		M	2	15.00	15.00	-	22.00	18.5	3.5
	Total		**27**	**17.00**	**16.65**	**19.00**	**22.00**	**17.11**	**0.52**
3	9	F	19	20.50	21.21	25.00	-	21.26	0.43
		M	2	26.00	-	28.00	-	27	1
	Total		**21**	**21.60**	**21.21**	**26.50**	**-**	**21.80**	**0.55**
4	12	F	23	31.30	22.95	-	-	23.69	0.69
		M	4	40.00	34.00	-	19.00	31.75	4.64
	Total		**27**	**34.33**	**23.91**	**-**	**19.00**	**24.88**	**1.01**
5	Adult	F	323	40.50	41.65	49.73	39.00	41.67	0.43
		M	27	59.90	53.45	35.00	37.00	52.04	2.61
	Total		**350**	**43.12**	**42.19**	**48.00**	**38.58**	**42.47**	**0.47**

Udder

The udder and teats are of variable size and shape. In good milking does the udder is well developed and teats are long and conical shaped. There is a clear cut indentation between two halves of the udder.

A well developed udder

Conical shaped teats

Management

Flock structure

The flocks observed in the native tract consisted of kids and adults of both sexes. The mixed flock ranging from 8 to 75 animals consisted of 70 to 80% Gohilwadi goats. Other mixed colour strains were also seen in the flocks. These flocks included 2 to 8 breeding bucks depending upon the size of flock. The kids of 1 to 3 months age are generally kept at home but sometime seen in the flock moving for pasture grazing. Some prosperous farmers kept cows and buffaloes in addition to sheep and goats.

Mixed flocks of Gohilwadi breed

Housing

Goats are generally kept in the open houses which consisted of thatched roof and katcha floor. The boundry wall is made up of bushes and sticks. Gates are temporarily made of bamboo sticks. There is no proper electricity or water supply in the houses. Few pucca houses consisting of asbestos or tiled roof and with concrete boundry wall were also seen. Some houses made to keep the sheep and goats were very spacious, neat and clean. For housing the kids temporary arrangements were made by the farmers. In case of small flocks consisting of 3-5 animals they shared the residence of farmer.

Type of goat house

Boundry wall and gate of Goat house

Goats sharing the farmer's residence

An arrangemnt for housing the kids

Feeding

Animals are kept on grazing and browsing in the open fields. Animals travel 8-10 km per day for grazing. They go to pastures in the morning and come back by 7.00 p.m. During noon hours they are brought to a place where water is available. The fodder resources are Babool pods(*Acacia noltica*), Ber (*Zizphus mauritiana* and *Z. nummulania*), Ardu (*Ailanthgus excelsa*), Khezri (*Prosopis cineraria*), Zepti (*Desomodicum diftusum*), Neem (*Azadirachta indica*) and Zingvo (*Dicanthium annulatum*). In case of stall feeding onion and garlic leaves, cotton stem, Zeera and gram plants are given to the animals. To maintain the libido of the breeding bucks during breeding season they are fed with the concentrate mixture. Groundnut cake is given @ 200gms/day to the breeding bucks and pregnant goats. The kids are kept on milk for 3-4 months after that they are gradually switched over to the grazing and browsing. Male kids are disposed off at 3-4 months of age while the female kids are retained in the flock.

Feeding, drinking, browsing and grazing in Gohilwadi goats

Health practices

Animals suffer from foot and Mouth disease, contagious caprine pneumonia and round worm infestations. The pneumonia and worm infestations are more commonly occurring in the young kids. The severity of infection may lead to high mortality. Mortality upto 10% were reported in the kids below three months of age. Foot and Mouth rottings was observed in Bhavnagar district in kids as well as adult animals during survey in the month of October. The animals are rarely taken to the veterinary hospitals for treatment. No preventive measures such as deworming, vaccination etc. were taken by the flock owners. However during veterinary camps some farmers take the advantage of getting the health coverage programme for their animals.

A Goat with rotten feet

A Goat with rotten mouth

Performance

Production

The Gohilwadi goats are multi purpose and are reared mainly for meat and milk. The milk yield per day as reported by the goat keepers ranged between 1.0 to 3.5 litres. The milk yield up to 4.0 litres was also reported in exceptional cases. The milk producing capacity can be enhanced with improved management and better nutrition quality. The milk is sold @ Rs.

8-10 per litre. In most of the cases milk is used for feeding the kids and home consumption only. The lactation length is about seven months. An average daily milk yield 1.710 kg and lactation length of 227 days have been reported for Gohilwadi goats (FAO data base) whereas that reported by Singh et al (2006) were 1.13 litre and 6.17 months respectively.

Milking of Gohilwadi goat

Reproduction

Goats are seasonal breeders and exhibit estrous in summer during April to June months. Kidding season is August to November. Goats conceiving in the summer months kid during September, October and November. This is the season when plenty of green fodder and browsing material is available. Due to the better climatic conditions and availability of green fodder for feeding kids attain better growth rate, litter size increases and rate of mortality decreases. Twinning is repoted as 40-50%. Age at first kidding is around 20 months and gestation period is 5 months. Goats can conceive again after 3–4 months of the kidding but those who rear the goats for milk purpose prefer single kidding in a year to have a full lactation length. A breeding buck is sold @ 3000 to 5000/- whereas the adult goat fetches Rs. 1000 to 2500/- depending upon the body weight.

A Gohilwadi breeding buck

Availability of good breeding bucks has always been a problem in the breeding tract. A flock of 70–80 animals have only 2–3 bucks whereas the farmers with the small flocks do not have their own buck. They share the community bucks or the bucks of the farmers keeping bigger flocks. Due to the more number of females per buck there is always a inbreeding pressure in the flock. Since bucks stay with females in the flock all the time, there is an every chance of getting undesired matings. Therefore, there is a practice that the goat keepers tie the prepuce of buck to the scrotum to avoid such matings.

Prepuce tide for controlled breeding

Population status

The total goat population in Gujarat state is 45,40,597 (Livestock census, 2003) which showed an increase of 3.53% over the goat population existed in 1997. The existing population of goats consists of 35,33,632 breeding females which again showed an increase of 0.58% over the population of females in 1997. The population of goats in the Gohilwadi distribution area is 4,59,367 comprising of 1,22,039 in Junagarh, 1,41,336 in Amreli and 1,95,992 in Bhavnagar districts. More than 50% of the goat population of goats in the breeding tract is exhibiting the characters of Gohilwadi breed. Based on the survey, population of Gohilwadi goats seems to be in comfortable

number and does not require the immediate attention for conservation. However, The maintenance of breed purity is of utmost impotance which can be achieved by raising and using the true breed bucks and avoiding the indiscriminate mating among the individuals.

Genetic Characterization

Isolation of DNA and PCR amplification

For genetic characterization fourty eight blood samples were collected from the unrelated randomly distributed animals in the breeding tract. Genomic DNA was isolated by the method of Sambrook *et al.* (1989). A battery of 25 microsatellite markers (Table 4) was selected based on the guidelines of ISAG & FAO's DADIS programme to generate data. Polymerase Chain Reaction (PCR) was carried out using 50-100 ng genomic DNA in a 25 µl reaction volume. The reaction mixture consisted of 200 µM dNTPs, 2.0 mM $MgCl_2$, 0.75 unit Taq DNA polymerase and 5.0 µl of each primer using PTC-200 PCR machine (M J Research). The "touchdown" PCR protocol was used with initial denaturation at 95 ^{0}C for 1 min, 3 cycles of 95 ^{0}C for 45 sec and 60 ^{0}C for 1 min, 3 cycles of 95 ^{0}C for 45 sec and 57^{0}C for 1 min, 3 cycles of 95 ^{0}C for 45 sec and 54 ^{0}C for 1 min, 3 cycles of 95 ^{0}C for 45 sec and 51^{0}C for 1 min, 20 cycles of 95 ^{0}C for 45 sec and 48 ^{0}C for 1 min. Six microlitre each of PCR products were loaded on to a 2 % agarose gel, electrophoresed and visualized over UV light to detect the amplification. The PCR products were run on automated DNA Sequencer of Applied Biosystems (ABI 3100 Avant). The electropherograms drawn through Gene Scan were used to estimate DNA fragment sizing details using Gene Mapper software (version 3.0) (Applied Biosystems).

Statistical Analysis

For 25 microsatellite loci analyzed, observed and expected heterozygosity estimates were calculated after Levene (1949) and Nei (1973)

Table 4. Microsatellite markers, their sequences, type of repeat, size range, location and accession number

SN	Locus	primer sequence	Type of repeat	Size Range	Ch. No.	Gen Bank Accession Number
1.	ILST008	gaatcatggattttctgggg tagcagtgagtgaggttggc	$(CA)_{12}$	167-195	14	L23483
2.	ILSTS059	gctgaacaatgtgatatgttcagg gggacaatactgtcttagatgctgc	$(CA)_4(GT)_2$	105-135	13	L37266
3.	ETH225	gatcaccttgccactatttcct acatgacagccagctgctact	$(CA)_{18}$	146-160	14	Z14043
4.	ILST044	agtcacccaaaagtaactgg acatgttgtattccaagtgc	$(GT)_{20}$	145-177	Ann	L37259
5.	ILSTS002	tctatacacatgtgctgtgc cttaggggtgaagtgacacg	$(CA)_{17}$	113-135	Ann	L23479
6.	OarFCB304	ccctaggagctttcaataaagaatcgg cgctgctgtcaactgggtcaggg	$(CT)_{11}(CT)_{15}$	119-169	Ann	L01535
7.	OarFCB48	gagttagtacaaggatgacaagaggcac gactctagaggatcgcaaagaaccag	$(CT)_{10}$	149-181	17	M82875
8.	OarHH64	cgttccctcactatggaaagttatatatgc cactctattgtaagaatttgaatgagagc	-	120-138	4	212[a]
9.	OarJMP29	gtatacacgtggacaccgctttgtac gaagtggcaagattcagaggggaag	$(CA)_{21}$	120-140	Ann	U30893
10.	ILSTS005	ggaagcaatgaaatctatagcc tgttctgtgagtttgtaagc	$(nn)_{39}$	174-190	10	L23481
11.	ILSTS019	aagggacctcatgtagaagc acttttggaccctgtagtgc	$(TG)_{10}$	142-162	Ann	L23492
12.	OMHC1	atctggtgggctacagtccatg gcaatgctttctaaattctgaggaa	-	179-209	Not Reported	228[a]
13.	ILSTS087	agcagacatgatgactcagc ctgcctcttttcttgagagc	$(CA)_{14}$	142-164	Ann	L37279
14.	ILSTS30	ctgcagttctgcatatgtgg cttagacaacaggggtttgg	$(CA)_{13}$	159-179	2	L37212

15.	ILSTS34	aagggtctaagtccactggc gacctggtttagcagagagc	$(GT)_{29}$	153-185	5	L37254
16.	ILSTS033	tattagagtggctcagtgcc atgcagacagttttagaggg	$(CA)_{12}$	151-187	12	L37213
17.	ILSTS049	caattttcttgtctctcccc gctgaatcttgtcaaacagg	$(CA)_{26}$	160-184	11	L37261
18.	ILSTS065	gctgcaaagagttgaacacc aactattacaggaggctccc	$(CA)_{22}$	105-135	24	L37269
19.	ILSTS058	gccttactaccatttccagc catcctgactttggctgtgg	$(GT)_{15}$	136-188	17	L37225
20.	ILSTS029	tgttttgatggaacacagcc tggatttagaccagggttgg	$(CA)_{19}$	148-191	3	L37252
21.	RM088	gatcctcttctgggaaaaagagac cctgttgaagtgaaccttcagaa	$(CA)_{14}$	109-147	4	U10392
22.	ILSTS022	agtctgaaggcctgagaacc cttacagtccttggggttgc	$(GT)_{21}$	186-202	Ann	L37208
23.	OARE129	aatccagtgtgtgaaagactaatccag gtagatcaagatatagaatatttttcaacacc	$(CA)_{14}$	130-175	7	L11051
24.	ILSTS082	ttcgttcctcatagtgctgg agaggattacaccaatcacc	$(GT)_{17}$	100-136	2	L37236
25.	RM4	cagcaaaatatcagcaaacct ccacctgggaaggcttta	$(CA)_{13}$	104-127	15	U32910

Polymorphic information contents (PIC) were estimated according to Botstein et al., (1980). The tests for deviation from Hardy-Weinberg equilibrium were also derived using the exact tests of POPGENE. Tests for pair wise linkage (genotypic) disequilibrium among the microsatellite loci were done using FSTAT version 2.9.3 an update version 1.2 (Goudet, 1995) for 25 microsatellite loci whose genotypes were determined directly. F-statistics were determined after Weir & Cocheran (1984) as used in F-Stat software with Jackknifing procedure applied over loci in deriving significance levels and Bootstrapping applied over loci in deriving 95% confidence intervals for these statistics.

and number of alleles as per Kimura and Crow (1964) as implemented in POPGENE software (Yeh et al., 1999).

To determine the genetic variation within the breed, parameters such as heterozygosity and Wright's F-statistics (Fis) were calculated acccording to Wright (1978).

The bottleneck hypothesis was investigated using BOTTLENECK 1.2.02 software (http://www.enasm/inra.fr/URLB; Cornuet and Luikart, (1996) to detect any recent reduction in the effective population size of Gohilwadi goats. In the first approach, based on the heterozygosity excess, three different tests namely, 'Sign test' , 'standardized differential test' and 'Wilcoxon sign rank test' were employed under different models of microsatellite evolution like the Infinite allele model (Ohta and Kimura, 1973), Stepwise mutation model (Kimura and Crow, 1964) and Two-phase model (Di Rienzo et al., 1994). The second approach was the graphical representation of mode-shift indicator proposed by Luikart and Cornuet (1997). The test requires measurement of allele frequencies from 5-20 polymorphic loci in a sample of approximately 20-30 individuals. The bottleneck compares heterozygosity expected (H_E) at Hardy-Weinberg equilibrium to the heterozygosity expected (H_{eq}) at mutation drift equilibrium in same sample, that has the same size and the same number of alleles.

Genetic Diversity

Estimates of genetic variation in terms of allele number, information index and heterozygosities are presented in the table 5. The F-values, Genetic diversity and PIC value are presented in table 6. The number of alleles observed across the studied microsatellite loci varied from 4 (ETH225, OarJMP29 and RM088) to 24 (OarFCB 304) with an overall mean of 10.12 ±0.827. The effective number of alleles across the loci was less than the observed number and varied from 1.094 (OarJMP29) to 12.73

Table 5. Measures of genetic variation in Gohilwadi goats

Locus	Sample Size	Number of alleles Obs.	Eff.	Information Index	Heterozygosity Obs.	Exp.	Nei
ILST008	48	4	1.412	0.589	0.250	0.295	0.292
ILSTS059	43	6	2.586	1.135	0.163	0.620	0.613
ETH225	27	4	2.031	0.948	0.074	0.517	0.507
ILST044	48	11	2.051	1.265	0.354	0.518	0.512
ILSTS002	39	12	8.134	2.268	0.564	0.888	0.877
OarFCB304	41	24	9.086	2.673	0.854	0.901	0.889
OarFCB48	44	11	5.363	1.929	0.795	0.823	0.813
OarHH64	48	12	8.947	2.299	0.667	0.898	0.888
OarJMP29	34	4	1.094	0.229	0.088	0.087	0.086
ILSTS005	45	7	2.653	1.265	0.200	0.630	0.623
ILSTS019	43	9	5.216	1.846	0.767	0.818	0.808
OMHC1	48	17	10.642	2.534	0.833	0.916	0.906
ILSTS087	38	13	8.022	2.261	0.421	0.887	0.875
ILSTS30	46	9	5.961	1.936	0.783	0.841	0.832
ILSTS34	48	6	1.633	0.820	0.250	0.392	0.387
ILSTS033	45	12	3.792	1.680	0.489	0.745	0.736
ILSTS049	46	9	3.405	1.559	0.435	0.714	0.706
ILSTS065	47	6	3.163	1.302	0.191	0.691	0.684
ILSTSO58	34	23	12.773	2.805	0.706	0.935	0.922
ILSTSO29	44	14	5.595	2.045	0.864	0.831	0.821
RM088	43	4	1.839	0.780	0.279	0.462	0.456
ILSTS022	47	6	1.952	0.914	0.383	0.493	0.488
OARE129	46	9	3.674	1.631	0.826	0.736	0.728
ILSTS082	48	15	5.977	2.184	0.979	0.841	0.833
RM4	45	6	2.619	1.167	0.400	0.625	0.618
Mean	43.5	10.12	4.785	1.603	0.505	0.684	0.676
S.E		0.827	0.486	0.104	0.042	0.033	0.033

Effective number of alleles [Kimura and Crow (1964)]

Shannon's Information index [Lewontin (1972)]

Expected heterozygosity were computed using Levene (1949) and Nei's (1973) expected heterozygosity

(ILSTS058). The Shannon information index (table 5) showed that all the loci were highly informative indicating the high polymorphism across the loci with an overall mean of 1.603 ± 0.104. The polymorphism exhibited by these markers indicated their suitability for genetic diversity analysis of goats. The average expected heterozygosity within the population ranged from 0.087 (OarJMP29) to 0.935 (ILSTS 058) with an overall mean of 0.684±0.33, whereas observed heterozygosity ranged from 0.088 (OarJMP29) to 0.979 ((ILSTS 082) with an average of 0.505±0.042. All 25 studied loci showed significant deviation from Hardy Weinberg Equilibrium. Twenty-two out of 25 loci showed significant heterozygote deficiency in Gohilwadi goat population.

The gene diversity across the studied loci for Gohilwadi breed of goat varied from 0.087 (OarJMP29) to 0.939 (ILSTS 058) with an overall mean of 0.840 ± 0.628 (Table 6). The allelic richness across the studied loci varied from 3.382 (OarJMP29) to 20.885 (ILSTS 058) with an overall mean of 13.138 ± 5.616.This reflected the sufficient number of the alleles per locus in the population independent of the sample size and thus can be used for comparing the different populations. The positive values of the F_{IS} ranged from 0.034 (OarFCB48) to 0.859 (ETH 225). The Poly Information Content (PIC) values varied from 0.084 (OarJMP29) to 0.917 (ILSTS058).

To detect any recent reduction in effective population size of Gohilwadi goats three different tests i.e. Sign Test, Standardized difference Test and Wilcoxan sign-rank Test were employed under different mutation models of microsatellite evolution i.e. Infinite allele (IAM), Stepwise mutation (SMM) and Two phase (TPM) models. The Sign and Wilcoxon tests detected significant departure from mutation-drift-equilibrium in the population at most of the studied loci. The deviation from the mutation drift equilibrium was significant under indefinite allele (IAM) and single step mutation (SMM)

Table 6. F-stat. analysis for microsatellite loci in Gohilwadi goats

Locus	Sample Size	Gene diversity	Allelic Richness	F_{is}	P-value	PIC
ILST008	48	0.295	3.548	0.154	0.1360	0.273
ILSTS059	43	0.626	5.233	0.740	0.0020	0.537
ETH225	27	0.526	4.000	0.859	0.0020	0.464
ILST044	48	0.520	9.012	0.318	0.0020	0.498
ILSTS002	39	0.893	11.575	0.368	0.0020	0.866
OarFCB304	41	0.902	19.763	0.053	0.1880	0.883
OarFCB48	44	0.823	9.680	0.034	0.3180	0.791
OarHH64	48	0.900	11.352	0.259	0.0020	0.878
OarJMP29	34	0.087	3.382	-0.015	1.0000	0.084
ILSTS005	45	0.635	6.174	0.685	0.0020	0.574
ILSTS019	43	0.818	8.436	0.062	0.2580	0.784
OMHC1	48	0.916	14.524	0.091	0.0480	0.899
ILSTS087	38	0.893	12.059	0.529	0.0020	0.863
ILSTS30	46	0.842	8.712	0.071	0.1920	0.811
ILSTS34	48	0.393	4.935	0.364	0.0020	0.366
ILSTS033	45	0.747	9.616	0.346	0.0020	0.701
ILSTS049	46	0.717	7.959	0.394	0.0020	0.671
ILSTS065	47	0.697	5.144	0.725	0.0020	0.628
ILSTSO58	34	0.939	20.885	0.248	0.0020	0.917
ILSTSO29	44	0.830	11.698	-0.040	0.8060	0.801
RM048	43	0.464	3.579	0.399	0.0040	0.388
ILSTS022	47	0.494	4.711	0.225	0.0360	0.431
OARE129	46	0.735	8.053	-0.124	0.9860	0.699
ILSTS082	48	0.840	13.138	-0.166	1.0000	0.818
RM4	45	0.628	5.616	0.363	0.0020	0.544

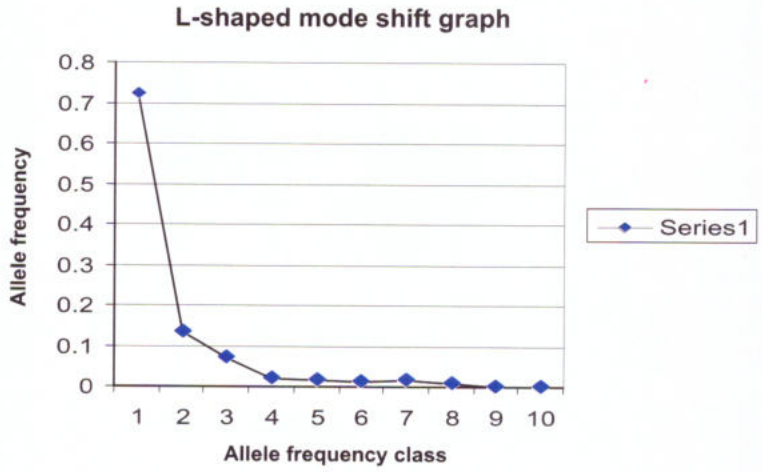
F_{is} is correlation between pairs of genes, within individuals within populations as
Calculated using F- stat software (Gondet, 1995) Gene diversity per locus and population
Polimorphic information content

models. The standardized differences test also revealed significant departure from mutation-drift-equilibrium. Expected number of loci under Sign test were 14.94 (8 loci with heterozygotic deficiency, 17 with excess, probability 0.26472); 14.89 (18 loci with deficiency, 7 with excess and probability 0.00139) and 14.78 (22 loci with deficiency, 3 with excess and probability 0.0000) under IAM, TPM and SMM respectively. The deviation was negative under TPM (T_2 = - 3.817, $P < 0.05$) and SMM (T2= -11.998) but positive under IAM (T_2 = 0.290).

Typing of Gohilwadi DNA resolved total 253 alleles at 25 microsatellite marker loci taken for this studies. All the genetic measures estimated revealed that there was substantial genetic variation within Gohilwadi goat population. The minimum number of alleles observed were 4 but the maximum was 24. The total number of alleles observed and the minimum number of alleles at a locus demonstrated that all microsatellite loci were sufficiently polymorphic and markers used were appropriate since the number of alleles resolved for each marker was either equal or more than the required number of alleles (at least four alleles) recommended for microsatellite markers to be used in the estimation of genetic distance (Barker, 1994). Higher genetic diversity observed in this study might be due to the large effective number of alleles, immigration of new genes resulting from intermixing of different populations and low selection pressure. The observed heterozygosity was lower than the expected heterozygosity for all the loci except that for ILSTS029, OARE129 and is def icit (Christiansen et al., 1974) but a close study can pin point the specific reason leading to the heterozygotic deficiency. The most probable reason observed here is the strong inbreeding which presumably resulting from the unplanned and indiscriminate mating prevailing in the breeding tract which led to the small effective population size or mating between relatives and genetic drift. The general practice of inbreeding in the region was to allow a few bucks for the whole village and also in the nearby villages.

The f estimates were higher and significantly different from zero indicating departures from random mating because of inbreeding within population and suggested that some of studied loci were homozygous in the population.

The different tests of bottleneck hypothesis under SMM model indicated significant deficiency of heterozygosity, possibly caused by introduction of unique/rare alleles by immigrants. As indicated by the L-shaped curve there is absence of any bottleneck in the Gohilwadi population in the recent past implying that there is no mode shift in the frequency distribution of alleles. In case of existence any bottle neck event the rare alleles are lost more often than the commonly occurring alleles and consequently there is a reduction in the population size. Alleles loss does not occur at the extremes of allele size distribution so the range in allele size remains unaffected. With the assumption that all loci fit the three different mutation models the values obtained for expected number of alleles and probabilities support the absence of any bottle neck in the population.



L-shaped mode shift graph showing absence of bottleneck in Gohilwadi goats

Conclusion

Looking at the goat population existed in different districts of Gujarat state comprising the breeding tract it can be concluded that Gohilwadi breed of goat is in a comfortable status and may not need any immediate attention for its conservation but to maintain this status good breeding bucks need to be prepared and supplied to the farmers. Incentives in terms of medicines, vaccines, mineral mixtures, insurances to the goat keepers may be provided by the state government so that further improvement in the growth and performance can be brought. The microsatellite marker studies indicated substantial genetic variation and polymorphism across studied loci in the Gohilwadi breed of goat. The breed was also receiving new genetic materials through introduction of immigrants. Appropriate breeding strategies should, therefore, be designed under field conditions for its improvement of its unique attributes like adaptability and fitness under harsh climatic conditions of the arid/semi-arid zone.

The survey team enjoying tea of Gohilwadi goat's milk in the field

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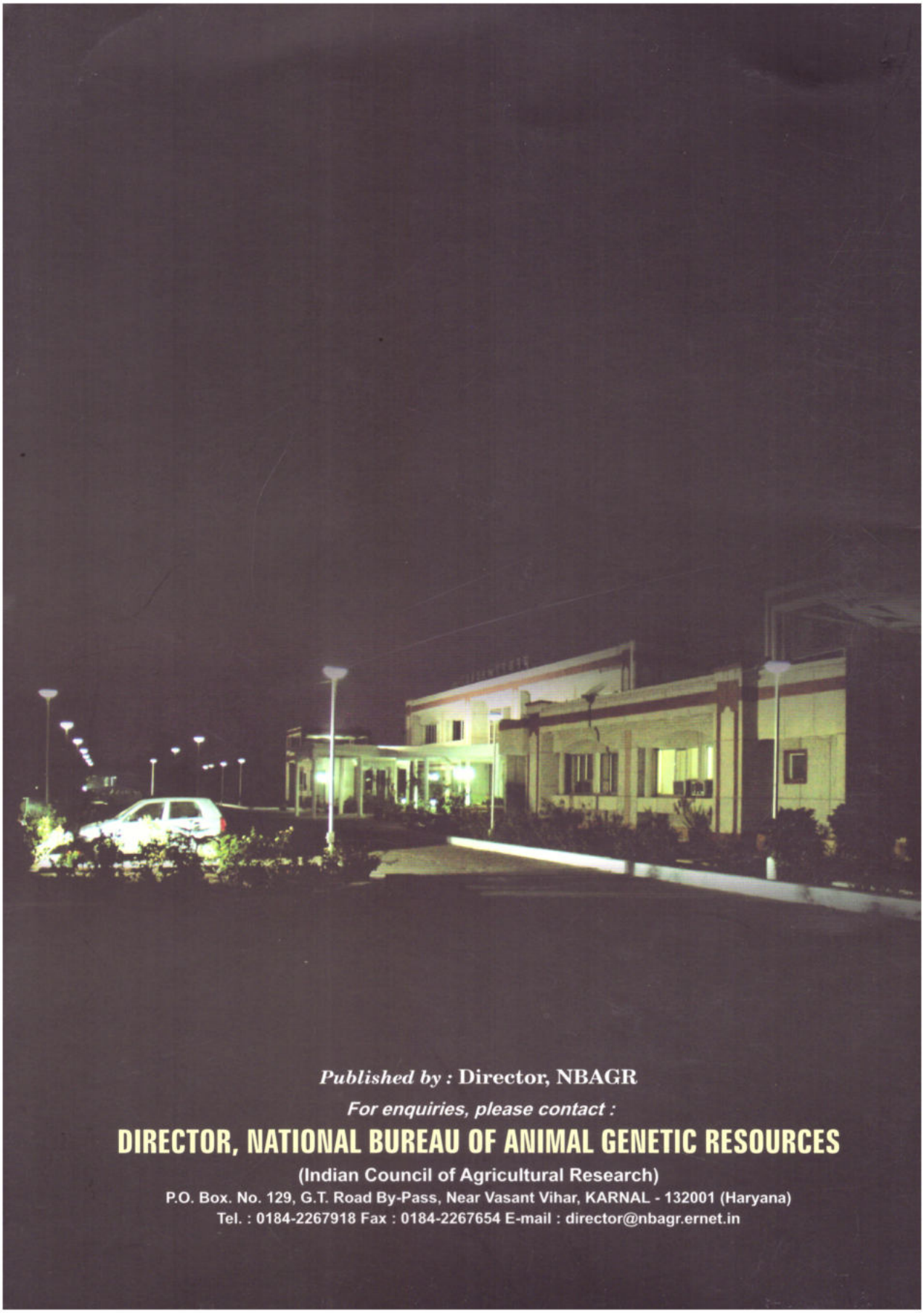

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