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(Indian Council of Agricultural Research)

P.B. No. 129, GT Road Bypass

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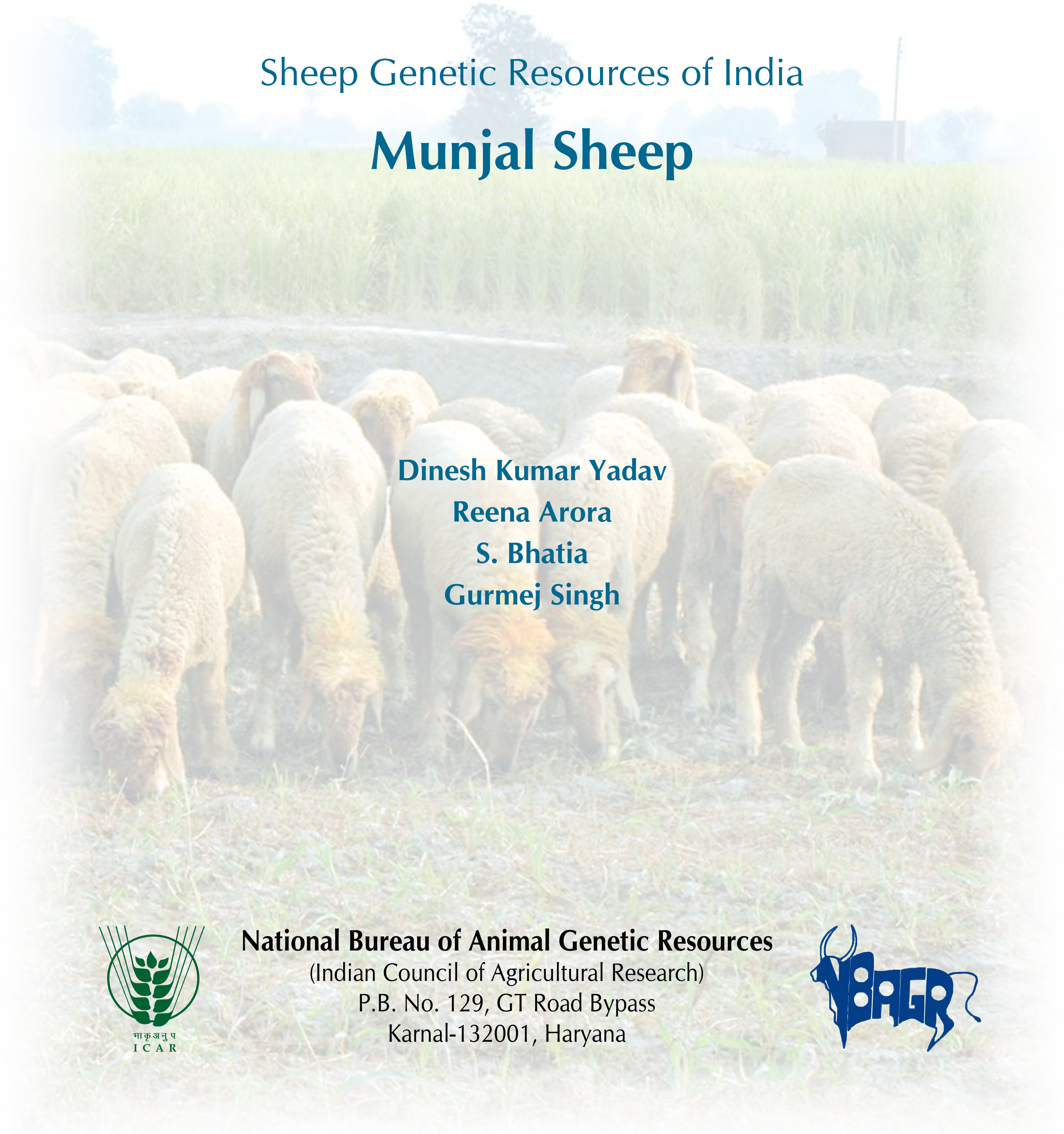

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CONTENTS

PREFACE

India is one of the few countries in the world, which has contributed richly to the international livestock gene pool in terms of number of breeds per species. Sheep biodiversity in India is characterized by various breeds/strains that are well adapted to the diverse environmental conditions found across the different agro-climatic regions. The abounding treasure of the Indian sheep (Ovis aries) diversity is represented by the 40-43 descript breeds and several lesser known ones distributed across the length and breadth of the country. These breeds have generally been named after their place of origin and some based on their prominent characteristics. Some of these breeds are unique in terms of meat, wool and prolificacy traits. A few breeds have evolved from the base populations created by crossing native and fine wool exotic breeds. However, intermixing of nearby breeds, introduction of exotic breeds and change in farming systems have led to the decline of purebred population resulting in dilution of genetic merit. Apart from these well recognized breeds, there are some other populations which are not recognized as breeds but are nevertheless thriving and need to be characterized.

Munjal, one such lesser known sheep, is primarily a mutton-type sheep which is popular for its reproductive efficiency among the farmers of Punjab, Haryana and Rajasthan states. Despite a better reproductive efficiency and having survived through times of identity crisis, Munjal has not been included in the list of descript sheep breeds of India. This monograph attempts to unify current information on physical characteristics, distribution, population size, production, reproduction, management practices and microsatellite based genetic profile of this sheep population. The information generated would have a direct impact on the recognition and conservation of this important sheep population at the National level. The authors are thankful to Director, NBAGR, Karnal for providing support in conducting survey on this important ovine genetic resource of the country. We hope that this bulletin will be of tremendous use in creating awareness among researchers, policy planners, breeders as well as students about the current status and characteristics of this undervalued and threatened ovine germplasm of North-Western India.

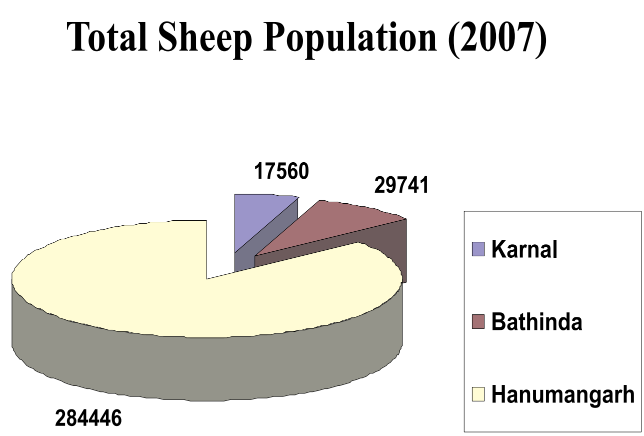
Authors

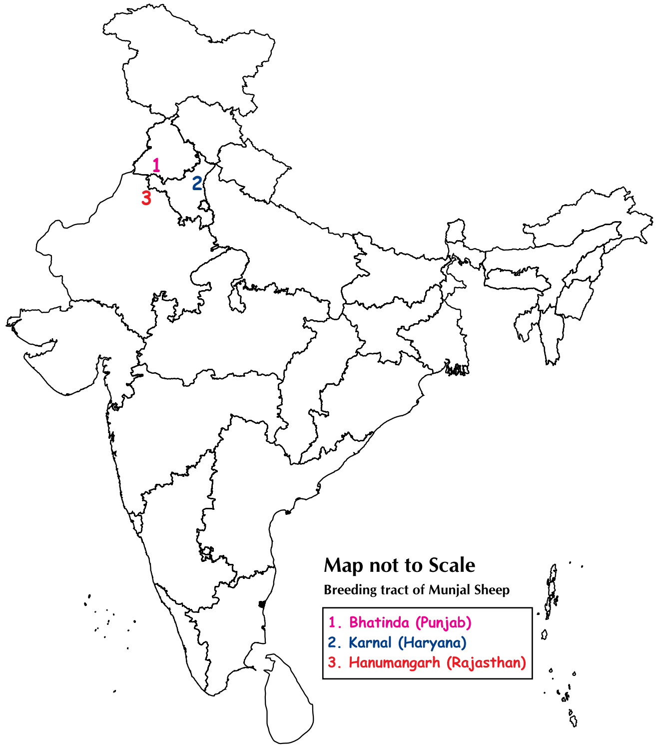
INTRODUCTION

Munjal is a mutton-type sheep popular among the farmers of Punjab, Haryana and Rajasthan for its better reproductive efficiency. It is supposed to have originated through the breeding of Nali and Lohi sheep and is found in districts of Hisar, Ambala, Karnal of Haryana; Patiala, Bathinda of Punjab; and Ganganagar, Hanumangarh of Rajasthan (Basuthakur, 1988; Mason, 1988). These sheep are mostly reared by shepherds and landless farmers. They graze them mostly at the outskirts of the villages, stubbles of the harvested crops, banks of the canals and road sides. Kushwaha et al (1999) studied the characteristics of Munjal sheep found in Rajasthan. Growth rate, age at first lambing and lambing interval are important factors that determine economic return from sheep farming. Reproductive efficiency is an important component of flock productivity of indigenous breeds of sheep. Poonia (2008) established under organized farm conditions that Munjal sheep is very economical breed of the country due to its earlier maturity, faster growth and shorter lambing interval as compared to Magra, Malpura and Muzaffarnagri sheep breeds.

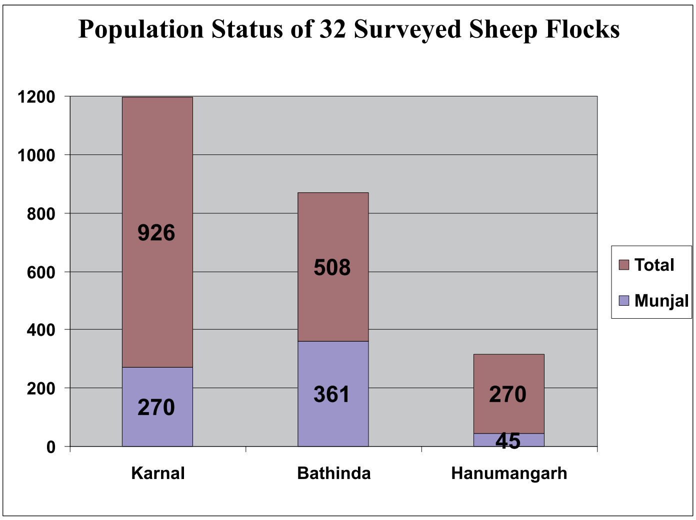
Despite its economic importance and distinct identity, Munjal sheep is not included in the list of descript sheep breeds of India, and thus have lived through times of identity crisis. As it is least discussed among the Indian sheep, the present study was carried out to unify the information on its phenotypic and genetic characterization, population status, production and reproduction traits, socio-economic status of the farmers etc. under field conditions.

Habitat and Population Status: The origin of Munjal sheep is not known but is believed to have originated in India through crossbreeding of Nali with Lohi sheep breeds around borders of Rajasthan, Punjab and Haryana (Basuthakur,1988; Mason, 1988). Being an important mutton/and wool-type sheep, it is popular among the sheep farmers for having heavier body weight. As per literature it was mainly distributed in the districts of Hisar, Ambala and Karnal of Haryana, Patiala and Bathinda of Punjab, and Ganganagar and Hanumangarh of Rajasthan (Basuthakur,





1988). However, discussions with the animal husbandry departments of Haryana, Punjab and Rajasthan, during the survey revealed shrinkage in the breeding tract of Munjal restricting it to Karnal, Bathinda and Hanumangarh districts of Haryana, Punjab and Rajasthan respectively. It was also noted that even in these areas there is further shrinkage in the breeding tract. These areas were extensively visited and 107 (34 flocks from Karnal, 30 flocks from Bathinda, and 43 flocks from Hanumangarh) sheep flocks were surveyed. It was observed that Munjal type animals were present only in 32 flocks. The total numbers of sheep in 32 studied flocks were 1704. The Munjal population was 676 and rest were crossbred and non-descript animals. The study indicated that Munjal sheep is mainly confined to Bathinda and Karnal districts and its population has decreased drastically.



MORPHOLOGICAL CHARACTERIZATION

To characterize the Munjal sheep, body biometry of 194 adult animals (42 males and 152 females), body weight of 80 lambs were recorded from 32 flocks, which were having varying numbers of Munjal sheep. All the measurements were taken with a measuring tape after making the animal stand squarely on an even ground. The body weights were recorded by weighing the animals with a weighing machine. The age of the animals was recorded by observing number of teeth, 2 teeth: 1.5 year old; 4 teeth: 2.5 years old; 6 teeth: 3.5 years old; 8 teeth: four years old and above.

PHYSICAL CHARACTERISTICS


Animals of Munjal sheep are quite big in size, tall, rectangular and massive having long head with roman nose and narrow forehead. Face is generally tan or brown in colour which may extend up to the neck. Both sexes are polled. Ears are large and leaf like hanging down with flat cheeks. Tail is long. Fleece is white. Udder is medium sized and well developed having medium teats.


BODY BIOMETRY

Average body weight and body biometry of adult Munjal sheep and average body weights of lambs are presented in Table - 1 and Table - 2 respectively. The average adult body weights of 42 rams and 152 ewes were 60.05±1.55 and 43.95±0.51 kg respectively. In adult males; the body length (cm), wither height (cm), chest girth (cm), paunch girth (cm), ear length (cm) and tail length (cm) were 83.85±0.85, 80.38±0.69, 91.76±0.73, 94.33±0.95, 18.81±0.98, 47.90±1.63 respectively; and the corresponding values in adult female were 75.60±0.33, 73.24±0.25, 83.78±0.39, 86.90±0.47, 18.47±0.49 and 42.02±0.68 respectively. Body weight (kg.) of male lambs in the age groups of 0-1, 1-3, 3-6, 6-9, 9-12 months were 6.31±0.48, 12.18±1.06, 21.4±2.62, 35.0±2.31, 41.8±1.80 respectively; and in female lambs were 4.13±0.62, 10.71±1.61, 15.86±1.24, 20.86±1.06, 24.20±1.02 respectively. The body biometry reflects that animal of Munjal sheep are quite large in size, tall, rectangular and massive with long tail. The body weights of lambs indicated that there was increasing trend in body weight with advancement in age and the yearlings in both sexes weighed from 37-46 kg in males and 22-27 kg in females. The body weights in 3 to 6 months age-group are important from disposal point of view, and those between 12 and 15 months are important from breeding point of view.

Table-1: Body Weight and Biometry of Adult Munjal Sheep.

Body Character	Adult Male (42)		Adult Female (152)	
	Average ± SE	*Range*	*Average ± SE*	*Range*
Body Weight (Kg)	60.05±1.55	41-83	43.95±0.51	30-64
Body Length (cm)	83.85±0.85	68-95	75.60± 0.33	63-87
Height at wither (cm)	80.38±0.69	72-91	73.24±0.25	65-81
Chest girth (cm)	91.76±0.73	80-100	83.78±0.39	71-95
Paunch Girth (cm)	94.33±0.95	82-110	86.90±0.47	70-100
Ear Length (cm)	18.81±0.98	14-47	18.47±0.49	14-51
Tail Length (cm)	47.90±1.63	19-68	42.02± 0.68	15-62

Table-2: Body Weight of Munjal Lambs

Age (month)	Male		Female	
	Average ± SE	*Range*	*Average ± SE*	*Range*
0-1	6.31 ± 0.48 (19)	3-10	4.13 ± 0.62 (8)	2-7
1-3	12.18 ± 1.06 (14)	7-20	10.71 ± 1.61 (7)	6-19
3-6	21.4 ± 2.62 (5)	17-30	15.86 ± 1.24 (7)	11-20
6-9	35.0 ± 2.31 (3)	31-39	20.86 ± 1.06 (7)	17-24
9-12	41.8 ± 1.80 (5)	37-46	24.20 ± 1.02 (5)	22-27

SOCIO-ECONOMIC STATUS OF THE SHEPHERDS/SHEEP FARMERS

Thirty two sheep farmers belonging to Balmiki, Gadaria, Bawaria, Jat Sikhs, Muslims, Rajput, Jats, Ramdasia, Thori and Scheduled Caste communities rearing the Munjal sheep were interviewed. The families belonged to low-income group; 95% were landless and rest were having 4-11 acres of land. The average family size was 6.82 with 3.44 males and 3.38 females. The overall literacy was 28%. Besides maintaining sheep 40, 53, 84 and 13 percent also maintained cattle, buffalo, goats and fowl respectively, whereas 19 percent maintained both cattle and buffalo.

FLOCK SIZE

The average flock size was 53 comprising 36 ewes, 2 rams and 15 lambs. Most of the farmers kept one or two rams. The farmers also maintained rams of Muzaffarnagri, Nali and Kheri breeds in their flocks. The percentage of Munjal and non-descript sheep was 42 and 58 respectively.

BREEDING AND REPRODUCTION

In most of the flocks Munjal sheep were observed to be genetically diluted. Of the 32 surveyed flocks in the three districts, the average breed purity was 42%. It ranged from 3-90% 60-80%, 30-60% and less than 30% in 6, 8, 4 and 8 flocks respectively. Farmers selected rams on the basis of body size and conformation; brown face colour, long tail and good height were the preferred characteristics. October-November was reported main lambing season and April-May, the minor. Lambing rate was 60- 80 % with a lambing interval of 5-6 months. Litter size was single; but some farmers also reported 4-10% twinning.

An ewe produced 7-10 lambs in its lifetime. Age at first lambing was 15-18 months. Age and weight at puberty in females were 10-12 months and 25-30 kg. Age at first breeding in males was 12-15 months with a breeding life of 6-10 years. Daily milk yield was 300-400 ml and lactation length was 90 -120 days.

MANAGEMENT PRACTICES

Munjal sheep are primarily maintained on grazing. The sheep flocks are stationary. Farmers, barring a few, do not provide any supplementary feed to any category of animals i.e. lactating ewes, pregnant ewes or lambs. A few farmers, however, provide concentrate to rams, lambs and pregnant ewes. The sheep are taken to water source two or three times a day. The animals are grazed about 6-8 hours a day. The distance travelled for grazing varied from 3-20 km/day. The lambs are kept in the pens for about 15-30 days after birth and thereafter join the flock for grazing. Women play significant role in lamb caring at home.

Majority of farmers provide housing especially during night. The flocks were housed generally in open enclosures. In 12% cases, the sheep pens were part of owner's house, whereas in the rest located adjacent to the owner's dwelling. The boundaries of the enclosures were made of tree branches/bushes. Some farmers also housed their sheep in stonewall thatched houses.

The farmers vaccinate their sheep against Haemorrhagic Septicaemia, Enterotoxaemia, FMD and Sheep Pox. Drenching was done against internal parasites with Albendazole, Nilverm, Panacur and Mebendazole etc. The mortality was about 5-10% in adults and 4-6% in lambs.

WOOL PRODUCTION

The animals are generally shorn twice a year in the month of September-October and March-April. Average greasy wool production was about 1800-2500 grams per annum. The price of wool varied from Rs. 35-40/- per kg.

DISPOSAL OF ANIMALS

Depending upon the condition of the animal, prices of adult ewes and rams varied from Rs. 2500-3000/- and Rs. 8000 -12000/- respectively. Surplus three months old male lambs fetch a price of Rs 1000-1200/-. Ewe lambs are kept for replacement. The animals are sold to butchers and traders.

GENETIC CHARACTERIZATION

Genetic characterization of Munjal sheep was achieved using microsatellite markers which are highly polymorphic, co-dominantly inherited and ubiquitous in nature.

SAMPLE COLLECTION AND DNA EXTRACTION

Blood samples were randomly collected from genetically unrelated Munjal sheep across its breeding tract. DNA was extracted from the white blood cells using a standard phenol/ chloroform/ isoamyl alcohol extraction protocol (Sambrook et al., 1989).

GENOTYPING

A panel of twenty five microsatellites were genotyped on the DNA samples of the Munjal sheep population (Table-3). The forward primer for each marker was fluorescently labelled with either FAM, NED, VIC or PET dye. Amplifications of the loci was performed in a 25μl final reaction volume containing at least 100ng of genomic DNA, 5 pM of each primer, 1.5 mM MgCl2, 200 μM dNTPs, 0.5 U Taq polymerase and 1x Taq buffer. A common "Touchdown" PCR programme used for amplification of all the twenty five markers involved 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 (FAO 1996). Amplification was confirmed on 2% agarose gel and the genotyping were carried out on ABI 3100 automated DNA sequencer using LIZ 500 as internal size standard. Allele sizing was done using GENEMAPPER software (ABI, USA).

STATISTICAL ANALYSIS

The GenAlEx6 (Peakall and Smouse, 2006) software was used to determine allele frequencies, observed number of alleles, effective number of alleles, observed heterozygosity, expected heterozygosity, within population inbreeding estimate and Hardy-Weinberg equilibrium (HWE) for each locus in Munjal sheep. BOTTLENECK (Piry et al., 1999) software was used to test whether a genetic bottleneck would be evident in the investigated sheep population.

LOCI VARIATION

All microsatellite loci amplified well and were polymorphic in nature (Crawford et al., 1995). A total of 216 distinct alleles were detected across the 25 analyzed microsatellite loci. These microsatellite loci exhibited high level of genetic variability as revealed by wide range of alleles which varied from 4 (BM6506) to 14 (INRA63). The effective number of alleles per locus ranged from 1.264 (CSSM47) to 8.399 (OarJMP29). The level of variation depicted by number of alleles at each locus serves as a measure of genetic variability having direct impact on differentiation of breeds within a species (Buchanan et al., 1994).

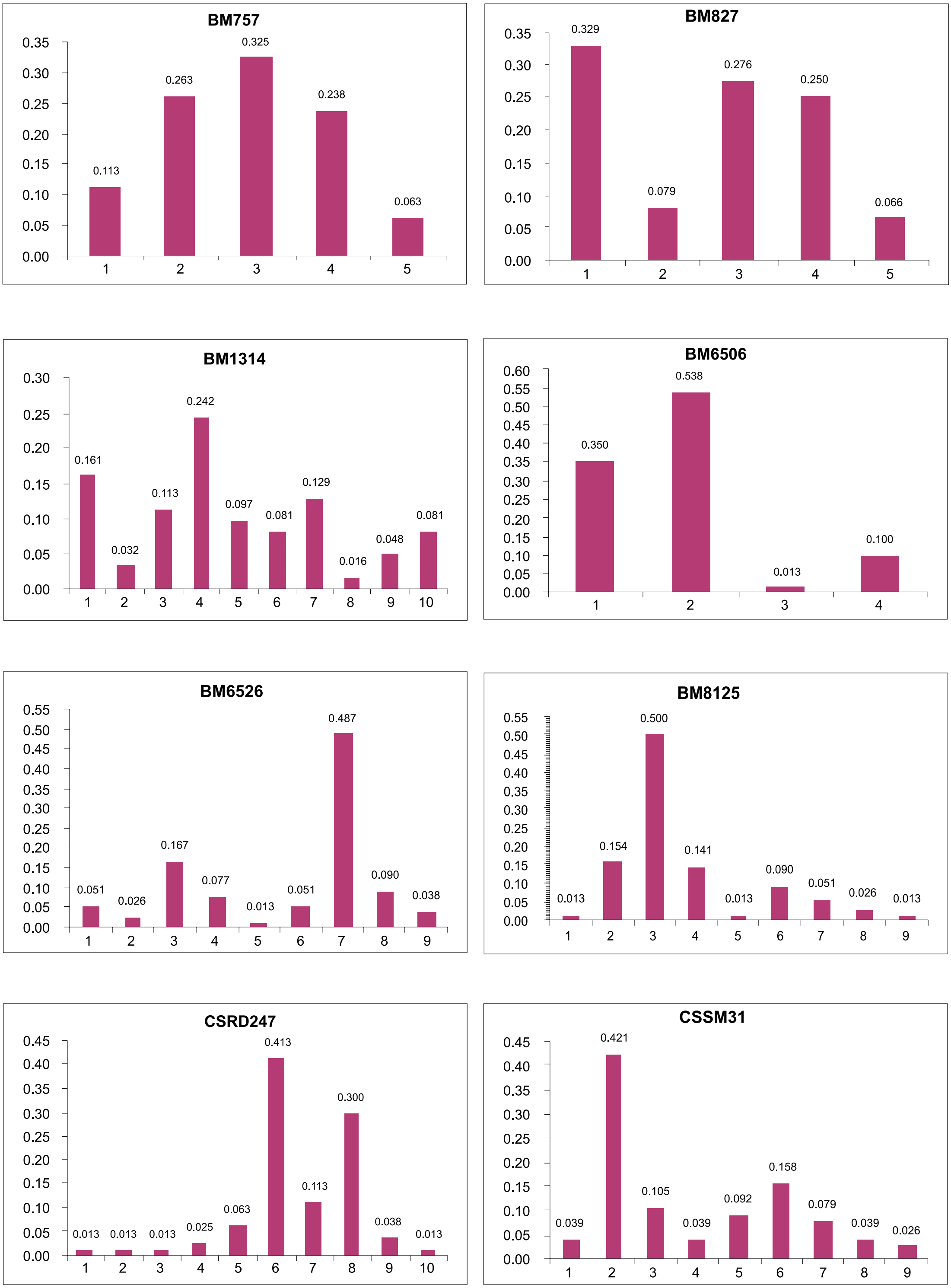
Allele frequency data revealed considerable variation in distribution of allele frequencies between loci 0.013 to 0.888 (Fig-1). Low frequency of most common alleles (<95%) at each investigated locus further substantiated polymorphic nature of the used microsatellites and their utility in measurement of diversity indices based genetic polymorphism studies.

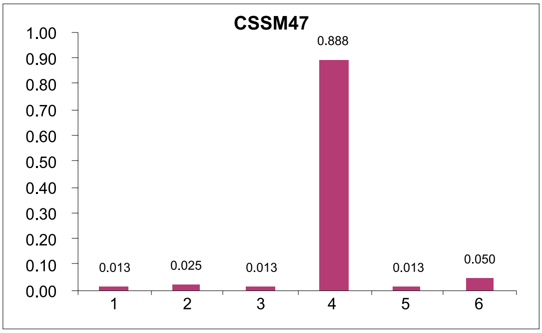
Observed and expected heterozygosity values of microsatellite loci ranged from 0.175 (CSSM47) to 0.925 (OarCP20) and 0.209 (CSSM47) to 0.881 (OarJMP29) respectively. The use of microsatellites with wide range of heterozygosity reduces the risk of overestimating genetic variability, which might occur with microsatellites exhibiting only high heterozygosity. The PIC values varied from 0.21 (CSSM47) to 0.994 (Oar JMP29). Fairly high PIC values (>0.5) for majority of markers employed (92%), supported their utility in biodiversity evaluation (Kemp et al., 1995) of native Indian sheep too (Fig-2).

Table-3: Primer sequences of 25 microsatellite markers used for molecular genetic characterization of Munjal sheep.

S. NO.	MARKER	PRIMER SEQUENCES(5′ → 3′)	CHROMOSOMAL LOCATION
1	BM757	F - Tgg AAA CAA TgT AAA CCT ggg R - TTg AgC CAC CAA ggA ACC	9
2	BM827	F -ggg CTg gTC gTA TgC TgA g R - gTT ggA CTT gCT gAA gTg ACC	3
3	BM1314	F -TTC CTC CTC TTC TCT CCA AAC R - ATC TCA AAC gCC AgT gTg g	22
4	BM6506	F -gCA CgT ggT AAA gAg ATg gC R - AgC AAC TTg AgC ATg gCA C	1
5	BM6526	F -CAT gCC AAA CAA TAT CCA gC R - TgA Agg Tag AgA gCA AgC AgC	26
6	BM8125	F -CTC TAT CTg Tgg AAA Agg Tgg g R - ggg ggT Tag ACT TCA ACA TAC g	17
7	CSRD247	F -ggA CTT gCC AgA ACT CTg CAA T R - CAC TgT ggT TTg TAT TAg TCA gg	14
8	CSSM31	F -CCA AgT TTA gTA CTT gTA AgT AgA R - gAC TCT CTA gCA CTT TAT CTg TgT	23
9	CSSM47	F -TCT CTg TCT CTA TCA CTA TAT ggC R - CTg ggC ACC TgA AAC TAT CAT CAT	2
10	HSC	F -CTg CCA ATg CAg AgA CAC AAg A R - gTC TgT CTC CTg TCT TgT CAT C	20
11	INRA63	F -gAC CAC AAA ggg ATT TgC ACA AgC R - AAA CCA CAg AAA TgC TTg gAA g	14
12	MAF214	F -AAT gCA ggA gAT CTg Agg CAg ggA Cg R - ggg TgA TCT TAg ggA ggT TTT ggA gg	16
13	OarAE129	F -AAT CCA gTg TgT gAA AgA CTA ATC CAg R - gTA gAT CAA gAT ATA gAA TAT TTT TCA ACA CC	5
14	OarCP20	F -gAT CCC CTg gAg gAg gAA ACg g R - ggC ATT TCA Tgg CTT Tag CAg g	21
15	OarCP34	F - gCT gAA CAA TgT gAT ATg TTC Agg R - ggg ACA ATA CTg TCT Tag ATg CTg C	3
16	OarCP49	F -CAg ACA Cgg CTT AgC AAC TAA ACg C R - gTg ggg ATg AAT ATT CCT TCA TAA gg	17
17	OarFCB48	F -gAg TTA gTA CAA ggA TgA CAA gAg gCA C R - gAC TCT AgA ggA TCg CAA AgA ACC Ag	17
18	OarFCB128	F -CAg CTg AgC AAC TAA gAC ATA CAT gCg R - ATT AAA GCA TCT TCT CTT TAT TTC CTC GC	2
19	OarHH35	F -AAT TgC ATT CAg TAT CTT TAA CAT CTg gC R - ATg AAA ATA TAA AgA gAA TgA ACC ACA Cgg	4
20	OarHH41	F -TCC ACA ggC TTA AAT CTA TAT AgC AAC C R - CCA gCT AAA gAT AAA AgA TgA TgT ggg Ag	10
21	OarHH47	F -TTT ATT gAC AAA CTC TCT TCC TAA CTC CAC C R - gTA gTT ATT TAA AAA AAT ATC ATA CCT CTT AAg g	18
22	OarHH64	F -CgT TCC CTC ACT ATg gAA AgT TAT ATA TgC R - CAC TCT ATT gTA AgA ATT TgA ATg AgA gC	4
23	OarJMP8	F -Cgg gAT gAT CTT CTg TCC AAA TAT gC R - CAT TTg CTT Tgg CTT CAg AAC CAg Ag	6
24	OarJMP29	F -gTA TAC ACg Tgg ACA CCg CTT TgT AC R - gAA gTg gCA AgA TTC AgA ggg gAA g	24
25	OarVH72	F -CTC Tag Agg ATC Tgg AAT gCA AAg CTC R - ggC CTC TCA Agg ggC AAg AGC Agg	25

Fig.1 Allele Frequencies Distribution at 25 Microsatellite Loci in Munjal Sheep

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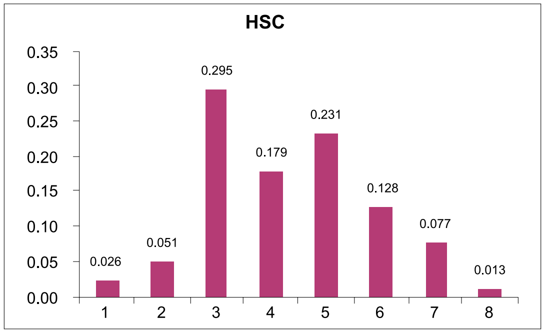
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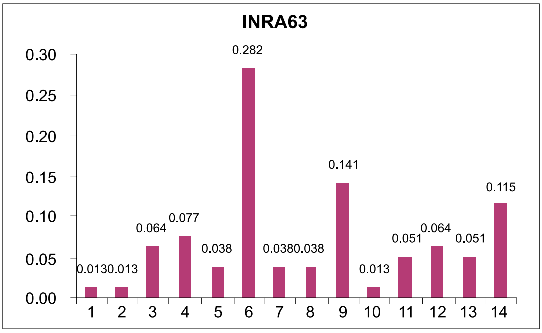
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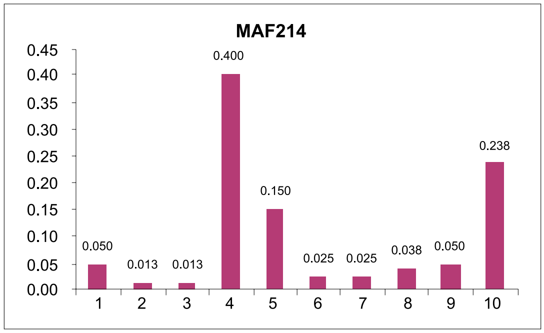
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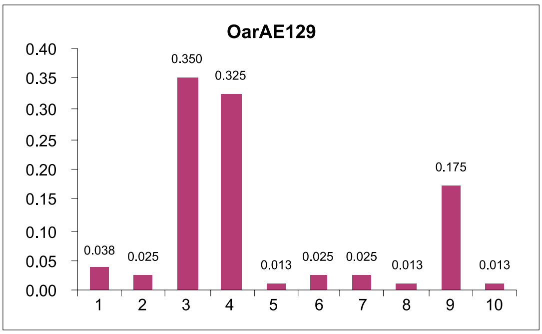
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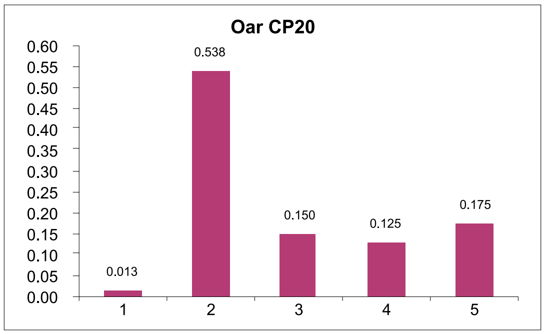
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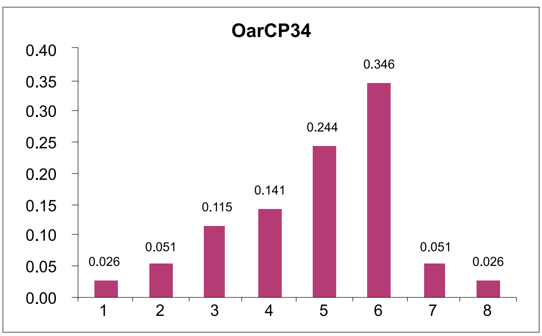
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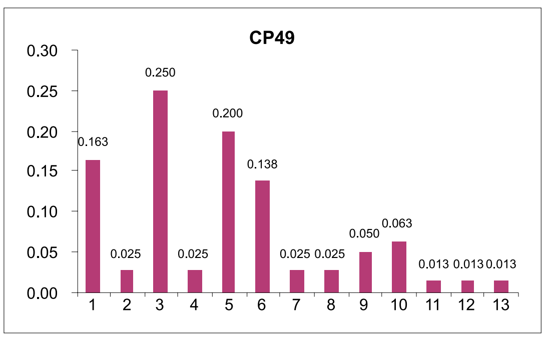
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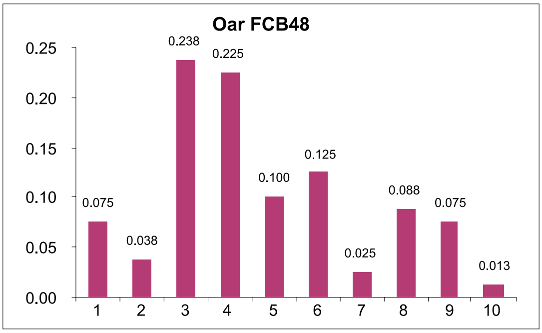
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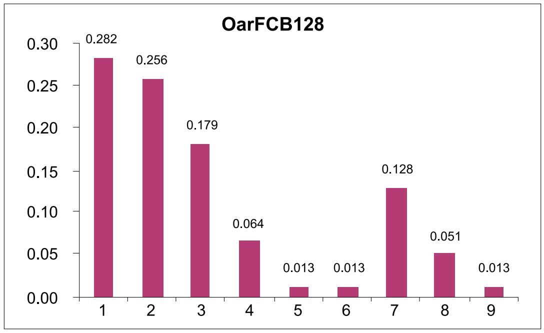
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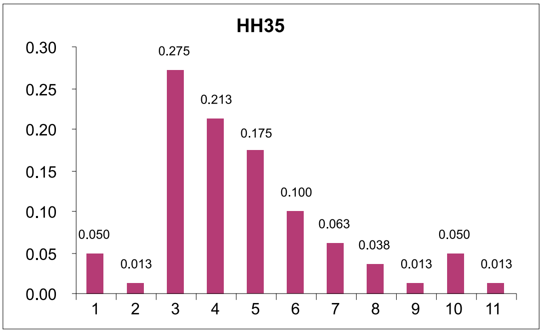
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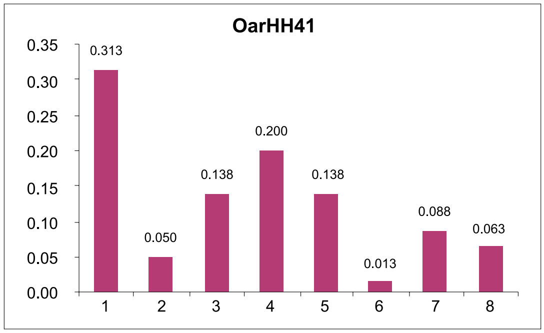
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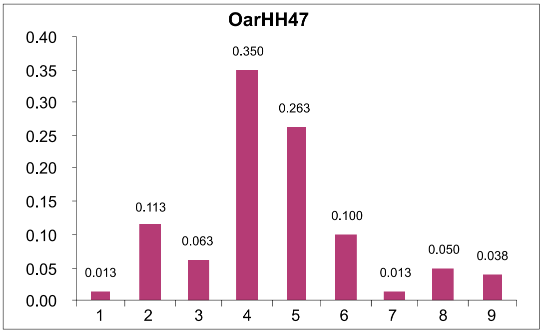
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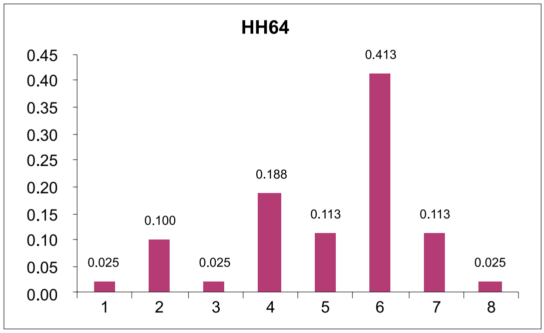
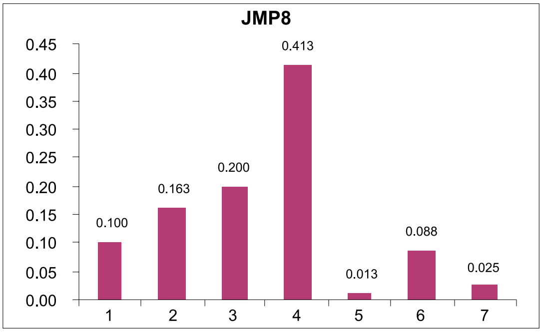
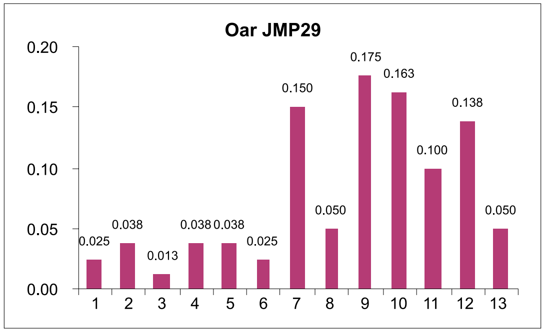
0.050
0.038


HH64
0.025
0.100
0.025
0.188
0.113
0.413
0.113
0.025


JMP8
0.100
0.163
0.200
0.413
0.013
0.088
0.025


Oar JMP29
0.025
0.038
0.013
0.038
0.038
0.025
0.150
0.050
0.175
0.163
0.100
0.138
0.050

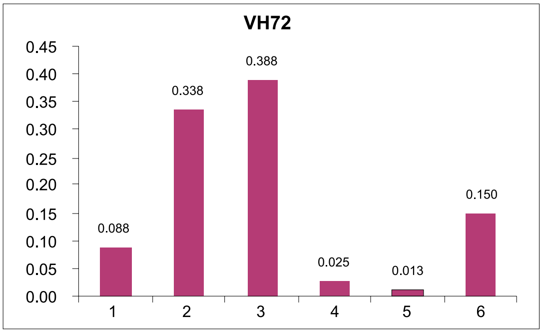


Fig-2: Polymorphism Information Content of different mircrosatellite loci in Munjal sheep

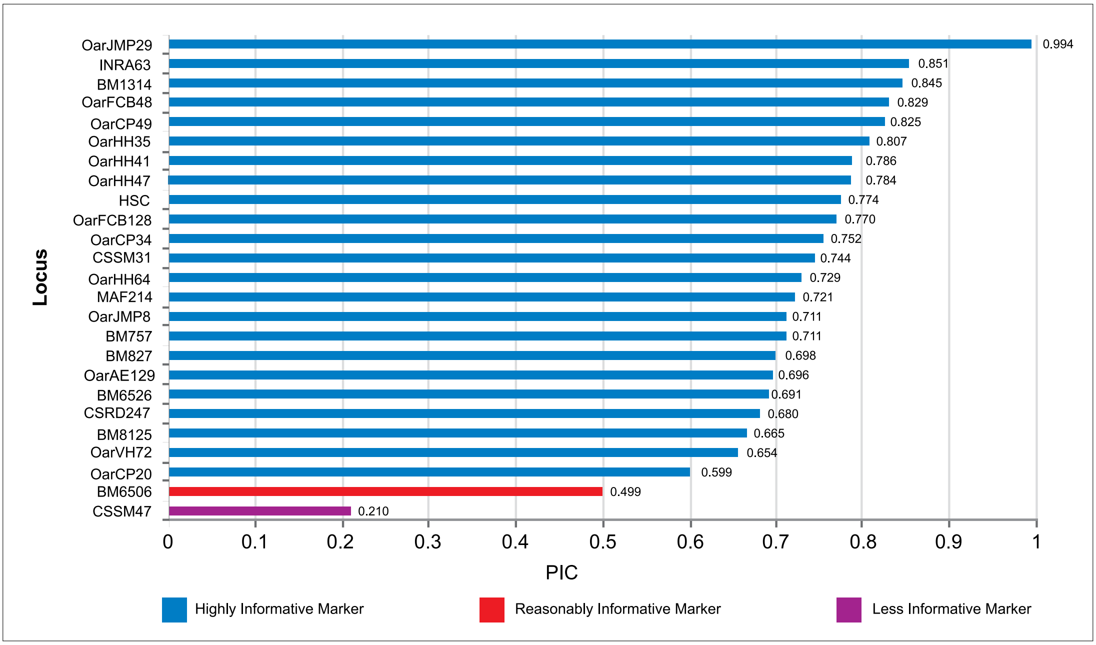


Table-4: Observed number of alleles, effective number of alleles, observed heterozygosity, expected heterozygosity and within population inbreeding estimate (F_{IS}) values across 25 microsatellite markers in Munjal sheep.

Genetic variability measures	Range	Mean
Observed number of alleles	4 (BM6506) - 14 (INRA63)	8.64
Effective number of alleles	1.264 (CSSM47) - 8.399 (OarJMP29)	4.57
Observed heterozygosity	0.175 (CSSM47) – 0.925 (OarCP20)	0.712
Expected heterozygosity.	0.209(CSSM47) - 0.881(OarJMP29)	0.744
Within population inbreeding estimate (F_{IS})	-0.513 (BM6506) - 0.637 (OarHH64)	0.034

INTRA BREED GENETIC DIVERSITY

Intra breed genetic variation is reflected by allele diversity (mean number of observed alleles over a range of loci), mean observed heterozygosity and gene diversity (mean expected heterozygosity) estimates. Allele diversity considered to be a reasonable indicator of genetic variation within the population, displayed high genetic variation (8.64) in Munjal sheep. The mean observed heterozygosity and gene diversity values of Munjal sheep were 0.712 and 0.744 respectively. The mean observed heterozygosity values, though lower than the gene diversity values, exhibited failure of significant differences in both the populations/breeds using ANOVA test ($p > 0.05$). The high value of gene diversity indicated that the population has retained the presence of several alleles although at a small frequency. Heterozygote deficiency analysis revealed significant deviation from HWE ($P < 0.001$) at several loci. The exact basis of this departure is difficult to explain, however, the presence of low frequency null alleles segregating at these loci may be a possible reason. Another reason for this deviation could be the positive F_{IS} (within population inbreeding estimates) values obtained. Since there was no consistent pattern of deviation from HWE across all loci, subsequent analyses were, therefore, carried out on the basis that Hardy-Weinberg equilibrium prevailed in the investigated population. The average within population inbreeding estimate (F_{IS}) was observed to be 0.034 ranging from -0.513 (BM6506) to 0.637 (OarHH64). The positive F_{IS} value though not significantly different from zero ($p > 0.05$) indicating a very low rate of inbreeding in the population. Similar tendencies of three variables viz., allele diversity, mean observed heterozygosity and gene diversity estimates observed in Munjal reflected the investigated population under mutation drift equilibrium (Hanslik et al., 2000). These measurements, however, behave differently when a population bottleneck is followed by a rapid population expansion (Kimmel et al., 1998).

ANALYSIS OF GENETIC BOTTLENECK

Efforts were made for estimation of genetic bottleneck by using the qualitative graphical method based on mode-shift distortion under the SMM (Stepwise Mutation Model) which is the most suited model for evolution of microsatellites. No Mode shift was detected in the frequency distribution of alleles and a normal L-shaped form was observed (Fig-3) for Munjal sheep. This finding further suggested absence of any recent reduction in the effective population size and non- bottlenecked population of Munjal under mutation drift equilibrium.

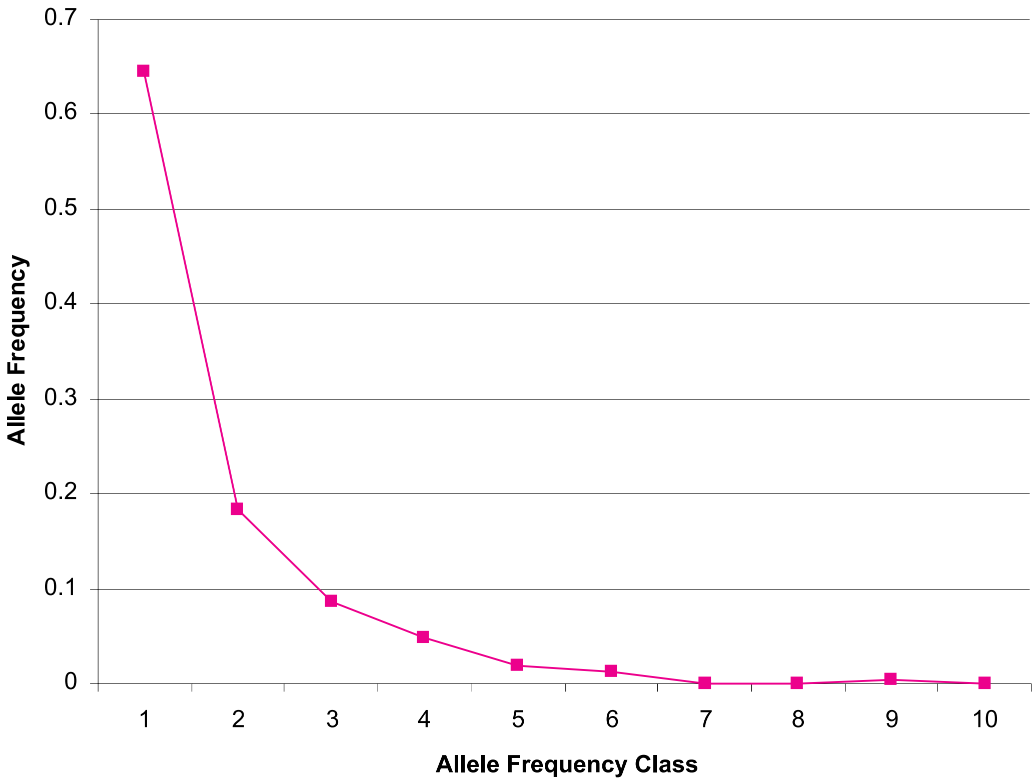


Fig-3: L-shaped curve depicting no mode-shift in Munjal sheep

SWOT ANALYSIS OF MUNJAL SHEEP

Strengths

- ✓ Better reproductive efficiency
- ✓ Mutton and wool production
- ✓ Reasonably good infrastructure for animal husbandry and veterinary services
- ✓ Proximity to NBAGR, SAUs and KVKs

Weaknesses

- o Paucity of elite breeding rams
- o Breed dilution
- o Non- availability of grazing area
- o Fodder scarcity
- o Low literacy among the sheep rearers
- o Inadequate knowledge of diseases control
- o Unavailability of proper medicines
- o Poor extension facilities for sheep rearing
- o Low social prestige associated with sheep farming
- o Lack of adequate credit support

Opportunities

- o Threatened population status
- o Importance of sheep in landless and marginal farmers
- o Public- Private Partnership, Munjal Sheep Breeders Association
- o Agro-forestry based community pastures
- o Utilization of existing infrastructure for breed improvement and conservation
- o Best rams competition shows

Threats

- ✓ Identity crisis, non recognition as a breed at national level
- ✓ Demand for local sheep, non adaptation resulting into slow growth
- ✓ Lack of support price of wool, role of middle man
- ✓ Lack of organized market for sale of wool, mutton and animals
- ✓ Sustainable financial backing, availability of micro credit
- ✓ Sustaining internal capabilities (trained extension manpower, elite rams)

CONCLUSION

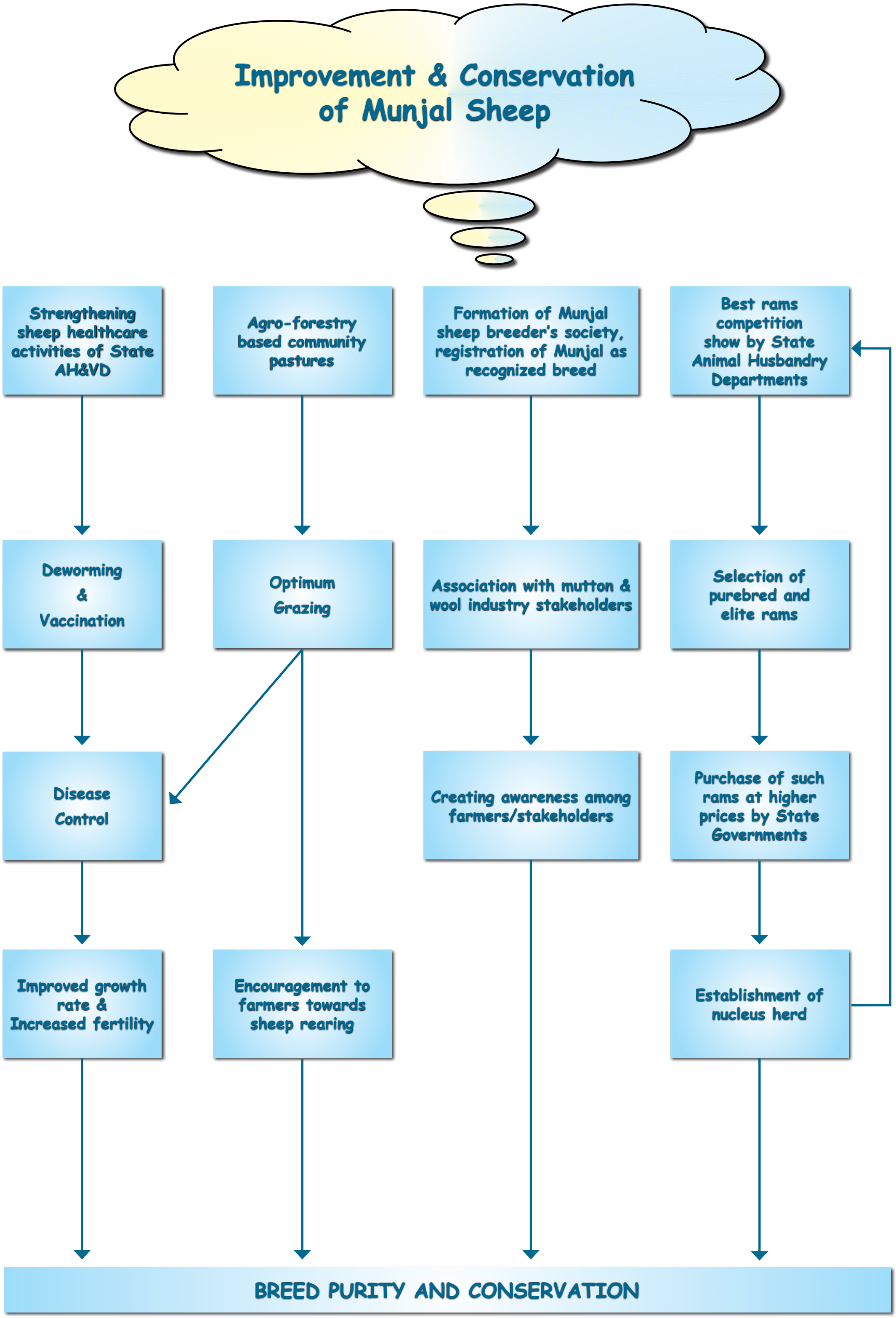
Munjal is an important dual-type sheep of North-Western semi arid region of India. The present study indicated that though the farmers preferred Munjal sheep in the past because of its large size, early breeding and substantial wool production, yet its current population in the breeding tract has considerably declined leading to its threatened status. The study further showed that there is substantial shrinkage in its breeding tract which is now mainly limited to some pockets of Karnal (Haryana) and Bathinda (Punjab) districts. Reduction in wool prices, non-preference for breed purity due to non- availability of proven rams, and several socio-economic factors like demand for mutton and shifting of profession by sheep rearers were some of the reported hurdles in its proliferation. The existing genetic dilution in the farmer's flocks is posing further dangers to its identity and population status. Besides this, lack of initiatives on the part of developmental and policy making agencies such as recognition as a descript breed at national level despite its documentation as an important sheep breed by Punjab Government, and systematic and concerted efforts for its breeding and improvement had their own toll on the present scenario of its threat to extinction.

Although the molecular genetic analysis revealed substantial genetic variation in Munjal sheep, the dwindling numbers are definitely a cause of concern. The genetic diversity can be utilized in future breeding strategies. The present investigation revealed Munjal sheep to have potential to be developed as a dual mutton and wool breed. Hence, improvement and effective breeding policies, management and feeding practices are required to upgrade the present germplasm. This study has, therefore, contributed to the knowledge of population structure, characterization and within breed genetic variability of Munjal sheep. The holistic approach on phenotypic characterization as well as genetic diversity analysis would enable to have a precise insight for its conservation and improvement programmes.

RECOMMENDATIONS

It appears that a very serious situation has arisen which may lead to complete loss of this important sheep population. Hence immediate steps for its registration and conservation are needed. Keeping in view above SWOT analysis, following important recommendations are suggested which are interwoven in the conservation model suggested below for proliferation of Munjal sheep.

1. Besides initiating improvement and effective breeding policies, sheep health care activities of the state animal husbandry departments should be strengthened.
2. Besides forming Munjal sheep breeder's society, Munjal sheep should be registered as a descript sheep breed at national level.
3. Agro - forestry based community pastures should be developed.
4. Best pure bred ram competition shows should be organized by the state animal husbandry departments.
5. Besides recognizing Munjal sheep as a national sheep breed; the core action of establishing a nucleus flock and implementing it as open nucleus breeding system with exchange of rams between nucleus herd and farmers flock is warranted immediately.


Improvement & Conservation of Munjal Sheep
Strengthening sheep healthcare activities of State AH&VD
Agro-forestry based community pastures
Formation of Munjal sheep breeder's society, registration of Munjal as recognized breed
Best rams competition show by State Animal Husbandry Departments
Deworming & Vaccination
Optimum Grazing
Association with mutton & wool industry stakeholders
Selection of purebred and elite rams
Disease Control
Creating awareness among farmers/stakeholders
Purchase of such rams at higher prices by State Governments
Improved growth rate & Increased fertility
Encouragement to farmers towards sheep rearing
Establishment of nucleus herd
BREED PURITY AND CONSERVATION

ACKNOWLEDGEMENTS

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"......On the surface, this is a photograph of a beautiful mother and her children.
Her beauty is there, yes, but there is something quiet and terrible behind that which is contrary to concept of a breed...."

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