Sheep Genetic Resources of India

MAGRA SHEEP

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Monograph No. 112/2018

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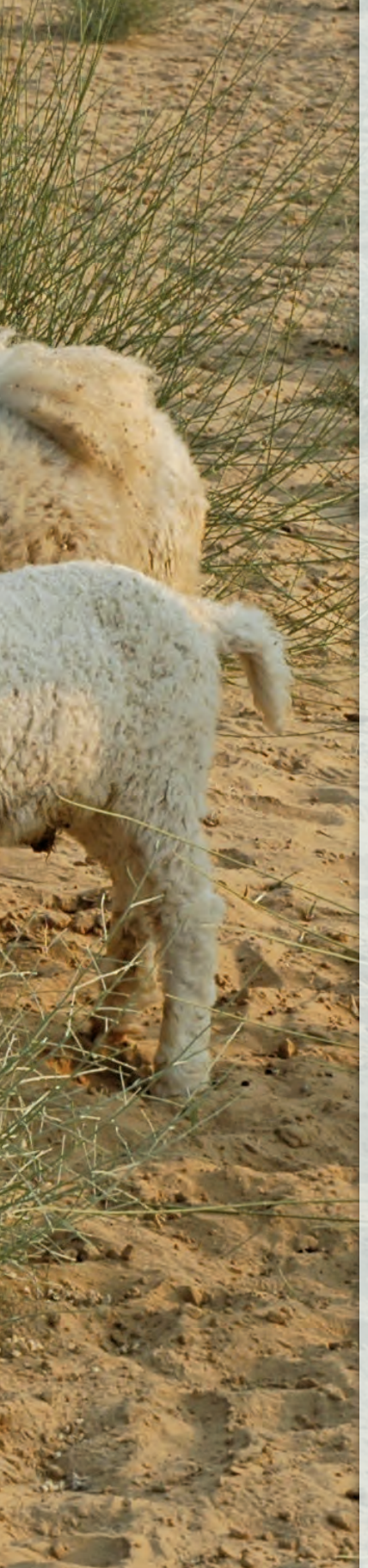
Published by: Director, ICAR-NBAGR, Karnal-132001 (Haryana)

Cover Design and Concept: Dr.

Printed by: Intech Printers and Publishers, Karnal

ISBN: 978-93-83537-41-9



PREFACE

Good understanding of livestock genetic resources is necessary for their maintenance, improvement and utilization. Since breed is the basic unit of a livestock species, therefore, importance of characterization of a breed under the agro-climatic conditions of its habitat is well recognized. It is better to undertake phenotypic and molecular genetic characterization simultaneously to measure and describe the potential and genetic diversity of a breed in its totality. Breed characterization is also important to establish national inventory of AnGR for their monitoring, utilization and improvement planning. In developing countries, contribution of a breed to the livelihood of the farmers is a central criterion to decide the importance of livestock genetic resources. In India, the state of Rajasthan is known for a number of important breeds of various livestock species including eight of sheep. These breeds thrive under harsh agro-climatic conditions of the state and yet contribute significantly to subsistence of the poor farmers. Magra is a carpet quality wool producing sheep breed of the state. A document on characteristics of this sheep breed with comprehensive information was not available. Therefore, this monograph is an attempt to document phenotypic characteristic, performance and genetic diversity in Magra sheep. We are sure that this document will not only be useful to the farmers, students and research workers but also for policy planners and other stakeholders. We are thankful to the Director, ICAR-National Bureau of Animal genetic Resources, and Karnal for the logistics support. We sincerely thank the sheep farmers who not only allowed us an access to the flocks but also provided information on household and sheep management practices.

Authors

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Introduction

~~In India Climatic conditions of Rajasthan state are characterized by low and uncertain rainfall in majority geographical area.~~ Therefore, water is an important and scarce resource in the state limiting the availability of fodder resources. Livestock farming in the state is an arduous task under these difficult agro-climatic conditions. Sheep, with high physical endurance, is a vital component of animal farming in the state contributing substantially to the income of the farmers. With 9.08 million sheep, which constitute about 14% of 65.07 million sheep population of the country, the state ranks at number 3 followed by the states of Andhra Pradesh and Karnataka (DAHD&F, 2012).

Of the 42 registered sheep breeds in India, eight are found in the state of Rajasthan comprising Nail, Chokla, Malpura, Sonadi, Marwari, Jaisalmeri, Magra and Pugal Chokla and Magra produce fleeces of fine carpet quality ~~fine carpet;~~ Nali of medium carpet quality; Jaisalmeri, Pugal and Marwari medium to coarse carpet quality fleece, whereas, Malpura and Sonadi are large sized breeds reared primarily for mutton production and produce very coarse fleeces. Kheri and Chitarangi are other important sheep populations of the state, besides the registered breeds. A recent study revealed that Chitarangigood growth, promising reproduction rate and produces fleeces of fine carpet quality. The animals of Chitarangi sheep phenotypically resemble those of Magra ~~breed~~ except ~~that Chitarangi animals are large in size with long ear pinna.~~ Kheri sheep has been developed by the migratory sheep breeders of the state by integrating adaptation trait of its progenitor Marwari sheep to trek long distances during migration with comparatively more body weight and lamb growth.

~~Most of the sheep breeds in Rajasthan thrive under the~~ scarcity of feed, fodder and water yet contribute significantly to the livelihood, employment and income of the farmers. Magra sheep inhabits Bikaner district of the state which lies in Arid Western Zone of the state. In Magra distribution area, sheep is reared by all communities including socially ~~unprivileged~~ as well as ~~advantaged~~ farmers.

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Data collection and analysis

Survey was undertaken in Bikaner, Lunkaransar and Nokha tehsils of Bikaner district using purposive sampling. Information related to morphological characterization and evaluation of Magra sheep were collected from 50 farmer flocks having about 5900 sheep. Relevant information were collected though interactions with the farmers and on the spot recording. Structured questionnaire was developed for recording of the information on socio-economic status of the farmers, management practices and health care, morphology and body biometry, breeding and reproduction, and disposal of live animals and various products.

Fig: Information recording from the farmers

fig 1

Data pertaining to body weight and body biometry were recorded on 406 ewes, 170 rams, 190 male lambs and 158 female lambs. The adult sheep were of 2-tooth to 8-tooth of age. Age was recorded using the dentition method because natural patterns of eruption of deciduous and permanent incisors in sheep are strongly related to age of the animals. Age of the lambs was recorded by making

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enquiries from the farmers along with on the spot judgment. Sick animals and pregnant ewes were excluded from the study. A 100 kg circular dial hanging balance with a least count of 0.5 kg was used to record the body weight (BW). Different body dimensions were measured using a steel tape and restraining the animal squarely on the ground in an unforced position. The body biometry measurements were recorded to the nearest centimeter. The traits measured included body length (BL), height at withers (HW), chest girth (CG), paunch girth (PG), ear length (EL) and tail length (TL). The body measurements were measured as described by Taye *et al.* (2010). The statistical analysis was done using LSMLMW software package(Harvey, 1990). A mixed model was used wherein the age effect was taken as fixed and flock effect as random. For estimating body weight in lambs, sex wise scatter diagrams were plotted by taking age along the x-axis and body weight along y-axis. A regression equation was then fitted.

For genetic analysis, genomic DNA was isolated and purified from 40 random blood samples using the standard phenol chloroform extraction method. Genetic variation was assessed in using a panel of 25 microsatellite markers recommended for sheep (Table 1, Bradley *et al.* 1997; Di Stasio 2001). The forward primer for each marker was fluorescently labeled with either FAM, NED, VIC or PET. Polymerase Chain Reaction (PCR) was carried out in a 25 µl of final reaction volume containing at least 100 ng of genomic DNA, 5 pM of each primer, 1.5 mM $MgCl_2$, 200µM dNTPs, 0.5 U *Taq polymerase* and 1x buffer. A common touchdown PCR programme was used for amplification. The 25 markers were divided into five multiplexes with five markers in each plex. The thermal touchdown profile used for amplification was as follows: 3 cycles of 45 sec at 95 °C, 1 min at 60 °C; 3 cycles of 45 sec at 95 °C, 1 min at 57 °C; 3 cycles of 45 sec at 95 °C, 1 min at 54 °C; 3 cycles of 45 sec at 95 °C, 1 min at 51 °C and 20 cycles of 45 sec at 92 °C, 1 min at 48 °C. Amplified products were checked on 2% agarose gel and the genotyping was carried out on an ABI 3100 automated DNA sequencer using LIZ 500 as the internal size standard. Allele sizing was performed using

Table 1. Primer sequences, type of repeat, size range, location and accession numbers of the used microsatellites

Locus	Primer sequence	Type of repeat	Size range (bp)	Chr. no.	GenBank Acc. no.
BM757	tggaaacaatgtaaacctggg ttg agc cac caa gga acc	$(GT)_{17}$	178-198	9	G18473
BM827	gggctggtcgtatgctga g gttggacttgctgaagtgacc	-	214-224	3	U06763
BM1314	ttcctcctcttctctccaaac atctcaaacgccagtgtg g	-	141-161	22	G18433
BM6506	gcacgtggtaaa gag atggc agcaacttgagcatggca c	-	189-199	1	G18455
BM6526	cat gccaaacaa tat ccagc tga agg tag aga gca agc agc	-	140-170	26	G18454
BM8125	ctctatctgtggaaaaggtgg g gggggt tag act tcaacatac g	-	105-121	17	G18475
CSRD247	ggacttgccaga act ctgcaa t cac tgt ggt ttg tat tag tca gg	$(AC)_n$	203-237	14	EU009450
CSSM31	cca agt tta gta ctt gta agt aga gac tct cta gca ctt tat ctg tgt	$AAAA(CA)_7TA(CA)_{25}$	162-182	23	U03838
CSSM47	tctctgtctctatcacta tat ggc ctgggcacctgaaac tat cat cat	$(TG)_{12}TATGTA(TG)_4$	120-160	2	U03821
HSC	ctgccaatg cag agacacaag a gtctgtctcctgtcttgt cat c	-	267-285	20	M90759
INRA63	gaccacaaagggatttgcacaagc aaacca cag aaatgcttggaa g	$(AC)_{13}$	165-203	14	X71507
MAF214	aatgcagga gat ctgagg cag gga cg gggtgatct tag ggaggttttggagg	-	187-231	16	M88160
OarAE129	aatccagtgtgtgaaagactaatc cag gta gat caa gat ata gaa tat ttt tca aca cc	$(AC)_{14}$	141-169	5	L11051
OarCP20	gat ccc ctg gag gag gaa acg g ggcatttcatggctt tag cag g	$(AC)_{14}$	67-79	21	U15695
OarCP34	gctgaacaatgtgatatgttcagg gggacaatactgtct tag atgctg c	$(AC)_{17}TTGCGTGT(CA)_4$	108-122	3	U15699
OarCP49	cag acacggcttagcaactaaacg c gtggggatgaatattccttcataagg	$(AC)_{17}$	80-110	17	U15702
OarFCB48	gag ttagtacaaggatgacaa gag gca c gactctagaggatcgcaaagaaccag	$(TG)_{11}CA(TG)_3$	142-164	17	M82875
OarFCB128	cag ctgagcaactaagacata cat gcg attaaagcatcttctctt tat ttcctcgc	$(GT)_6GC(GT)_{15}$	97-123	2	L01532
OarHH35	aattgcatt cag tatctttaa cat ctggc atg aaa ata taa aga gaa tga acc aca cgg	$(TG)_{17}$	111-139	4	L12554
OarHH41	tccacaggcttaaatcta tat agcaac c ccagctaaagataaaagatgatgtgggag	$(AC)_{23}$	118-140	10	L12555
OarHH47	tttattgacaaactctcttcctaactccac c gtagttatttaaaaaaatatcatacctcttaag g	$(AC)_{32}$	124-146	18	L12557
OarHH64	cgttccctc act atggaaagt tat atatgc cactctattgtaagaatttgaatgagagc	$(TG)_{17}$	120-134	4	L12558
OarJMP8	cgg gat gatcttctgtccaaa tat gc cat ttgctttggctt cag aac cag ag	$(gT)_n$	115-129	6	U35059
OarJMP29	gtatacacgtggacaccgctttgt ac gaagtggcaagattcagaggggaa g	$(CA)_{21}$	86-144	24	U30893
OarVH72	ctc tag aggatctggaatgcaaagctc ggcctctcaaggggcaagagcagg	$(AC)_{14}$	121-133	25	L12548

GENEMAPPER software. Allele frequencies, observed number of alleles (N_a), observed heterozygosity (H_o) and expected heterozygosity (H_e) were calculated using the GenAlex program (Peakall and Smouse, 2005). Polymorphism information content (PIC) was calculated according to Botstein *et al.* (1980). The genetic bottleneck effect was inferred for the populations using mode shift analysis under the assumption of the two-phase microsatellite mutation model, implemented in the program Bottleneck version 1.2.02 (Piry*et al.*, 1999).

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Distribution, geography and agro-climatic conditions

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Magra sheep prevails in Bikaner district of Rajasthan state, however, the pure specimen of the breed are found in south-eastern part of the district.The number of sheep in Bikaner district i.e. the Magra distribution area was 0.653million (AHD Rajasthan, Livestock Census-2012), whereas, Magra sheep population has been reported as 0.554 million (DAHD&F, 2013). This substantiates our survey results that 80 to 95% sheep in the flocks conformed to Magra breed characteristics.

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observation

Table 2: Sheep population (million)

Year	India	Rajasthan	Bikaner
1977	40.907	9.938	0.797
1982	48.765	13.431	1.079
1987	45.703	9.932	0.826
1992	50.783	12.491	0.953
1997	56.361	14.585	1.148
2003	61.469	10.054	0.929
2007	71.558	11.190	0.708
2012	65.069	9.080	0.653

The sheep population of the country, Rajasthan state and Bikaner district is given in the Table2. From 1977 to 2012, there has been a pronounced increase in the sheep population of the country,that of the Rajasthan state has decreased slightly with large fluctuations

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over the years and that of Bikaner district, which represents Magra sheep, fluctuated from 1977 to 1997 and registered a steady decline thereafter.

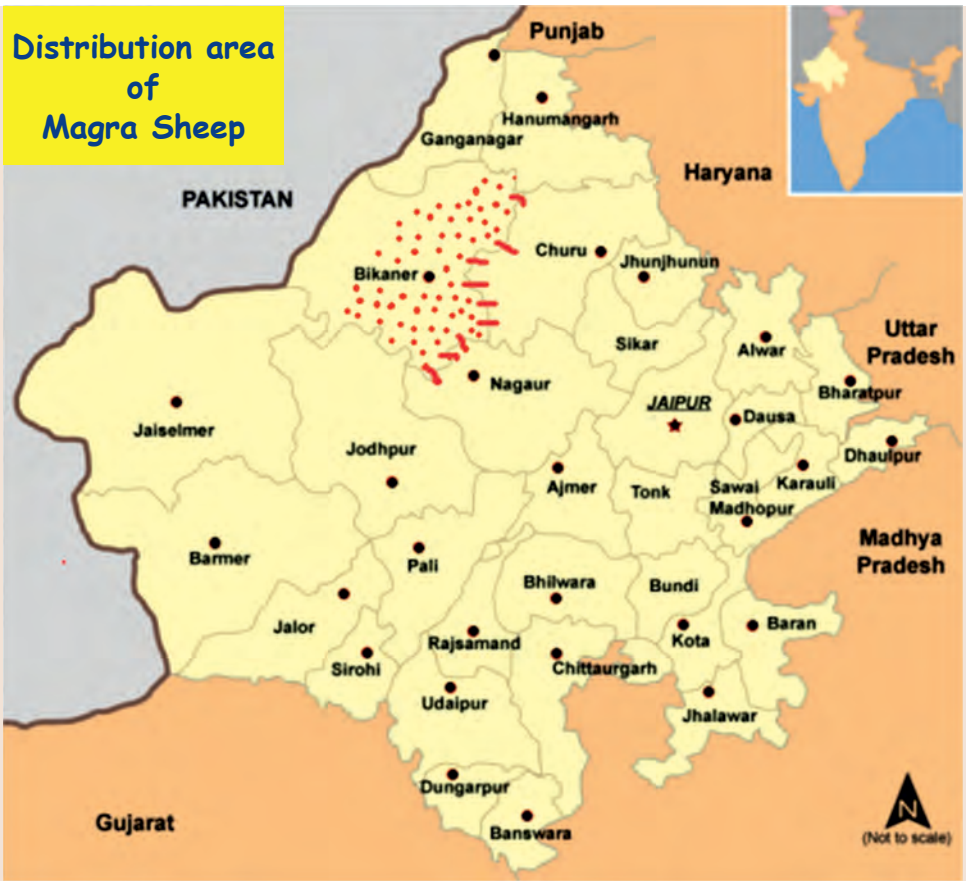
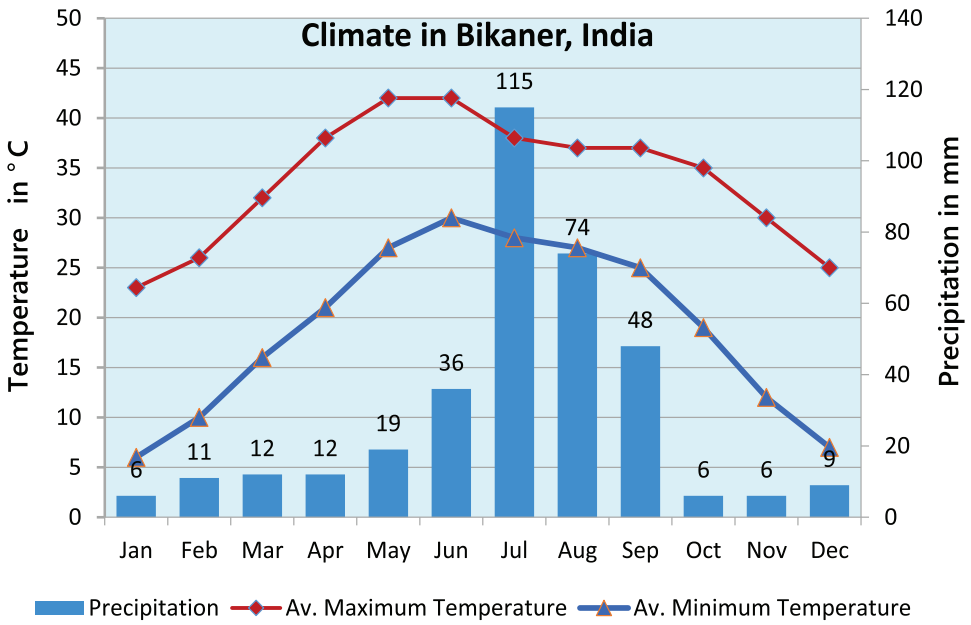


Fig: Magra sheep distribution area

Bikaner district, the breeding tract of Magra sheep, is situated at 28.0229° N, 73.3119° E in Arid Western Zone of Rajasthan state. The Indira Gandhi canal, also known as the Rajasthan canal, runs through the district from northeast to southwest, providing irrigation water for the district. Soils are calcareous throughout and soil colour ranges from reddish brown to nearly white.

The climatic conditions are depicted in the Figure. Average maximum temperature, average minimum temperature and



precipitation showed wide variations over the months of a year. The average maximum temperature ranged from 23 °C in January to 42 °C in May and June whereas the average minimum temperature ranged from 6 °C in the month of January to 30 °C in June. The weather of Rajasthan is characterized by four seasons viz. Summer (March to mid-June), Rainy (Mid-June to September), Retreating Monsoon (October to November) and Winter (December to February). The agro-climatic conditions of the district are harsh with uncertain rainfall and therefore, livestock rearing, particularly the sheep species, is the natural choice of the farmers. Singh *et al.* (2016) assessed the adaptability of Magra, Marwari and Choka sheep breeds under climatic condition of Bikaner based on effect of heat stress on the ~~hematological~~ and physio-biochemical parameters and reported that Magra sheep had highest adaptability (83.29%) followed by Marwari (80.41%) and Chokla (79.13%). They reasoned that higher adaptability of Magra sheep might be due to their white and lustrous coat which reflects more ~~sun light~~ as compared to other sheep breeds.

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remove

Chokla

hae

sunlight

The major feed and fodder resource of the region are given below:

- Trees: Khejri(*Prospis cinararia*), Babool (*Acacia arabica*), Jaal (*Salvadora oleiods*), Subabool(*Leucaena leucocephala)*, Vilayatibabool(*Prospis juliflora*).

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- Grasses: Sewan (*Lasiurus sindicus*), Anjan(*Cenchrus ciliaris*) and Dhaman (*Cenchrus setigerus)*, Dechab(*Cyperus rotundus*) and Blue Panic (*Panicum antidotale*), Murath (Panicum turgidum), Ganthia (*Dactyloctenium scindicum*).

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Fig: Feed and fodder resources ~~& fodder storage~~

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- Shrubs: Bui (*Aervato mentosa*), Phog (*Calligonum polygonoides*), Pala (*Zizyphus nummularia*), Gokhru (*Tribuluster restris*), Kheemp (*Leptospira pyrotechnica*), Kair (*Capparis deciduas*), Lana (*Haloxylon recurvum*)

caption: fodder storage

- Crops: Bajra (*Pennisetum typhoides*), Moth (*Phaseolus aconitifolius*), Moong (*Phaseolus aurens*) and Guar (*Cynopsis tetragonaloba*).

Flock Structure and management practices

The flocks of Magra sheep were large sized; the average flock size was 118 (24-310) comprising 65 ewes (14-200), 6 rams (0-30), 12 adult males (0-50) and 35 lambs (2-100). The flock purity in terms of proportion of sheep phenotypically conforming to Magra breed characteristics was 80to 95-% in majority flocks.

80 to 95%

The sheep in this area are maintained by all the farming communities including *Jat, Rajput* and *Naik*. Majority of the farmers possessed unirrigated land ranging from 7to 35 acres; less than 10% of the farmers possessed irrigated land of 2-10 acre in size. Average family size was 12.2 with a literacy rate of 38.8% in males and 16.9% in females. Besides sheep 80, 38, 98, 46, 74 and 40 percent of the farmers also maintained cattle, buffaloes, goats, camel, donkey and dogs respectively. None of the farmers maintained poultry.

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Sheep are housed in the open courtyards. The walls of the courtyards were 4-6 feet in height and made from mud or thorny bushes. The sheep are penned in the courtyards during hot hours of the day in summer and during night in winter season. The young lambs are in hut like structures made from mud with conical roof when adult animals are out for grazing. However, when the adult animals are in the pens, the lambs also stay with them. During migration the sheep are penned in the open.

hutlike

Fig: A sheep farmer's house.

The sheep are grazed from 6 am to 8 pm, but are rested during the hot hours of the day in summer. Grazing during the early morning hours from about 4 am to 9 am and the late evening from 5 pm onward for about 2-3hoursiswasa common practice. All the shepherds were male with their age ranging from 18 to 50 years. The sheep are watered once (noon), twice (morning and evening) or thrice (morning, noon and evening) in a day depending upon theseason. The flocks walked about 12-15 km in a day while grazing. The sheep graze on natural pastures in

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Fig: Housing of sheep and lambs

Fig : A flock in the grazing area

winter. Feeding on tree loppingis a routinepractice. The flocks are supplemented with straw duringrains and lean periods of the year. The major trees, shrubs, grasses and crops of the area are mentioned above. Rams, pregnant ewes, lactating ewes and lambs aresupplemented with concentrate (*bajra, guar, groundnut, moth*), pods and leaves (*khejri, subabool and babool*) and straw (*bajra, groundnut, guar, moth*). Most of the flocks migrated to the state ofHaryana and Punjab in March/April and returned to their homestead in July/August with the onset of monsoon.

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Disease prevalence and mortality

Enterotoxaemia and sheep pox were the common diseases against which vaccination was practiced. Various broad spectrum antihelminthics (*Nilverm, Panacure, Albendazole* etc.) wereused for prevention and control of endoparasitic infestation. The mortality rate ranged between5-20% in adults and 10-15 % in lambs. Themortality rates of23.4% inadultsand 29% in lambsreported by Tyagi (1965) were higher as compared to those in the present study.Jat*et al.* (2005) reported the morbidity rate of 34.63, 25.63 and 16.01 in 0-3, 3-6 and 6-12 months of age groupsrespectivelyin Magra sheep. Theyreported that the morbidity was highest due to pyrexia/PPR(9.2%), followed by conjunctivitis (8.58%), diarrhea (7.64%) and pneumonia (2.18%) in 0-3months age group; due to diarrhea (9.05%) followed by conjunctivitis (5.56%) and pyrexia/PPR in 3-6 months age group; and due to miscellaneous causes (6.46%), followed by diarrhea (3.65%) and conjunctivitis (3.09%) in 6-12 months of age group.

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add 16.01%

Morphology and body biometry

Magra animals are medium to large-sized and well built. The coat color is white. Face is white with brown patches around the eyes, the characteristic of this breed. The *RaataChakria/ Chakria* names of the breed are derived from this characteristic. The breed is also known as *Boochi, BoochiKan, Magreti* and *Bikaneri Chokla*. Nose line is straight. The brown patches may extend up to nostrils in a few animals. Muzzle is pink. Earpinna are small to medium and tubular.

Ear-pinna

Fig: A Magra ram

Fig: A Magra ewes

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Fig: Face of Magra sheep

Fig: Posterior region of Magra Ewe

The names *boochi* and *boochikan* are derived from the shape of the ear-pinna. Average ear length was 6.5±0.24 and 6.9±0.15 cm in adult males and females respectively. Both the sexes are polled. Wattles are absent. Body is deep with medium sized legs. The hooves are brown or mixture of brown and gray colours. The hooves are wide apart which may be an adaptation to walk over the sandy soils of Bikaner. Tail is thin and medium sized. Average tail length was 21.5±0.2 and 20.2±0.2 cm in adult males and females respectively. Fleece is of medium carpet quality, lustrous white and not very dense. Face, belly and legs are devoid of wool.

Table: Least Square means of body weight and biometry in Magra sheep

Trait	~~Rams~~ Male		~~Ewes~~ Female	
	Mean	Range	Mean	Range
BW (kg)	38.6±0.79 (167)	25-52	30.2±0.42 (401)	19.5-43
BL (cm)	66.2±0.66 (167)	54-76	61.6±0.36 (401)	50-70
HW (cm)	66.6±0.61 (167)	55-76	62.9±0.26 (401)	55-80
CG (cm)	79.5±0.71 (167)	66-90	74.5±0.39 (401)	58-96
PG (cm)	87.2±0.98 (167)	70-101	81.3±0.66 (401)	60-98
EL (cm)	6.5±0.24 (167)	3-10	6.9±0.15 (401)	3-12
TL (cm)	21.5±0.20 (167)	11-28	20.2±0.21 (401)	9-27

The average body weightswere 30.2±0.4 and 38.6±0.7 kg in ewes and rams in farmers' flocks. Lower body weights of24.36±0.45 and 26.85±0.48 kg were reported by Acharya (1982) in Magra ewes and rams, respectively. The least-squares means for various body biometry traits are given in the Table. Acharya (1982) reported higher values of65.55±0.31 cm and 81.64±0.51 cm for body length and chest girth respectively in adult females, whereas, the height at wither was of similar magnitude. In adult males, lower values were reported for chest girth and height at wither when compared with the least squares means obtained in the present study. The effect of flock was highly significant (P< 0.01) on BW, BL, HW, CG and PG both in ewes and rams. The effect of age was highly significant in rams on all the traits (p<0.01), but in ewes it was highly significant on BW and CG, significant (p<0.05) on BL

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and non-significant on HW and PG. Therefore, it can be inferred that body weight and biometry traits can be improved through improved management in Magra sheep.

High phenotypic correlations were observed among BW, BL, HW, CG and PG traits in Magra adult males and comparatively lower in adult female. Body weight had highest correlation with CG followed BL, HW and PG in males. The high correlation of body weight with other body biometry traits indicates acumen of the sheep farmers for selection of breeding rams based on body size. The correlations with ear length and tail length were low in both the sexes.

Table: Phenotypic correlation among various traits in Magra sheep

	BW	BL	HW	CG	PG	EL	TL
BW		0.74	0.59	0.84	0.55	-0.09	0
BL	0.48		0.51	0.64	0.41	-0.11	-0.01
HW	0.36	0.35		0.6	0.22	-0.01	0.09
CG	0.61	0.27	0.23		0.55	-0.1	-0.07
PG	0.61	0.22	0.14	0.49		0.04	-0.02
EL	0.06	0.06	0.05	0.04	-0.04		0.06
TL	0.16	0.04	0.17	0.05	0.05	0.13	

Note: The coefficients above the diagonal are for male and below the diagonal for female

Genetic diversity

All the microsatellite loci amplified well and were observed to be polymorphic with ≥5 alleles per locus. The mean polymorphism information content (PIC) value (0.741) reflected high level of genetic variability and utility of the markers used (Fig…). Following the criteria of Botstein *et al.* (1980), in the present study 92% of the markers were highly informative (PIC >0.5) while 8% were moderately informative with 0.25<PIC<0.5. The most polymorphic locus was INRA63 and CSSM47 was observed to be the least polymorphic.

Table: Genetic diversity indices in Magra sheep across 25 microsatellite markers

Locus	Na	Ne	Ho	He
BM0757	9	4.984	0.750	0.799
BM827	7	3.450	0.553	0.710
BM1314	8	5.838	0.278	0.829
BM6506	7	2.852	0.550	0.649
BM6526	13	5.461	0.718	0.817
BM8125	8	1.998	0.525	0.499
CSRD247	9	3.543	0.600	0.718
CSSM31	9	5.461	0.655	0.817
CSSM47	8	1.892	0.258	0.471
HSC	9	5.042	0.811	0.802
INRA63	15	11.351	0.923	0.912
MAF214	9	4.857	0.912	0.794
OarAE129	11	5.178	0.750	0.807
OarCP20	10	2.540	0.605	0.606
OarCP34	8	4.272	0.769	0.766
OarCP49	15	8.767	1.000	0.886
OarFCB48	11	5.793	0.788	0.827
OarFCB128	9	5.165	0.667	0.806
OarHH35	10	5.776	0.575	0.827
OarHH41	8	5.531	0.824	0.819
OarHH47	11	6.549	0.684	0.847
OarHH64	5	2.914	0.237	0.657
OarJMP08	9	5.424	0.775	0.816
OarJMP29	14	6.794	0.825	0.853
OarVH72	7	5.576	0.757	0.821
Mean	9.560	5.080	0.672	0.766

Na : allele number; Ne :effective allele number;

Ho: observed heterozygosity; He: expected heterozygosity

The allele size range of the loci was in agreement with that of the loci investigated earlier in other Indian sheep breeds (Arora *et al.* 2011a; b; c). High level of genetic variation was observed within the Magra sheep samples as assessed from various genetic diversity measures (Table…). The number of alleles observed at a locus is an indication of genetic variability at that locus having

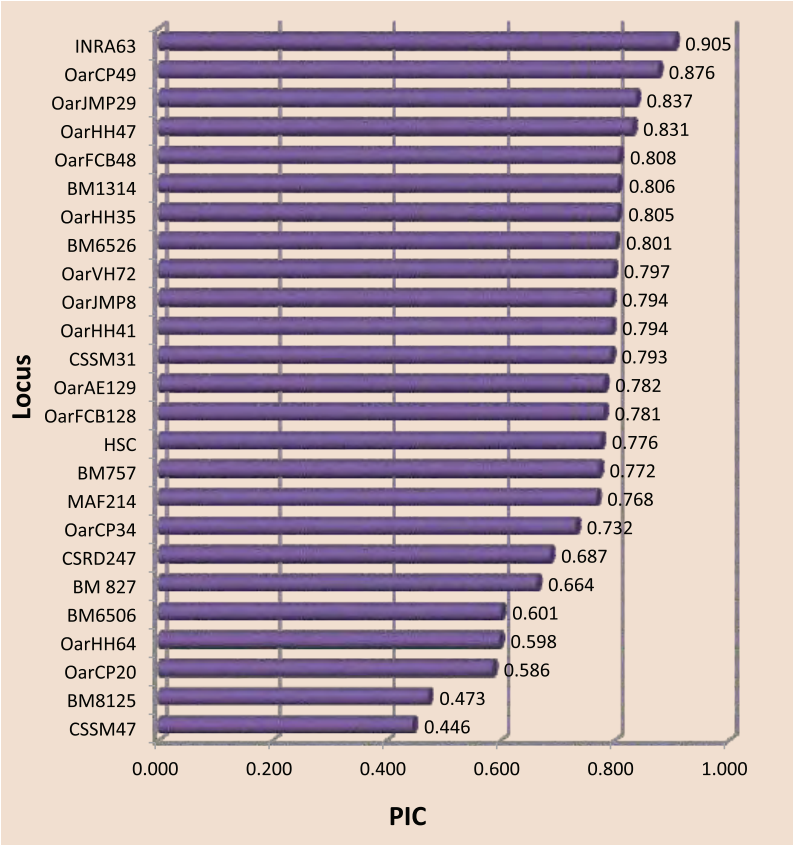


Figure. Polymorphism information content (PIC) of 25 microsatellite markers in Magra sheep

direct impact on differentiation of breeds within a species. In total 239 alleles were detected across 25 microsatellite loci that were typed. The number of observable alleles at each locus ranged from 5 (OarHH64) to a maximum of 15 (INRA63, OarCP49) in this breed. The mean number of alleles was 9.56 across these loci. The effective number of alleles, being lower than the observed number of alleles ranged between 1.892 (CSSM47) to 11.351 (INRA63). The average observed heterozygosity was less than the expected. The intrapopulation observed heterozygosity ranged from 0.237 (OarHH64) to 1.0 (OarCP49). The expected heterozygosity per locus varied from 0.471 (CSSM47) to 0.912 (INRA63) in Magra sheep. The values of mean observed heterozygosity and gene

diversity (mean expected heterozygosity) of 0.672 and 0.766 were relatively similar to those of other domestic sheep breeds investigated earlier (Arora *et al.* 2011a, b, c). The results show that Magra sheep breed possessed a high level of genetic diversity.

Bottleneck analysis

The programme BOTTLENECK was used to test for bottlenecks in the recent breeding history of this sheep population. The typical L-like distribution of the allele frequencies obtained in the Mode shift test (Cornuet and Luikart 1996) strongly indicated that a recent bottleneck was very unlikely (Fig....). This finding clearly suggested absence

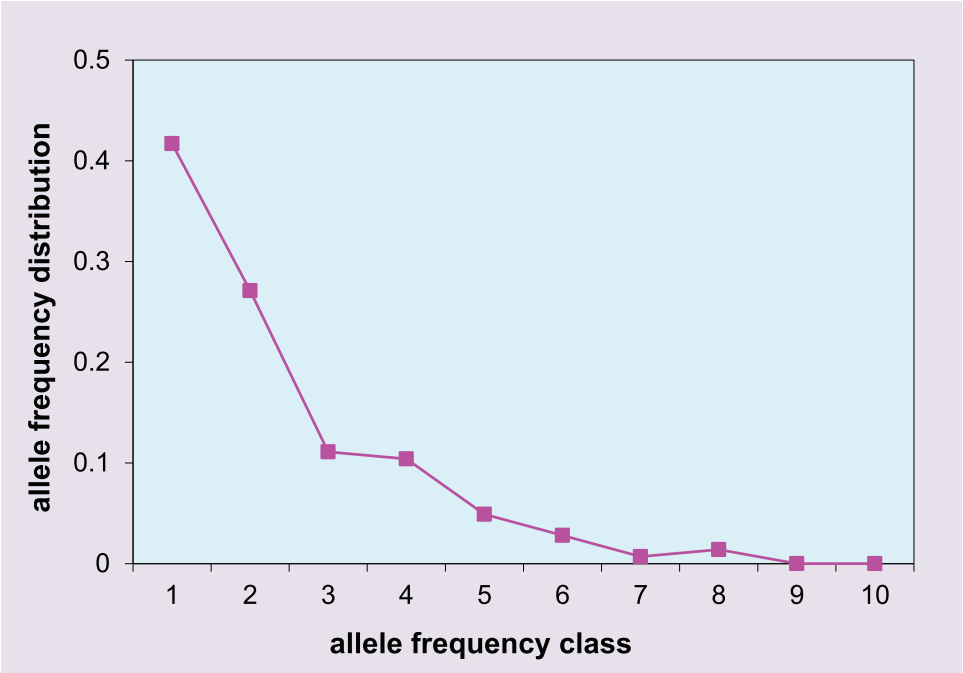


Figure : Normal L-Shaped curve depicting no Mode-shift in Magra sheep.

of a recent reduction in the effective population size or a genetic bottleneck. The absence of genetic bottleneck in the experimental population is consistent with the results of similar studies on sheep breeds of India (Arora and Bhatia 2009; Arora *et al.* 2011b).

Breeding and reproduction

Rams are selected for body size, body conformation, and soft wool. This indicates that the sheep farmers are selecting the breeding rams based on a selection index combing the traits of economic importance. This is done on visual appraisal without any recording or mathematical calculations; their experience must have endowed them with enough insight to consider the traits of economic importance and giving an appropriate weightage. Most of the sheep farmers maintain breed purity and take into consideration breed characteristics (ring around the eyes, stumpy ears and small tail) while selecting the breeding males. Age at first breeding ranged from 18 to 24 months in rams. A ram is used for 2-5 years for breeding the ewes. Acharya (1982) has reported selection of males on the basis of wool production and exchange of rams with other sheep farmers to avoid inbreeding.

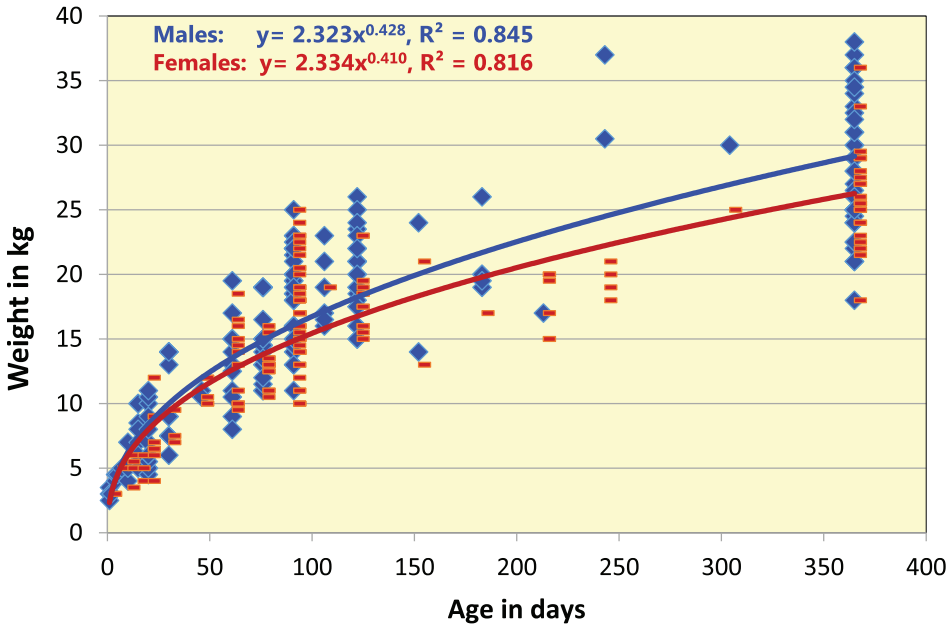
add caption

November to January is the major lambing seasons corresponding to June to July breeding season indicating that the breeding starts

with the onset of the monsoon. July-August was reported as the minor lambing season. In ewes, age at first lambing was 18-24 months. Lambing percent ranged between70-80–% with a lambing interval of about 15 months. Considering the availability of nutritious species of herbs, shrubs and trees in the field, the lambing rate can be improved up to 90% with better feeding and management practices.However, concerted efforts are required for pasture development and tree plantation as long-term planning. The lambing rate was reported as 79.23% in field flocks and 85.00% in farm flocks on the basis of ewe available in Magra sheep (ICAR-CSWRI, 2018).In lactating ewes, the daily milk yield was reported tofrom 250 to 500 ml with the lactation length of 90-120 days. The milk is sucked by the lambs and the ewes are not milked for human consumption.

Body weight in lambs

The body weight, age and sex of the lambs were recorded on 190 male and 158 female lambs from the farmers' flocks. Sex wise scatter diagram were plotted by taking age along the x-axis



and body weight along y-axis and regression equations were then fitted. Fig.... depicts the regression equations fitted for estimating body weight in lambs. The power equations were the best fit and explained 84.5 and 81.6-% variation in body weights of male and female lambs respectively. Body weights at 3, 6 and 12 months were estimated using the best fitted equations. The estimated body weight are depicted in Table....Birth weight are the weights measured from the sheep flocks. Table: Estimated body weights of lambs in Magra sheep.

space

table heading

Age	Male	Female
Birth	3.0	3.0
3-month	16.0	14.8
6-month	21.6	19.8
12-month	29.0	26.2

The estimated body weights at birth, 3, 6 and 12 months of age were 3.0, 16.0, 21.6 and 29.0 kg in male and 3.0, 14.8, 19.8 and 26.2 kg in female lambs respectively. The least-squares means for body weight reported under the farm management conditions at CSWRI, Bikaner at birth, 3, 6 and 12 months of age were 3.10±0.01, 16.21±0.10, 24.80±0.15 and 32.04±0.17 kgin male and 2.95±0.01, 14.60±0.10, 21.32±0.15 and 26.94±0.15 kg in female lambs respectively (Narula*et al.* 2009), which were similar to the body weight estimated in present study except higher body weights at 6 month and 12 month of ages in male lambs.The body weights reported by Dass*et al.* (2004) under the same farm management period were lower than those reported by Narula*et al.*(2009). The effect of year were reported to be significant in both the studies indicating that fluctuating agroclimatic conditions over the years and availability of feed and fodder might be responsible for variations in body weights.

equal size for all ±

space

Production and marketing

Magra breed is known for fine carpet quality wool production. The wool is white and lustrous and fetches good price among the Rajasthan wools. The animals are shorn thrice a year in March, July and November. The greasy wool production ranged from

1.5 to 2.5 kg per annum in three clips. The wool from March clip was reported to fetch more price. The wool production under the field conditions in Magra sheep at Kotra, Kanasar, and Jalwalicentres was reported as 678.74±-4.34 g, 688.56±15.69 g and 678.89±5.58 g (Spring clip), 553.16±5.02 g, 538.27±10.79 g and 541.90±11.12 g (Autumn clip), and 555.31±7.32 g, 537.50±9.77 g and 513.64±22.95 g (Winter clip) and having fibre diameter, medullation and staple length of 36.17±0.49 µ, 42.27±1.78% and 5.66±0.09 cm (NWPSI, Annual Report, 2014-15). The annual wool production reported earlier under the farm management conditions was 1.81 ± 0.03 kg with a fibre diameter, medullation and staple length of 32.89±0.25 µ, 51.58±2.04-%, 6.85±0.09 cm respectively (CSWRI, Annual Report-2005).

all ± eual size

Fig: Magra sheep wool

Though Magra is a carpet wool producing sheep, but the major income of the farmersis from sale of live animals. About 70% of the farmers reported sale of surplus male lambs at around 12 months of the age while the remaining 30% at the age of 6-7

months. The rams were sold after having been used for breeding for 2-5 years. Similarly, the old ewes of 7-8 years of age are also disposed off. The live animals were sold to the traders. Majority of the farmers used sheep droppings for fertilizing their own agricultural fields. However, a few farmers sold the sheep droppings to other farmers.

Central Wool Development Board, Jodhpur, Rajasthan is implementing Sheep and Wool Improvement Scheme, Sheep Breeders Insurance Scheme and Sheep Insurance Scheme. Similarly, Animal Husbandry Department, Government of Rajasthan is implementing a number of programmes like promoting small animal farming, disease control and prevention by providing services at farmers' doorsteps, appropriate deworming schedules, support to migratory flocks and pastoralists, providing market for sheep and wool, etc. These schemes and programmes may help a long way in enhancing Magra sheep production and improvement.

Conclusion and recommendations

The agro climatic conditions of Bikaner district of Rajasthan are apt for animal production including sheep farming. The region is endowed with various nutritious species of herbs, shrubs and trees which help sustenance of livestock species during the lean periods. Magra sheep is well adapted to the agro-climatic conditions of the region and contributes to the subsistence of the poor farmers.

The values of mean observed heterozygosity and gene diversity revealed that Magra sheep breed possessed a high level of genetic diversity. Typical L-like distribution of the allele frequencies obtained in the Mode shift test clearly suggested absence of a genetic bottleneck or recent reduction in the effective population size.

The lustrous fine carpet quality wool fetches premium price as compared to wool from other sheep breeds in the state. Sale of surplus lambs, old ewes and rams is major source of income of the sheep farmers. Sheep droppings are used to enhance the soil

fertility of agricultural field or is a source of income for land less farmers.

The breeding practices followed by the farmers were appropriate. However, there is a scope of achieving lambing rate up to 90% on ewe available basis through culling of unfertile ewes, adequate grazing and management. The mortality and morbidity rates can be reduced through proper hygiene and healthcare. This will directly enhance the returns from sheep farming.

The State Government's insurance policy for the sheep and the shepherd may be of great help to the sheep farmers of this area and should be extended to all the sheep of Magra breed.

Acknowledgement

The majority information reported in the monograph were generated under the project entitled, "Characterization and evaluation of Magra sheep breed in its native tract". The survey was undertaken in the breeding tract of Magra sheep. A number of persons and organizations helped us in successful execution of the project. We will like to thank them. The Director, National Bureau of Animal Genetic Resources, Karnal provided all logistics support and guidance. Dr C.K. Murdia, the then Head, AGB division, RAU, Bikaner could be easily available for necessary discussion regarding distribution of the breed and the survey plan. Shri Subhash Chander and Shri Moti Ram, technical staff of the Bureau accompanied us and rendered necessary help in survey. We are thankful to all of them. The sheep farmers of the area were of great help to us for undertaking the field survey for phenotypic characterization of the breed. They allowed us an access to their flocks, handled the sheep meticulously for recording the body biometry and body weight and provided valuable information on sheep production and reproduction. Sometimes, they had to retain their sheep in the pens till the collection of the information from the flock was completed. Some of the farmers accompanied us from one flock to the other and helped us establishing contacts with the farmers. We are grateful to all of them for their selfless help and assistance.

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