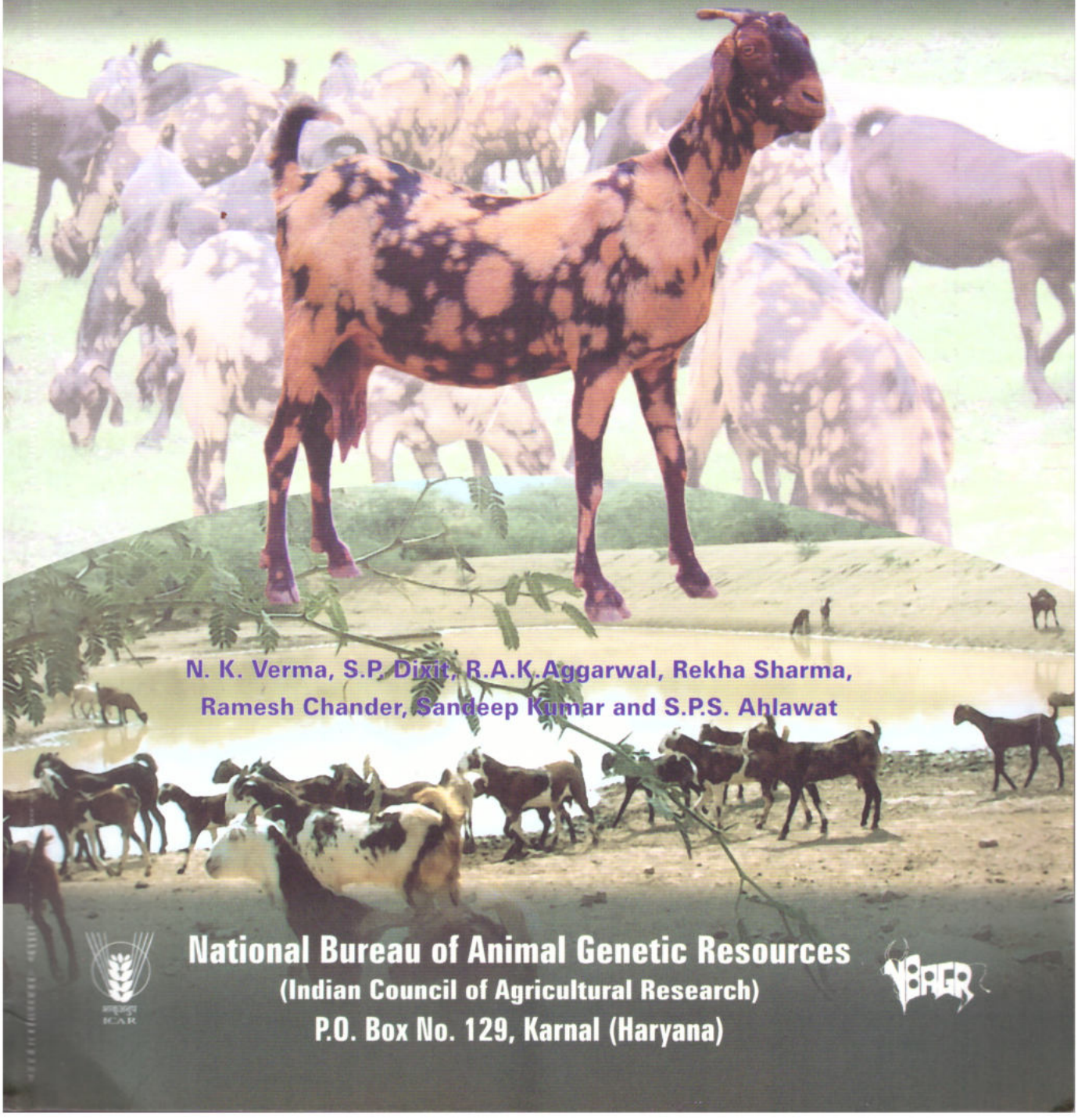
Goat Genetic Resources of India

SIROHI

– A Popular Goat of Arid and Semi-Arid Region



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(Indian Council of Agricultural Research)
P.O. Box No. 129, Karnal (Haryana)

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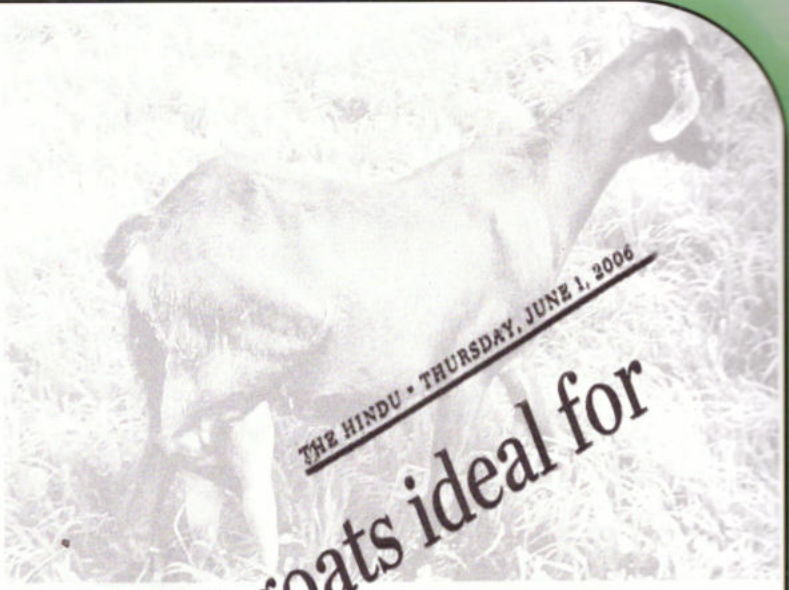
FARMER'S NOTEBOOK

Rearing Sirohi goats ideal for small scale farmers

The breed is popular for its weight gain and better lactation

M.J. PRABU



MILKING REGIMEN: *Does are milked twice a day and 2-3 litres of milk can be got from first kids.*

SOCIALLY, GOATS have provided livelihood security to small and marginal farmers and particularly, landless labourers.

Goats are medium in size and consume a variety of grasses, weeds, bushes and kitchen waste and produce higher amount of milk with lower input cost, when compared with cattle.

Common breeds such as Jamunapari, Barbari, Beetal, Jakarana, Marwari, and Black Bengal are used for milk and meat and for up grading of non-descript breeds in India.

Another common Indian breed is called Sirohi, which derives its name from the Sirohi district of Rajasthan.

The breed is also known by other names such as Devgarhi, Parbatsari, and Ajmeri.

Dual-purpose animals

Sirohi goats are [illegible] animals, which are reared for both meat and milk, according to Prof. [illegible] Officer-in-Charge, Livestock Research Station (LRS), Vallabhnagar of Maharana Pratap University of Agriculture & Technology, Udaipur, Rajasthan.

The animals are [illegible] their weight gain and lactation even under poor quality rearing conditions according to him.

The animals are resistant to major diseases and are easily adaptable to different climatic conditions.

Widely distributed

Though the main breeding tracts of Sirohi animals are situated in the Aravalli hills of Rajasthan, they are also widely distributed in several other Indian states.

"The skin colour of the goat varies from light brown to dark brown sometimes with light brown patches on the body. The [illegible] bucks (males) are heavier than the does (females). Animals with a tapering body shape are preferred for milk and those with a cylindrical body shape for meat production.

The animals can be stall-fed as well as sent for grazing. It is ideal to feed the animals reared in a stall with about 3-5 kg of green fodder every day.

In addition, the animals must be fed with a concentrate mixture of barley and channa gram along with 2 per cent mineral mixture and 1 per cent common salt.

Does normally come to heat at one year of age. The normal breeding ratio is one buck for 30 does. Does can be bred twice a year.

Getting more kids

Usually a buck can service 30-35 does in a single breeding season.

"Farmers must provide about 300 gm of barley mixture mixed with channa dhal to get more healthy kids in a single kidding. This is called flushing," said Prof Nagda.

The gestation period usually lasts for about 150 days. "It is advisable to keep pregnant does, fifteen days before kidding, in separate enclosures with straw bedding and fresh water.

In case of any difficulty during delivery of lambs immediate veterinary attention is necessary," said. About 30-40 per cent of does give birth to twins or triplets, according to Prof. Nagda. Weaning of kids is done at 3-4 months of age. Does are milked twice a day and 2-3 litres of milk can be got from does with first kids.

Hardy animals

Though the animals are hardy and resistant to major diseases and infections, farmers are advised to deworm and vaccinate the animals against enterotoxaemia and foot and mouth infections regularly.

The University maintains a healthy flock of Sirohi breed at its Livestock Research Station (LRS), Vallabhnagar.

Breedable bucks are being supplied to several farmers. Bucks are priced at Rs.5,000 and Does at Rs.3-3,500.

Prof. R.K. Nagda, can be reached at LRS, Vallabhnagar, Maharana Pratap University of Agriculture & Technology, Udaipur, Rajasthan, mobile: 94147-34827.

Monograph 29, 2006

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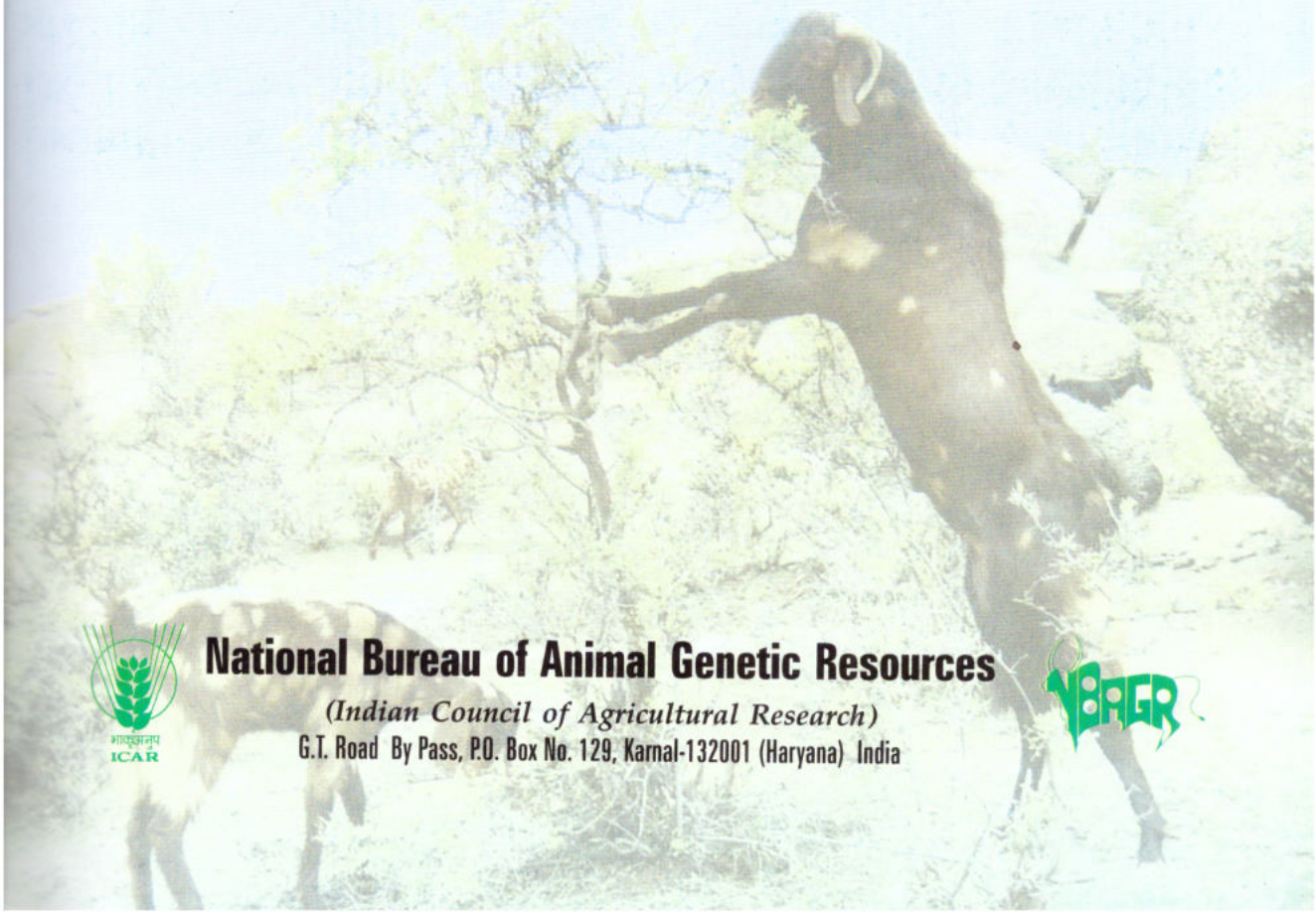

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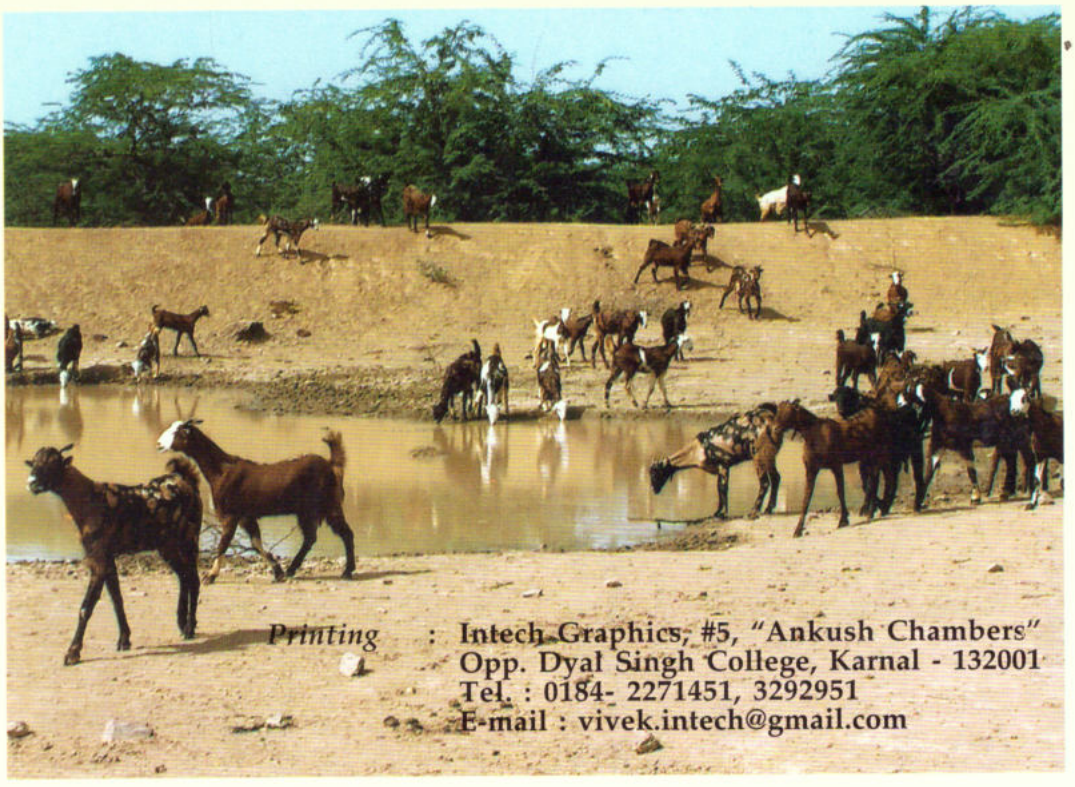

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FOREWORD

Goat is a multi purpose animal and plays a significant role in the economy and nutrition of landless, small and marginal farmers of the country. The goat population of 120 million contributes 24.8% of the total livestock population of the country. Among the twenty well defined breeds 'Sirohi' forms an important constituent of indigenous goat germplasm. Sirohi goat is liked by the farmers for its coat colour and production performance. Besides this, these animals remained in great demand because of their religious and ritualistic importance. In the recent past many breeds have shown the declining population trend due to certain known and unknown reasons. Moreover, indiscriminate breeding among the small ruminants has led to the dilution of their genetic constitution. Lack of breed wise census makes it difficult to have an estimate of the population of a particular breed. Realizing all these the scientists of this institute has taken a studies on phenotypic and genetic characterization of Sirohi breed of goat by conducting pilot surveys in its breeding tract. The information generated during the studies have been compiled and forms the basis of this bulletin. I hope that the bulletin "Sirohi-A Popular Goat of Arid and Semi Arid Region" will be useful to the researchers, surveyors and policy planners in taking up the research and development programmes for the sustainable utilization of Sirohi breed of goat. I would like to appreciate the authors for their endeavour to bring out this bulletin.

(S.P.S. Ahlawat)

PREFACE

Goat is a multi purpose animal and is one of the smallest ruminants domesticated around 9000 to 7000 BC This species has served the mankind earlier and longer than cattle and sheep. They contribute significantly to the income of the poor families through their production and reproduction performances. 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. In addition to the low input resources, 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 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.

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 inhabiting different regions and having variable features are claimed to be the local breeds of that region. Each breed has its own utilization in the native region where they have adapted to perform to their best.

Sirohi goats are reared mainly for milk and meat purpose. They can easily survive under harsh tropical climatic conditions and poor availability of feed and fodder resources. Inspite of their ecological and economic importance this breed of goat has not got the due attention of researchers/surveyors. The indiscriminate breeding has led to the dilution of its genetic make up. Further, time to time investigation are required to know the changing features and performance of the breed and also to

know the current status of its population so that the timely steps can be taken to implement the appropriate action to save the breed from further deterioration. Realising the importance of the breed, a project was undertaken to characterize the Sirohi breed at its phenotypic and genetic level. The information generated during the investigation may be useful for planning sustainable improvement, conservation and utilization of the breed.

At the outset authors would like to express the deep gratitude to Dr. S.P.S. Ahlawat, the Director, NBAGR for providing facilities to carry out this work. We are also grateful to the Deputy Directors of Sirohi, Udaipur and Ajmer districts, for the support provided by them during the survey visits. The whole hearted support provided by Dr. K.P. Singh Assistant Professor of Sardarkrushinagar Dantiwara Agricultural University, Sardarkrushinagar Gujrat and Dr. O.P. Pathodiya, incharge AICRP on Sirohi goats is duly acknowledged. The consent and cooperation of goat keepers during blood sampling and other data collection on their animals is worth mentioning and is thankfully acknowledged. The authors convey their heartfelt thanks to Dr. Jyotsna Behl, Scientist, SS, Sh Subhash Chander, T-II, and other staff of Immunogenetics laboratory for their support during the processing of blood samples. Lastly we are grateful to those who have directly or indirectly helped in completion of this project and preparation of this bulletin.

Authors

Survey Team with a progressive farmer and his farm workers

Some Facts About Goats: (goatworld.com)

- Goats were the first animals to be tamed by the humans
- There are over 210 breeds of goats all over the world.
- Goats occur in varied coat colours. Indiscriminate breeding has led to the mixing of colours resulting in more combinations of colours
- Goats can eat each and everything.
- Goats are intelligent animals and can learn how to open latches on farm gates.
- Goats can run, climb, crawl under fences and jump over 5 feet. They can also stand on their hind legs to reach the branches of trees or shrubs.
- In a mixed herd, goats tend to remain together with the animals of same breed. Kids prefer to remain nearby their mothers, even if separted for years and reintroduced.
- Goat kids have 8 small, sharp teeth in their lower front jaw which fall out and are replaced by permanent teeth. The age of a goat can be closely determined by their teeth.
- Like males, females are also capable of growing beard.
- The pupil of goat is rectangular in shape. The animals can see sharply in the night.
- Goats being ruminant have four stomach compartments (rumen, reticulam, Omasum, and abomasum). The elementary canal is about 25 times the length of goat. The total blood volume is about 1/12 of animal's body weight. It takes about 14 seconds for goat blood to complete one circulation.
- Goats can encounter the same diseases as sheep and cattle. Pneumonia and coccidiosis can bring sudden death to animals.
- Some milch breeds can yield as high as 6 liters of milk. The goat milk has more medicinal value than that of cow, sheep and buffalo.
- 'Goaty' odor of milk is produced by the presence of the buck at the time of milking whose scent glands are odoriferous. Milk produced in the absence of buck does not bear the goaty odor.
- Goats can live upto 10-12 years sometimes upto 15 years.

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1. Introduction

Sirohi breed is one of the important defined breeds of India (Acharya, 1982) who has its own place among the breeds inhabiting the arid to semiarid region of the country. It has made its place by replacing the non descript type goats in the region. Because of its shining coat colour, colour pattern, beautiful look and good performance as a dual purpose animal (milk and meat) under field conditions, the Sirohi goats have special liking of the people for religious and ritualistic purpose. This breed has proved an excellent goat breed with respect to disease resistance, adaptability, growth and production performance. As a part of mandated activity a team of NBAGR intended to characterize the Sirohi goat breed at its phenotypic as well as genetic level. Survey visits were conducted in the breeding tract of Sirohi goats to collect the information on population status, morphometerics, production, reproduction parammeters, managemental practices followed and the economic status of the people rearing them. The data on body traits, body weights of 230 animals consisting of different age groups, sexes spreaded over the different villages of Sirohi, Udaipur, Ajmer, Rajsmand districts of Rajasthan and adjoining areas of Gujrat state were collected. The information collected during the visits were analysed using SPSS 11.5.5 for Windows (www SPSS.com / tech / 7) and the averages of various body traits are presented here in this bulletin. Blood samples collected from the unrelated animals of different regions were analysed for the genetic characterization of this breed.

2. Native Tract

Sirohi goat derived its name from Sirohi district of Rajasthan state of India. They are found in arid and semi arid region along with most part of Arawali hills and districts of central and southern Rajasthan. The pure form of this

breed is found in the villages of Sirohi, Ajmer, Udaipur, Chittorgarh, Rajsamand and Bhilwara districts of Rajasthan and also adjacent districts like Palanpur, Patan of Gujrat. The breeding tract of Sirohi breed falls in the semi arid region of the Rajasthan state. The monthly temperature ranged 9.3 to 22.3° C (Average 16.5° C) minimum and 19.3 to 31.5° C (Average 24.9° C) maximum. The average monthly relative humidity (%) is 5.5 in morning and 48 in the evening. The annual rainfall is 169 cms.

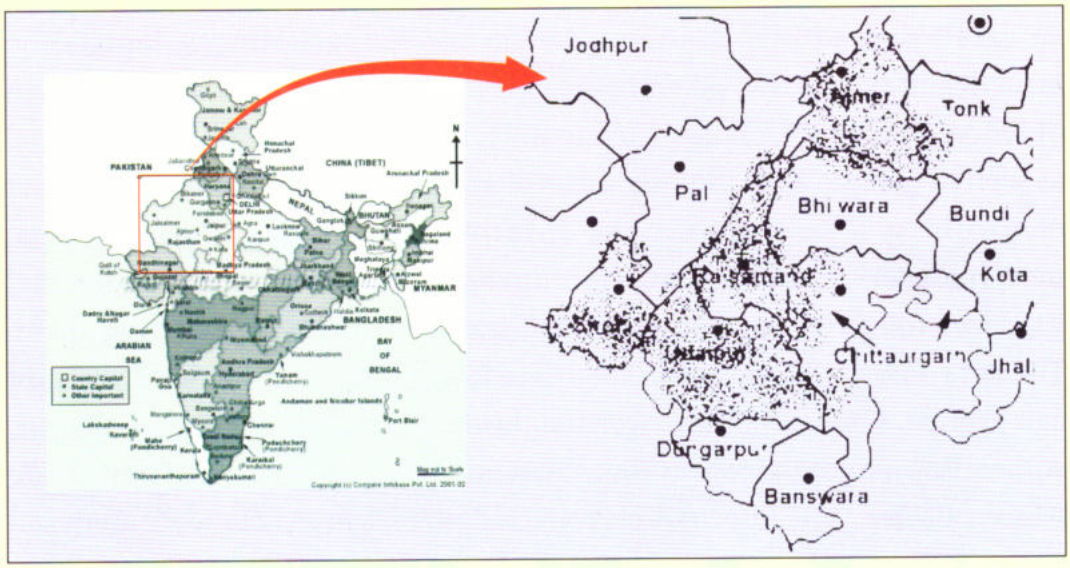

Fig. 1: Distribution of Sirohi goats in Rajasthan

3. Population Size

The total goat population in Rajasthan state is about 1,68,08,030 (17th Livestock census 2003) which is mainly constituted by Sirohi and Marwari goats. The goat population of Sirohi district is 3,32,843 which is mostly dominated by Sirohi goats. Goat populations in Rajsmand, Udaipur, Ajmer, and Chittorgarh districts is 499334, 1164,316, 602114, 637965 respectively . However. because of lack of breed wise census no official figure is available on Sirohi goats

found in these districts. Keeping in view the varied percentage of Sirohi goats in Sirohi, Rajsmand Udaipur, Ajmer and Chittorgarh districts of Rajasthan respectively observed during the visits, the population of Sirohi goats in the State has been estimated as 10.03 Lacks approximately.

4. Utility of Animal

Sirohi goats are used for meat as well as milk purpose. They are reared to 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.

5. Phenotypic Characterization

Sirohi goat is a compact, medium sized animal. The animal looks beautiful and alert having strong body with good postures. Average body measurements of various traits and body weights of Sirohi goats age and sex wise, region wise and coat colour wise are given in table 1, 2 and 3 respectively.

Coat colour : The coat colour is predominantly brown with light or dark patches. Animals with brown / black colour with large white patches are also present. The size of the brown spots determines the purity of breed. Smaller the size more the purity. The size of the spots go on decreasing from belly to the neck region. The goats with such spotted pattern are locally called 'Majithi'. Animals with uniform brown colour are also seen in the flocks. These uniformly brown coloured goats are sometimes referred to as Parbatsari. Animals of different colour variants have been shown in figure 2.

Brown spots all over body (K1)

Spotted body with white face (K2)

Uniform brown colour (K3)

Fig. 2 : Colour variants of Sirohi goats

Head and Face: Head is proportionate to body size. Face is long and slightly convex. The eyes are brown with brown eye lids. Nose is slightly roman type. Muzzle is brown (Fig. 3.)

Wattle: Wattles were observed in about 40% animals of both sexes.

Ears: Ears are flat and leaf like, medium sized and drooping (Fig. 3). As a managemental practice the ears are cut short so as to save them from entangling in the bushes or dipping in the water at the time of drinking.

Horns: The horns are medium sized, grey in colour and curved upward and backward. The horns of males are stronger than that of females. Polled male and female goats were also seen in the Devgarh and Ramsar (Fig. 2 and 3).

Fig. 3 : Body traits of Sirohi goats

Tail: Tail is matching with the coat colour and is twisted in upward direction. The size reaches upto 16 cms. Males have slightly longer tail.

Body Height and Length: The female kids of 3 months age were found to have better height than males (table 1) but with the progression of age males attain more height and length. Animals of Devgarh area were observed to have more body height and length than the goats of other regions (table 2).

This may be due to the fact that animals of this area are better looked after under AICRP being operative in the area.

Girth: Chest Girth and Paunch Girth also show the same pattern as the body height and length in the animals of Devgarh area (table 2).

Udder and Teats: The udder is small and round with medium sized teats placed laterally. However animals having good milk yield (2.0 - 3.0 liters per day) show a well developed udder and teats (Fig. 4).

Fig. 4 : Well developed udder and teats

Table-1: Sex wise biometerics of young and adult Sirohi goats

Traits	3 Months		6 Months		Adult	
	F	M	F	M	F	M
Body Height	62.60±4.54	59.00±1.89	65.22±0.76	68.24±0.82	74.57±0.44	78.89±1.45
Body Length	59.80±3.71	56.80±1.82	62.96±0.71	66.10±0.76	74.19±0.47	77.94±1.68
Chest Girth	60.60±4.64	54.80±1.65	62.04±0.89	64.57±1.07	74.10±0.56	77.50±1.79
Paunch Girth	60.40±4.54	54.60±0.80	62.04±1.00	66.05±1.31	75.22±0.78	77.78±2.03
Face length	16.40±0.87	14.80±0.37	16.35±0.22	17.38±0.43	19.35±0.64	19.56±3.34
Ear Length	6.60±1.05	13.00±1.30	8.91±1.86	14.24±1.91	5.76±0.65	14.42±1.33
Horn Length	5.80±0.63	2.80±0.79	2.78±0.94	1.14±0.62	9.90±0.52	10.22±0.36
Tail Length	15.20±1.11	17.00±0.99	14.04±0.77	14.76±1.08	16.01±0.21	18.06±0.49
Body Wt	22.40±1.53	16.40±0.97	22.13±0.76	26.67±1.45	35.27±0.74	42.83±1.56

Table-2: Region wise biometerics of adult Sirohi goats

Traits	Region					
	Banaskanth	Devgarh	Pinwara	Ramsar	Reodar	Sirohi
Body Height	73.71±0.84	79.21±2.10	74.38±0.86	76.00±0.00	77.55±0.83	77.21±1.27
Body Length	71.91±0.80	79.93±2.29	74.10±0.98	75.00±0.00	77.70±0.87	78.16±1.35
Chest Girth	70.90±0.86	78.64±2.31	74.00±1.04	70.00±0.00	79.61±1.04	77.89±1.80
Paunch Girth	71.19±1.02	78.71±2.58	75.92±1.27	69.00±0.00	81.27±1.25	77.79±3.71
Face length	18.72±0.19	18.71±0.42	19.22±1.24	18.00±0.00	19.45±0.24	19.39±3.38
Ear Length	7.72±1.09	15.36±1.32	6.74±1.25	19.00±0.00	6.76±1.53	4.05±1.52
Horn Length	9.29±0.82	00.00±0.00	10.00±0.80	00.00±0.00	14.91±0.77	11.21±1.61
Tail Length	15.55±0.41	17.14±0.56	17.24±0.25	15.00±0.00	17.03±0.41	15.50±1.17
Body Wts.	31.19±1.05	45.43±1.77	36.16±1.37	35.00±0.00	42.70±1.66	39.37±1.72

Table-3: Biometerics of different colour variants of Sirohi goats

Traits	Colour pattern		
	K1	K2	K3
Body Height	75.62±0.73	75.12±0.77	75.85±0.77
Body Length	75.36±0.80	73.90±0.80	76.55±1.07
Chest Girth	75.09±0.86	74.00±0.97	76.05±1.21
Paunch Girth	76.05±1.19	74.82±1.11	77.35±1.54
Face length	19.20±0.75	18.93±0.19	21.90±3.31
Ear Length	7.57±0.92	6.81±1.01	9.60±0.34
Horn Length	10.09±0.68	10.66±0.84	6.65±0.37
Tail Length	16.57±0.34	16.11±0.35	16.70±0.48
Body Wts.	36.80±1.15	35.42±1.31	38.06±1.19

6. Body Weights

Males generally have more body weights than the females. Like the other body traits average body weights were also observed to be more in the animals of Devgarh area. Among the different colour variants animals with uniform brown coat colour (Parbatsari) showed higher body weights in addition to the other body traits (table 3).

7. Management Practices

Sirohi goats are reared by the people belonging to Rabbari, Grasia, Meena, Mali and Kolabi community. Most of the people of these community are landless or have small holdings. They prefer to live in nuclear family. They live in katcha houses with thatched roof and temporary fencing which they call 'Baara'. Most of these houses do not have electricity and water facilities. The farmers keep their goats in both open and close housing. They use Community land for grazing of their animals under extensive system of management. The adult animals are sent for grazing whereas the young kids are kept at home. Maintaining large flocks of goats under extensive system is increasing due to increase in livestock number and shrinkage of grazing lands. The semi-intensive system where in supplementary feeding is provided to the animals is increasing with small flocks (Chandramouli *et al. 1992).* Women have a significant contribution in the management of goats. They involve themselves in stall feeding, preparing special ration for pregnant or kidding animals, milking of goats etc. The man involve themselves in taking the flocks to pastures, sale and purchase of animals, milking of goats and taking care of sick animals. For landless people goat rearing is a sole business to earn their livelihood. Pathodiya *et al* (2004) reported better performance of Sirohi goats reared by schedule caste than the other castes because schedule cast people rear animals on their own land.

7.1. Flock size and structure

Sirohi goats are seen in a group of 10 to over 100 animals. The flock consists of adult males, females and kids. Small flocks do not have bucks whereas

4-5 breeding bucks are seen in a flock of 50-80 animals. The kids below 3-4 months are not seen in the flocks moving for pasture grazing. The flock size is very fluctuating in case of goats. It increases when more number of female kids born in a year and decreases suddenly after the fast disposal of animals during the festival seasons. Mortality and culling are the two main factors affecting the flock size significantly. The kids born with low birth weight (< 2.0 kgs) generally becomes the culling stock . Therefore, dam's better body weight at service and heavier birth weight of the kids are responsible for better replacement stock in a flock (Arun *et al.*, 2003). A mixed flock of Sirohi goats is shown in fig. 5.

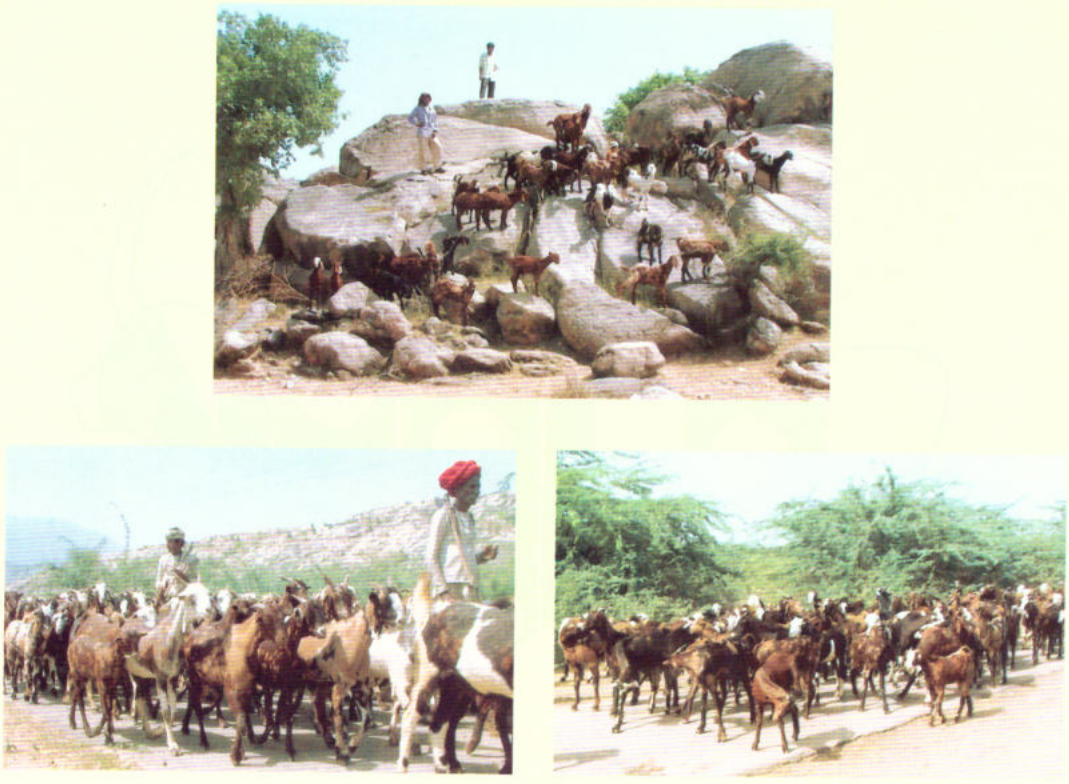

Fig. 5: Flocks consisting of male, females, different colour variants of Sirohi goats

7.2. Feeding

The feeding practices varied from stall feeding, semi- stall feeding, grazing alone, and grazing with supplement feed. It is generally believed that goats eat anything and everything which sometimes may not be true. The goat has sensitive lips and are in the habit of mouthing and smelling for food that is clean and tasty. Goats avoid soiled food unless they are pushed to the extent of starvation. Sirohi goats are usually maintained under field grazing however, stall feeding has also been observed. The small flocks of 1-5 animals are kept on stall feeding whereas the large flocks are sent for

Fig. 6: Sirohi goats grazing, Browsing and drinking

pasture feeding. They stay in the field for 8-10 hours during the day time. The natural grasses, shrubs, trees and crop residues form the part of pasture grazing. Fodder resources consist of leaves of Pala (Zizyphus jujube), Khejri (Prosopis cineraria), Ber (Zizyphus rotundifolia), Neem (Azadirachta indica), Babool (Acacia Arabica), Kikkar (Acacia nilotica) etc.. Stall fed animals are supplemented with the concentrate consisting of Loom, Guar, Moth, Moong, Bajra, Jowar etc. Most of the goat keepers give unchaffed green/dry fodder in addition to the concentrate. The pregnant animals and good milch goats are given special allowance in the form of bajra, Jowar, barley, wheat, buttermilk and cakes. The new born kids are kept on milk feeding and are allowed to suckle their mothers ad-lib. They are weaned at 2 to 3 months of their age. Kids at the one month age also start browsing and are provided with tree eloping. These goats can consume 4 -5 liters of water in a day. The types of feeding is shown in fig. 6.

7.3. Housing

Animals are kept separately in open housing during the day time and in closed housing during night. Animal houses (locally called as 'Baara') are Katcha with thatched or tiled roofs (fig. 7). The goat houses do not have any proper drainage and electricity supply. The open houses are fenced with 5-6 feet long wooden logs and bushes to avoid the entry of beasts. In some cases concrete boundry wall was also seen. The gates of houses are temporarily made of wooden logs or bamboo sticks. The animal houses are made near to the farmer's residence. In case of small flocks the animals share its owner's residence. Kids up to one month of age are kept separately.

Fig. 7 : Housing systems of Sirohi goats

7.4. Health

The survey revealed that goats show mortality due to PPR, Surra, HS and cold. The other diseases reported in Sirohi goats are Diarrhoea, Tympany, Fever, Pneumonia, Abortion, Retention of placenta, skin diseases, Wound, Mange and Mastitis among which diarrohea is more common. Deworming is done before the onset of Monsoon. The highest mortality was reported in the kids of age below 3 months which is due to Pneumonia or Diarrohea. The disease incidence increases in rainy season. An overall mortality of 3.91% in Sirohi goats was reported during the year 2004-05 under AICRP survey. The poor management and unhygenic conditions increase the incidence of

Fig. 9: Goat keepers treating their animals

diseases and thus leads to the high mortality. In case of commonly occurring diseases and the external injuries farmers practice the self medications. The farmers rarely take their animals to the veterinary hospitals for treatment however, they get them vaccinated for FMD and Entrotoximia whenever there are camps for vaccination. This breed of goat has proved to be an excellent goat breed with respect to disease resistance under the dry hot climate conditions,

8. Performance

8.1. Reproduction

Reproduction is a key phenomenon responsible for perpetuation of a breed population. Kidding in goats is not regularly distributed through out the year. It occurs twice in a year i.e. June-July (Rainy season) and Oct. – Nov. (Winter season). The rainy season is more pronounced breeding season which may result upto 90% kidding in the winter season. Some Goats like Jakhrana show maturity at the age less than one year (Verma et al., 2005) but in case of Sirohi it is slightly higher and the doe can attain maturity at the age 1-1.5 years. The average age at first conception is 518 days, weight at

first conception is 23.30 kgs, age at first kidding is 669.46 and weight at first kidding is 26.73 (AICRP Annual report, 2004-05). A doe can conceive again after 3-5 months of the kidding. The gestation period is around 150 days. The kidding interval is 10-12 months. A doe can kid only once in a year but with the improved feeding the kidding interval can be reduced. Acharya (1988) has reported kidding interval in Indian goats ranging from 282 in Black Bengal goats to 376 days in Malabari goats. This shows that there is a breed to breed variation and depends upon the season of last kidding. Postpartum oestrus interval is very important for reproductive performance. The post partum interval in Sirohi goats varied from 62.6 (April to June kiddings) to 217.8 (October to November kiddings). The range is intermediate between that of Marwari and Kutchi breeds (Neeru, 2003). Mojority of Sirohi goats give single birth but twinning was also reported in 20% cases. The twinning percentage increases with the improved management. Twinning is very common (about 50%) in the goats of Devgarh tehsil of Rajsmandh district. A doe can conceive 8-10 times in its life span.

Fig. 10: Breeding male of Sirohi breed

Fig.11: Male and female goats

Fig. 12: Newly born Sirohi kid

The average birth weight of Sirohi kids has been reported as 2.50kgs (Neeru et al, 2004). The birth weight is affected by the year of birth, breed, type of birth, sex of kid and age of dam. The single over multiple births and males over females have significantly higher body weight at birth. Similarly, kids born during November to February had higher birth weight than those born during July to October (Jinger et al., 2005).

8.2. Production

Most of the milch breeds of goat inhabit the North-Western region of the country. Sirohi is one of them inhabiting the semi arid region. Sirohi goats are reared for both milk and meat purpose. The daily milk yield and lactation length averaged as 418ml and 167.5 days respectively under semi intensive system (Dharam Singh, 2005). The average lactation yield was reported to be 101.3 kgs under normal conditions (Without supplementation of feed) however increased upto 169 kgs in animals supplemented with 450 gms/ head/day concentrate mixture (Singh, 2004). Data collected on milk performance of Sirohi goats kept under field conditions under the Indo-Swiss Goat Development Project (ISGP) revealed average of 180 days milk yield as 245.25 kgs. The yield was higher for goats kidding between July and September because of the better fodder availability and milder day

Fig. 8: Milking of Sirohi goat

temperature than for the does kidding in December. The type of birth also affected the lactation yield. The reports revealed that lactation yield was higher in does giving single birth. Production traits such as lactation yield, lactation length, daily milk yield are under the influence of genetic as well as non-genetic factors. The non-genetic factors like season of kidding, age at first conception, order of lactation, stage of lactation etc. have more importance for the high yielding milch goats like Jamnapari, Jakhrana, Beetal etc. The lactation yield and yield per day of lactation of Jakhrana and Sirohi goats did not differ significantly between themselves but differed significantly from Marwari and Barbari goats (Barhat and Chowdhary, 1977). The year of recording, season of kidding, parity and lactation length had significant effect on the production traits. (Prakash et al., 1971 and Prasad et al. 1972).

9. Breeding

There is no well defined breeding policy for the small ruminants however because of high demand of pure Sirohi animals farmers try to maintain the purity of breed. Goat keepers maintain 2-3 breeding bucks in a flock of 100 animals. These bucks are also shared by the people who maintain small flocks. The bucks are given special ration during the breeding season. In some villages a community buck is available. This buck is left on attaining the maturity. This is considered as a relegious practice. Hence, the buck is also called as a 'Amar Bakra' or 'Mata ka Bakra'. An All India Coordinated Resarch Project on Goat Improvement is in operation at Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan) for the improvement of Sirohi goats. Under this project the farm for rearing the male and female animals exists at Vallabhnagar which is about 20 kms away from Udaipur. Another farm for rearing the males for breeding purpose was started at Ramsar under Indo-Swiss Project which at present is maintained by the state Government. These farms make available the elite male animals to the farmers for the propagation and conservation of the

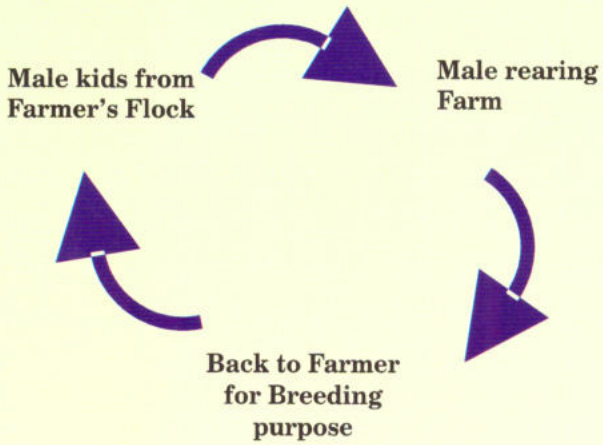

Fig. 13: Open Nucleus Breeding Scheme

breed in the breeding tract. The performance of progenies of such bucks is monitored. The impact study of superior germ plasm dissemination indicated an additional gain in terms of body weight, milk yield of animal over the base population and thus contributing to the income of the farmers of that area.

10. Molecular Genetic Characterization

10.1. DNA Extraction: Blood samples were collected at random from 50 unrelated animals of Sirohi breed spreaded over different districts of Rajasthan. The samples were drawn from jugular vein in EDTA treated vacutainers. DNA extraction was performed using standard protocol (Sambrook *et al.*, 1989). Quantity and Quality was checked on 0.6% agarose gel. DNA was diluted to a final concentration of 50 ng/μl and stored at 4ºC till further use.

10.2. DNA amplification by PCR: A battery of 25 microsatellite markers viz. ILST008, ILSTS059 , ETH225, ILSTS34 ILST044, , ILSTS002, OarFCB304 , OarFCB48, OarHH64 , OarJMP29, ILSTS005, ILSTS019, OMHC1, ILSTS087, ILSTS30, ILSTS033, ILSTS049, ILSTS065, ILSTSO58, ILSTSO29, , RM088, ILSTS022, OARE129 ILSTS082, RM4 was selected based on the guidelines of ISAG &FAO's DADIS (Domestic Animal Diversity Information System) MoDAD programme for generating the data with a panel of 50 animals. Polymerase Chain Reaction (PCR) reactions were carried out on PTC- 200 PCR machine (MJ Thermal Cycler) using a "touchdown" program (annealing temperature 60°-48°C). The 25 μl reaction volume consisted of 200mM each of dATP, dCTP, dGTP and dTTP; 50mM KCl; 10mM Tris HCl (pH 9.0); 0.1% triton X-100; 2.0 mM $MgCl_{2,}$ 0.75 unit of Taq DNA polymerase and 4 ng/μl of each primer. The PCR protocol consisted of initial denaturation at 95º C for 1 min, 3 cycles of 95 º C for 45 sec, 60 º C for 1 min, 3 cycles of 95 º C for 45 sec and 54 º C for 1 min 3 cycles of 95 º C for 45 sec and 51 º C for 1 min, 20 cycles of 95 º C for 45 sec and 48 º C for 1 min. At the end of reaction, 5.0 μl of stop dye containing 95% formamide, 0.25% bromophenol blue and 0.25% Xylene cyanol was added. 6.0 μl of PCR products were loaded on to a 2% Agarose gel, electrophoresed and visualized over UV light after ethidium bromide staining to detect amplification.

10.3. Genetic conformation and Allelic Polymorphism: For microsatellite Analysis primers were 5′ –end labeled with one of the four flourescent dyes: 6-FAM (Blue), HEX (Green), NED (Yellow) and PET (Red) as supplied by Applied Bio System, U.K. The microsatellite genotyping was carried out on ABI Avant automated DNA sequencer (Applied Bio System) with LIZ 500 as internal lane standard. After the completion of the electrophoresis the data was collected and analyzed using Gene Mapper software (Version 3.0 Applied Biosystems). The sequences with chromatogram were visualized, edited for vector sequence and saved by ABI PRISM DNA Sequencing Analysis software.

The statistical analysis was carried out using POPGENE software (Yeh *et al.*, 1999). The Heterozygosity was calculated using the formulae given by (Nei, 1978). The effective number of alleles (n) was calculated as $n = 1/F$ (Kimura and Crow, 1964). Where F is the sum of squares of allele frequencies. The bottleneck hypothesis was investigated using BOTTLENECK 1.2.01 (Cornuet and Luikart, 1996).

The genetic variation in Sirohi breed of goat was measured in terms of number of alleles and heterozygosities (Observed as well as expected) and presented in table 5.

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.	Gene 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	tctatacacatgtgctgtgcc ttaggggtgaagtgacacg	$(CA)_{17}$	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	agtctgaaggcctgagaaccc ttacagtccttggggttgc	$(GT)_{21}$	186-202	Ann	L37208
23.	OARE129	aatccagtgtgtgaaagactaatccag gtagatcaagatatagaatatttttcaacacc	$(CA)_{14}$	130-175	7	L11051
24.	ILSTS082	ttcgttcctcatagtgctgg ag aggattacaccaatcacc	$(GT)_{17}$	100-136	2	L37236
25.	RM4	cagcaaaatatcagcaaacct ccacctgggaaggcctttta	$(CA)_{13}$	104-127	15	U32910

Table-5: Measures of genetic variation in Sirohi goats

S.N.	Locus	Sample Size	Observed number of alleles	Effective number of alleles	Shannon's Information index	Heterozygosity		Nei
						Obse-rved	Expec-ted	
1.	ILST008	48	5	2.05	0.93	0.12	0.52	0.51
2.	ILSTS059	52	14	8.12	2.27	0.73	0.88	0.88
3.	ETH225	41	8	3.06	1.53	0.02	0.68	0.67
4.	ILST044	48	13	4.14	1.81	0.44	0.76	0.76
5.	ILSTS002	51	13	8.13	2.27	0.68	0.88	0.88
6.	OarFCB304	49	25	11.01	2.75	0.67	0.92	0.91
7.	OarFCB48	50	17	10.42	2.56	0.68	0.91	0.90
8.	OarHH64	49	9	5.65	1.94	0.43	0.83	0.82
9.	OarJMP29	47	9	4.06	1.78	0.28	0.76	0.75
10.	ILSTS005	44	9	5.20	1.83	0.41	0.82	0.81
11.	ILSTS019	47	10	7.78	2.16	0.66	0.88	0.87
12.	OMHC1	49	19	10.11	2.58	0.84	0.91	0.90
13.	ILSTS087	41	8	5.16	1.78	0.22	0.82	0.81
14.	ILSTS30	52	12	7.62	2.16	0.67	0.88	0.87
15.	ILSTS34	51	11	2.16	1.31	0.29	0.54	0.54
16.	ILSTS033	39	24	7.70	2.64	0.43	0.88	0.87
17.	ILSTS049	52	11	4.58	1.81	0.54	0.79	0.78
18.	ILSTS065	52	6	4.18	1.56	0.54	0.77	0.76
19.	ILSTS058	47	24	14.07	2.85	0.72	0.94	0.93
20.	ILSTS029	46	9	1.99	1.18	0.43	0.50	0.49
21.	RM048	46	7	5.41	1.80	0.22	0.82	0.81
22.	ILSTS022	51	9	3.62	1.58	0.47	0.73	0.72
23.	OARE129	52	8	4.93	1.79	0.67	0.80	0.79
24.	ILSTS082	52	13	6.73	2.11	0.96	0.86	0.85
25.	RM4	52	5	2.35	1.03	0.44	0.58	0.57
Mean		48.5	11.92	6.00	1.92	0.50	0.79	0.78
S.E			1.15	0.62	0.10	0.05	0.03	0.03

F-statistics was applied to analyse the data obtained on microsatellite loci. The locus wise values obtained for allelic richness, gene diversity, Fis have been shown in table 6.

Table-6: Wright's F-statistic analysis for microsatellite loci in Sirohi goats

SN	Locus	Sample Size	Gene diversity	Allelic richness	Fis	p-value
1.	ILST008	48	0.52	4.32	0.76	0.01
2.	ILSTS059	52	0.89	11.42	0.18	0.01
3.	ETH225	41	0.69	7.70	0.96	0.01
4.	ILST044	48	0.77	10.38	0.43	0.01
5.	ILSTS002	51	0.89	11.39	0.23	0.01
6.	OarFCB304	49	0.92	18.57	0.27	0.01
7.	OarFCB48	50	0.92	14.87	0.26	0.01
8.	OarHH64	49	0.84	8.73	0.49	0.01
9.	OarJMP29	47	0.77	8.72	0.64	0.01
10.	ILSTS005	44	0.82	7.99	0.50	0.01
11.	ILSTS019	47	0.88	9.79	0.25	0.01
12.	OMHC1	49	0.91	15.62	0.08	0.05
13.	ILSTS087	41	0.82	7.39	0.73	0.01
14.	ILSTS30	52	0.88	10.07	0.23	0.01
15.	ILSTS34	51	0.54	8.56	0.46	0.01
16.	ILSTS033	39	0.89	19.52	0.51	0.01
17.	ILSTS049	52	0.79	9.04	0.32	0.01
18.	ILSTS065	52	0.77	5.89	0.30	0.01
19.	ILSTS058	47	0.94	18.60	0.23	0.01
20.	ILSTS029	46	0.50	7.59	0.14	0.05
21.	RM048	46	0.83	6.95	0.74	0.01
22.	ILSTS022	51	0.73	7.37	0.36	0.01
23.	OARE129	52	0.81	7.64	0.16	0.01
24.	ILSTS082	52	0.86	10.71	-0.12	0.05
25.	RM4	52	0.58	4.30	0.24	0.01

Table-7: Bottleneck analysis for microstellite loci in Sirohi breed of goat

Locus*	Sample size	Observed He	Model					
			IAM		TPM		SMM	
			Heq	Prob	Heq	Prob	Heq	Prob
ILST008	48	0.52	0.51	0.43	0.59	0.23	0.66	0.06
ILSTS059	52	0.88	0.81	0.06	0.86	0.26	0.89	0.28
ETH225	41	0.68	0.69	0.38	0.75	0.17	0.80	0.02
ILST044	48	0.77	0.80	0.23	0.85	0.03	0.88	0.00
ILSTS002	51	0.89	0.80	0.03	0.85	0.15	0.88	0.46
OarFCB304	49	0.92	0.92	0.45	0.94	0.08	0.95	0.01
OarFCB48	50	0.91	0.86	0.04	0.89	0.23	0.91	0.41
OarHH64	49	0.83	0.70	0.56	0.77	0.16	0.82	0.51
OarJMP29	47	0.76	0.71	0.40	0.77	0.34	0.82	0.06
ILSTS005	44	0.81	0.72	0.12	0.78	0.33	0.83	0.32
ILSTS019	47	0.88	0.74	0.00	0.80	0.01	0.84	0.08
OMHC1	49	0.91	0.88	0.18	0.91	0.49	0.93	0.09
ILSTS087	41	0.82	0.69	0.05	0.75	0.17	0.80	0.46
ILSTS30	52	0.88	0.77	0.02	0.84	0.14	0.87	0.49
ILSTS34	51	0.54	0.76	0.03	0.82	0.00	0.86	0.00
ILSTS033	39	0.88	0.92	0.51	0.94	0.02	0.95	0.01
ILSTS049	52	0.79	0.76	0.44	0.82	0.21	0.86	0.02
ILSTS065	52	0.77	0.57	0.36	0.65	0.09	0.73	0.29
ILSTS058	47	0.94	0.91	0.08	0.93	0.46	0,94	0.24
ILSTS029	46	0.50	0.71	0.06	0.77	0.00	0.83	0,00
RM048	46	0.82	0.63	0.00	0.70	0.01	0.77	0.10
ILSTS022	51	0.73	0.70	0.48	0.77	0.23	0.82	0.02
OARE129	52	0.80	0.67	0.06	.74	0.20	0,79	0.48
ILSTS082	52	0.86	0.79	0.17	0.85	0.43	0.88	0.12
RM4	52	0.58	0.51	0.41	0.59	0.37	0.67	0.12

Finally, the bottleneck hypothesis was investigated.The test for the departure from mutation drift equilibrium was based on heterozygosity excess or deficiency. It compared heterozygosity expected at Hardy Weinberg equilibrium to the heterozygosity expected (Heq) at mutation drift equilibrium in a sample that had the same size and the same number of alleles. All the three models i.e. IAM (Infinite Allele Model, TPM (Two Phase Model) and SMM (Stepwise Mutation Model) were used to calculate the Heq and the values are given in table 7.

The observed and effective number of alleles at 25 microsatellite loci varied from 5 (ILST008, RM4) to 25 (Oar FCB 304) and from 1.92 (ILST 008) to 14.07 (ILSTS058) respectively. The average Shannon's information index of 1.92 indicated high polymorphism across the studied loci. Set of 25 microsatellite markers was found suitable to study the biodiversity because all the markers meet the criteria of minimum 4 number of alleles per locus (table 5). The average observed and expected heterozygosity across the loci were 0.50 and 0.79 respectively (table 5). All the loci under study deviated significantly from Hardy Weinberg equilibrium. The allelic richness varied from 4.30 (RM4) to 19.52 (ILSTS033). F-statistic analysis revealed heterozygote deficit of 0.24. All the loci except ILSTS082 were heterozygotic deficit ($p < 0.05$). Moderate and higher values of observed heterozygosity and heterozygositc deficiency respectively indicated towards inbreeding in the population. As farmers maintain less number of breeding bucks in the flock and only aggressive buck is able to serve most of the flock, the chances of inbreeding increases in the population. The other possible reasons for heterozygotic deficiency could be the segregation of non amplifying alleles, Wahlund effects (presence of subpopulations) and locus under selection but it is difficult to distinguish among these factors (Christiansen et al., 1974). The population analysis based on microsatellite markers revealed substantial genetic variation in the population which may be exploited for further improvement of the breed through appropriate breeding strategies.

11. Conclusion and Recommendations

Sirohi breed forms an important component of livestock of the Rajasthan state. The animal is utilized as a multipurpose animal and has been used as an improver breed. It has made its place in the rural economy by replacing the other non descript type of goats. The animal was found in different colour variants. The uniform brown coloured animals (also called Parbatsari) were observed to have better body metrics. Because of the varied colour patterns Sirohi goats have ornamental value and are in great demand at the festive occasions. The farmers get a handsome amount by selling the bucks at such occasions. To maintain the purity of this breed it is desired to practice the pure breeding by using the elite bucks. The farms established to rear the breeding bucks are doing a great service in maintaining the purity of this breed. Genetic improvement of field stock through Network project, AICRP or Open Nucleus Breeding Scheme should be encouraged. Development of Breed society can help in conservation and sustainable utilization of this important breed. Sirohi goat breeders may be encouraged to maintain proper production and reproduction data so that suitable consultancies can be provided by the experts on the problems faced by the breeders. Elaborative molecular research approach may be taken up to identify the elite animals with useful genes and use them to propagate the breed and also to improve the non descript type of goats of that region.

References

Acharya, R.M.(1982) . Sheep and Goats breeds in India. F.A.O. Animal Production and Health Paper No. 30, F.A.O., Rome

Acharya, R.M. (1988). Goat meat production in Asia. Proccedings of workshop held in Tandojam, Pakistan. 13-18 March, 1988. pp 14-29.

AICRP on Goat Improvement (Sirohi field unit). Annual report, 2004-05, Livestock Research Station Vallabhnagar, Directorate of Research, Maharana Pratap University of Agricultural & Technology, Udaipur (Rajasthan).

Arun Kumar, A.K.S. Tomer, B.S. Mehta and A.L. Arora (2003). Variability in replacement rate and its components in Sirohi goats of Rajasthan. Indian J. Anim. Sci. 73(7): 798-801.

Barhat, N.K. and Chowdhary, M.S. (1977). Factors affecting some production traits in Rajasthani goats. NDRI Publication No. 77-91.

Botstein, D., White, R.L. Skolnick, M and Davis R.W. (1980) Construction of a genetic linkage map in man using restriction fragment length potymorphisms. Am J. Hum. Genet. 32: 314-331

Chandramouli, D; Subbarama Naidu, A., Sarjuna Rao, K and Sheshagiri Rao, K. (1992) Goats and Sheep management practices. Proc. Meat and Slaughter House By - products Handling systems, CLR, Madras, India. 15-17 July, 1992.

Christiansen, F.B, Frydenberg O, Gyldenholm, S.O. and Simonsen, V (1974) Genetics of Zoarces populations VI. Further evidence, based on age group samples, of a heterozygote deficit ESTIII polymorphism. Heriditas 77: 225-236.

Cornuet, J.M., Luikart, G. (1996) Description and power analysis of two tests for detecting recent populaton bottlenecks from allele frequency data. Genetics 144: 2001-2014.

Dharam Singh, (2005). Factors affecting lactation traits in Sirohi goats maintained under semi- intensive system. Proceedings of VIII National Conference on Animal Genetics and Breeding, 8-10 March, 2005, pp58.

Jinger, S.C., Pathodiya, M.L., Gurjar, M.L. and Brijendra Singh (2005) Preweaning Growth in Sirohi kids under field condition. Proceedings of VIII National Conference on Animal Genetics and Breeding, 8-10 March, 2005, pp53.

Kimura, M and Crow, JF (1964) The number of alleles that can be maintained in a finite population. Genetics 49, 725-738.

Neeru, Dharam Singh, Puneet Kumar and A.K. Goel (2003) Factors affecting postpartum oestrus interval in goats. Indian I Anim. Sci. 73 (4) : 408-409.

Neeru, Dharam Singh and Puneet Kumar (2004). Factors affecting birth weight of kids in Indian goats. Indian J. Anim. Prod. 36(1-4): 32-35.

Nei, M. (1973) Analysis of gene diversity in subdivided populations Proc. Natl. Acad Sci. USA 70: 3321-3323

Ohta T and Kimura M (1973) A model of mutation appropriate to estimate the number of elctrophoretically detectable alleles in a finite population. Genet. Res. Camb. 22: 201 – 204.

Pathodiya, O.P., Khadda, B.S., Gurjar, M.L. and Tailor, S.P. (2004) Some economic traits of Sirohi goats in field conditions. Indian J. Anim. Sci.74(1): 102-103.

Prakash , C., Acharya, R.M. and Dhillon, J.S.(1971). Indian J. Anim. Sci. 41: 356 .

Prasad, S.P. , Roy, A. and Pandey, M.D. (1972). Agra Univ. J. of Res. , 20 : 31

Sambrook, J. Fritisch, EF and Maniatis, T. (1989) Molecular cloning: A laboratory manual 2nd ed Cold spsringer Harbour, cold spring Laboratory Press, NY

Singh, N.P. (2004). Supplementary feeding of Sirohi goats durng pregnancy and lactation. . Indian J. Anim. Prod. 36(1-4): 36-39.

Verma, N.K., Dixit, S.P. and Ahlawat, S.P.S. (2005) Jakhrana Goat- A precious dairy germplasm of semi arid region. Indian Dairy man 57(7): 63-67.

Yeh Francis, C., Yang, R.C., Boyle, Timothy, B.J., Ye H and Mao Jndyx (1999) Popgene version 1.32, the user friendly shareware for population genetic analysis, Molecular Biology and Biotechnology Centres University of Alberta, Canada, (http://www.ualberta.ca/fych/fych.

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