

Goat Genetic Resources of India

CHANGTHANGI

- A Pashmina Breed of Ladakh



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National Bureau of Animal Genetic Resources

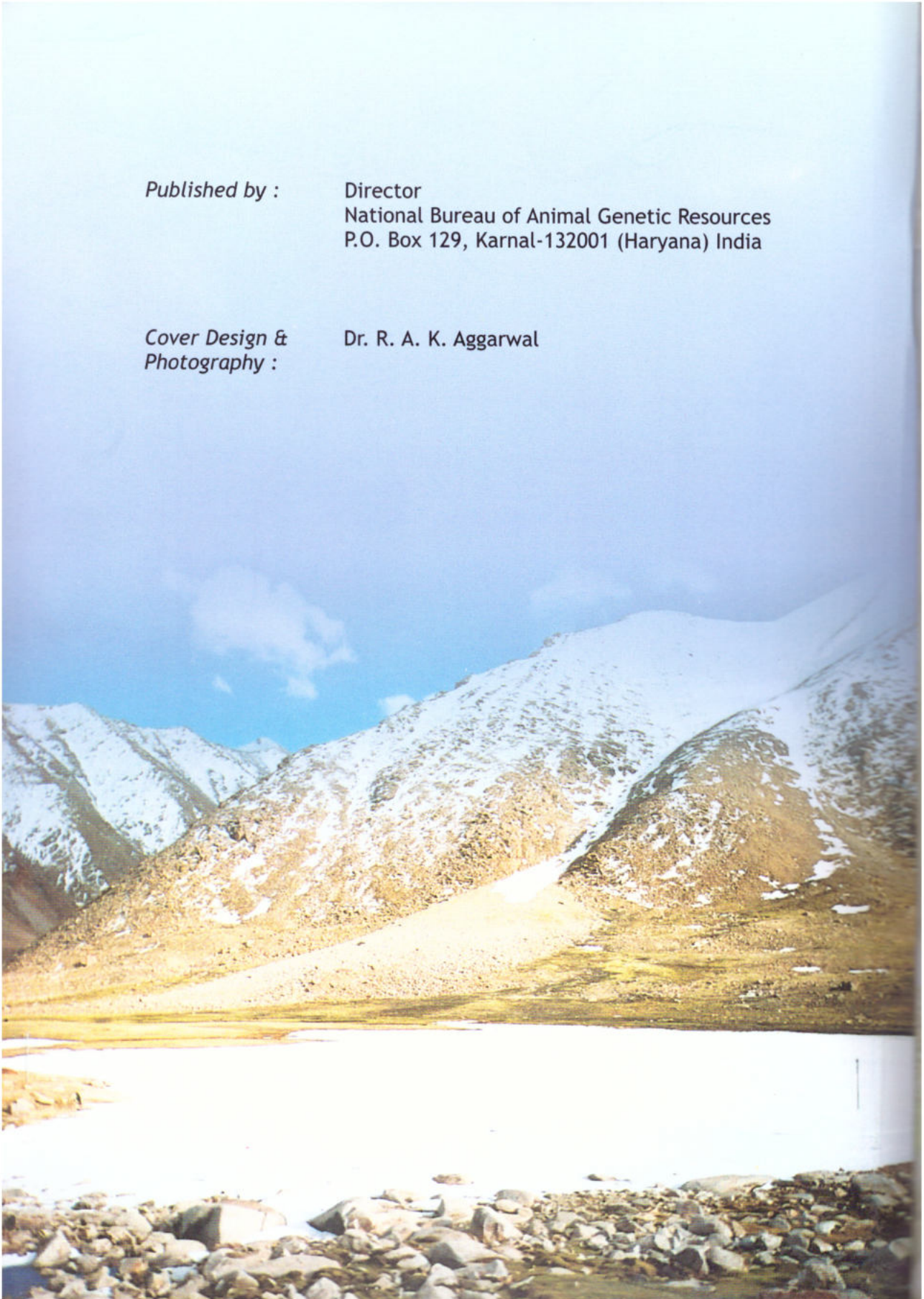
(Indian Council of Agricultural Research)

P.O. Box No. 129, Karnal (Haryana)



Published by : Director
National Bureau of Animal Genetic Resources
P.O. Box 129, Karnal-132001 (Haryana) India

*Cover Design &
Photography :* Dr. R. A. K. Aggarwal



Monograph 57, 2007

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1. Introduction

Goats are an important source of meat, milk, skin manure and fiber. The fiber of goat origin is classified as mohair, pashmina and hair, however, mohair and pashmina have the commercial importance due to its utilization in textile industry. There are two breeds of pashmina yielding goats viz. Chegu and Changthangi in India (Acharya, 1982). Both of these breeds are found at high altitudes in the trans himalayan mountain range bordering Tibet. Changthangi goats are localized in Changthang sub division of Ladakh region of Jammu and Kashmir. This region is characterized by extremes of environmental conditions such as high intensity electric storms, dry atmosphere, persistent hypoxia etc. which causes environmental stresses affecting the animals life. However, despite difficult environmental conditions and limited grazing resources, Ladakh inhabits some excellent and rare species of livestock.

2. Habitat and body bio-metrics of the breed

2.1 Native tract

The natural habitat of the Changthangi breed of goat is the Changthang region of Leh district in Jammu and Kashmir (Fig. 1), which is one of the highest plateau in the world. These goats are reared by a nomadic tribe known as “Changpa” and the breed is named after its natural habitat.



Fig1. The Breeding tract of Changthangi goats in Ladakh region of Jammu and Kashmir



2.2 Climatic conditions of the region

The Ladakh region constitutes nearly one third of the area of Jammu and Kashmir state of India. It is a plateau characterized by sandy soil and brown rocks among snow covered high range northwestern Himalayan mountains lying 3000 to 6000 mts. above m.s.l. and bordering Tibet. The region lies between 30° and 60° latitude and 75° to 81° longitude. The annual rainfall of the region is only 8 to 9 cm. The temperature in the summer reaches as high as 35° C and in winter it dips down to -50° C. This large variation in day and night temperatures causes diurnal change in animals. The Changthang region, which is a native breeding tract of Changthangi goats, has similar environmental conditions. This region has an excessive surface water system due to perennial supply of melted glacier water, but due to rugged terrain insignificant amount of water is utilized for irrigation. The soil is alluvial and is suitable for the cultivation of cereal crops like wheat and barley, where irrigation facilities exist. The important pasture species found in the area are grasses such as *Poa pratensis*, *Festuca rubra*, *Bromus macrostachy*, *Elymus sibiricus*, *Agropyron lange-aristatum* etc., legumes such as *Astragalus tri bulipolius*, *Oxytropis micropylla*, *Cicer microphyllum* etc. and bushes such as *Cargana vesicolor*, *Myricaria germonica*, *Myricaria prostrata* (Mir, 2000). Due to poor agricultural production, livestock farming is a major source of livelihood for the farmers of this region. Some of the typical features of the breeding tract has been shown in Figures 2 a,b,c,d,e,f.



Fig. 2a A pasture land surrounded by mountains



Fig. 2b A lake surrounded by mountain



Fig. 2d A lake in the region



Fig 2e Barren mountains at high altitude



Fig. 2f A pastureland



Fig 2g A frozen lake

Fig. 2 Typical topography in breeding tract of Changthangi goat

2.3 Body conformation traits

Changthangi goats are sturdy, medium sized with a long hair coat (Fig. 3a, b).



Fig. 3a Adult pair of Changthangi goat



Fig 3b A flock of Changthangi goats



Changthangi Goat

Length and height of animals are of almost equal dimensions (Table 1) but, with a large heart girth, which gives the impression of a compact body with a slight bulging chest. A deep chest indicates large pulmonary organs, which is considered vital for adaptation to a low oxygen environment (Misra et al., 1998).

Table 1. Body measurements of Changthangi goats at different stages of life (cm).

Age group	Sex	Body length	Heart girth	Height of wither	Reference
Birth	Male	21.18	29.53	26.64	Darokhan and Tomar, 1983 ^a
-	Female	20.53	28.45	25.72	Darokhan and Tomar, 1983 ^a
-	Overall	21.52	21.56	24.48	Patil, 1992
Birth	Overall	26.00	29.90	27.7	Bhattacharya et al., 2004
2 yrs	Male	51.20	65.00	55.60	Misra et. al 1998
2 yrs	Female	49.00	54.10	49.10	Misra et. al 1998
Adult	-	53.82	66.57	50.54	Patil, 1992
-	Male	52.40	65.20	51.60	Acharya, 1992
-	Female	49.80	63.00	49.00	Acharya, 1992

These goats have a reasonably long coat of silky and lustrous hair, which makes a guard for the animal against the extreme low climatic temperature. Animals of both sexes are generally horned but a few polled animals can be seen in both sexes. The horns are large and twisted like a corkscrew, and are directed upwards, outwards and backwards (Fig 4 a, b). In males the horns are thicker and longer. The beard is present in both sexes. They have a tuft of hair on the forehead, which is more pronounced in males.

The body colour is generally white but varies from white to light brown and mixture of black, white, brown and grey (Fig 5a, b, c). The whole body is covered with long hair with fine undercoat of pashmina. The face and



Fig. (4 a, b) Horn shapes in Changthangi goats

muzzle are devoid of hair. Head is small, triangular and held high above back line, with a strong and well set neck. The ears are small, erected and stumpy. With these body features the animals look very stout and can walk very long distances every day in search of pasture grasses and herbs. The



Fig. 5 a, b, c Different colours of Changthangi goats

Changthangi Goat

yield of Pashmina and its quality depends upon the size of animal and differ from place to place. The females mature very quickly and can conceive at the age of 6 months. The goat guard is not normally clipped but there are exceptions.

2.4 Body weight

The Changthangi is a highly agile animal well adapted to the sparse grazing possibilities of Changthang. The birth weights of Changthangi male and female kids (Fig. 6) and the average birth weights reported by different workers has been given in Table 2. The mean weight of goat at the time of birth ranges from 1.82 kg to 2.25 kg and male weighs more than female as reported by many workers. The season of kidding had hardly any effect on the birth weights but period, sex and age of dam at kidding significantly affected growth at different ages (Misra et al., 1998).

The average body weights of Changthangi goats at the age of 3 months, 6 months, 12 months, 24 months and 36 months reported by different workers have been given in Table 3. The adult male weighs 31.02 kg, whereas adult female of same age weighs 25.75 kg (Fig 7, 8)



Fig 6 Male and female kids of Changthangi goat

Table. 2 Average birth weight (kg) of Changthangi goats

Male	Female	Overall	Reference
2.03	1.82	-	Darokhan & Tomar, 1983 ^a
2.25	2.13	-	Patil, 1992
2.24	2.04	2.14	Misra et al., 1998
-	-	2.13 (Season I)	Misra et al., 1998
-	-	2.15 (Season II)	Misra et al., 1998
-	-	2.13 (June- Nov.)	Singh et al., 1992
-	-	2.15 (Dec- May).	Singh et al., 1992
-	-	2.23 (Feb- May).	Singh et al., 1992
2.11	2.06	-	Bhattacharua et al., 2004

Table. 3 Body weight (kg) at different months of age in Changthangi goats

Sex	3 M	6 M	12 M	24 M	36 M	Reference
Overall	9.28	-	-	-	-	Acharya, 1992
Overall	-	15.90	-	-	-	Arora, 1992
Male	8.00	10.46	20.20	-	-	Patil, 1992
Female	7.43	9.01	19.00	-	-	Patil, 1992
Overall (June- Nov.)	9.07	10.06	15.56	-	-	Singh et al., 1992
Overall (Dec- May)	7.81	10.30	16.09	-	-	Singh et al., 1992
Overall (Feb- May)	7.99	10.50	13.47	-	-	Singh et al., 1992
Male	-	-	-	25.50	-	Patil, 1992
Female	-	-	-	22.07	-	Patil, 1992
Male	-	-	-	-	31.02	Patil, 1992
Female	-	-	-	-	25.72	Patil, 1992
Male	9.5	11.0	16.2	24.9	29.8	Misra et al., 1998
Female	7.4	9.5	15.4	20.1	23.5	Misra et al., 1998
Overall	8.4	10.2	15.8	-	-	Misra et al., 1998

3. Flock management and feeding

In majority of flocks the size of flock per family ranges from 300 to 500 animals which include sheep and goat both. The larger flocks comprising of

Changthangi Goat



Fig 7. Adult Changthangi female goat



Fig 8. Adult Changthangi male goat

700 sheep and goats are also noticed in Changthang. The goats are kept under an open range system throughout the year (Fig. 9). In summer they migrate to high altitude (12000ft to 19000ft) alpine pastures for grazing and in winter they are brought down to the valleys (Fig 10). The animals graze for average 9 hours during winter and 13 hours during summer months (Fig. 11, 12). The animals receive a concentrate mixture and alfalfa (Fig. 13, 14) as per requirements (Misra et al., 1998). Every family sends one shepherd with its livestock which are grazed separately and not allowed to mix with other flocks. In Changthang region Changthangi goats are reared by Changpas, who are either Rongpas or Nomads. Rongpas have permanent establishment in village. They have little land holding but good number of livestock. These people send their family members on specific routes with the livestock. They remain in Rebos (Tent) while on migratory routes. The livestock come back to the village for a month or two during autumn at the time of harvesting barley fields. The livestock rearing system of these people is a mixture of nomadism and trans humance. Nomads don't have permanent establishments and no land holdings. The male shepherds use an overcoat called "Goncha" in winters, which is very thick and made of goat/sheep skin with an inner lining of manually processed lamb pelt. The female shepherds use thick gown called "Rachok" made of goat skin. The nomadic



Fig 9. Goats kept in open at farm



Fig 10. Flock of goats on migratory rout



Fig 11. Goats going to pasture for grazing



Fig 12. Goats drinking water during grazing



Fig 13. Trees and shrubs in pasture



Fig 14. A stack of alfalfa

changpas try to restrict the goat population in their herds to an optimum level. The goat dung is used in the “Chullas” of the nomads and is a very important source of fuel for use in winter. The goat feaces is used as a sources of fuel by the nomads in winter.

Changthangi Goat

4. Reproduction performance

As per the common practice, one family reserves 1-3 bucks depending upon the strength of the flock, for breeding purposes. These bucks are priced possessions of the family and remain in the flock until their utility is exhausted. As a result, one flock has lot of progenies of a single buck. Thus the chances of inbreeding increases. The nomads are very possessive about their bucks and normally do not exchange them with other bucks. No standard culling practice is followed . The age at puberty is 889 ± 16 days. Rates of kidding and twinning are 85.3 % and 0.6% respectively. Most of the kidding (97%) occurs in September and October (Misra, 1985). Kumar (2000) reported the age at first tuppung, age at first kidding, gestation period, kidding interval and letter size of Changthangi goat as $668+18$ days, $830+13$ days, 152 days, $397+ 7$ days and 1, respectively.

5. Rearing and survival

The mothering ability of Changthangi goat is extremely poor. Most of the does abandon their kids soon after parturition. This is probably due to the poor milk yield of the dam, which is insufficient to meet the needs of suckling kids (Fig 15, 16). Early weaning of kids is therefore a source of annoyance to their mothers (Misra et al., 1998). In spite of early weaning, low mortality rate has been observed by many workers (Table 4.).



Fig 15 Udder of Changthangi female



Fig 16 Kids sucking milk

Table 4. Mortality rate (%) in Changthangi goats

Age group	Mortality percent	Reference
Suckling (Up to 4 Months)	0.6	Gupta 1981
—	2.3	Misra et al., 1998
Weaner (4-12 Months)	4.2	Gupta 1981
—	3.9	Misra et al., 1998
Adult (> 1 year)	1.5	Misra et al., 1998

The higher survival rate in the kids of this breed, indicates its resistance to the commonly occurring diseases like pneumonia, diarrhoea etc. and better adaptability to harsh climatic conditions prevailing in its original habitat.

6. Health

The Changthangi goat of Ladakh is highly adapted to the environmental conditions of the area. The animals are very stout and have resistance to common ailments. However they are protected against clostridial diseases with a multi component vaccine. Preventive measures are also taken against coccidial, helminthic and liver fluke infections with suitable anthelmintics.

7. Performance

7.1 Production performance

Milk and Chevon Yield: The mature does yield 200ml-300ml of milk per day when the kids are weaned. After weaning of kids the available milk becomes an important item for domestic consumption and is a readily available supplement of the routine diet of the nomadic changpas. The Chevon (goat meat) is relished by people in Ladakh. About 15-20% of the goat population is culled every year and are sold to butchers for meat.

7.2 Pashmina yield

Ladakh, the region of the Himalaya, has the credit for introduction of Pashmina as "Cashmere" to the world through the famous Kashmiri artisans. Pashmina/Cashmere is the name given to the fine wooly undercoat produced by a variety of goats in the cold arid desert and temperate region of the world during particular season. The goat down (fibre) produced by



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the Changra is one of the best fiber in the world and was the original historical raw material for the famous shawl industry of Kashmir, which became very famous in the world as objects of finest art and craft. It received the erroneous name “Cashmere” due to its age old association with the Kashmiri artisans connected with the textile industry.

Ladakh produces about 42000 kgs of raw Pashmina but the production can be increased three fold, if the purpose of goat keeping in the rest of Ladakh is changed and scientific breeding and husbandry tactics are scrupulously introduced. Ladakhi Pashmina is, possibly the best in the world with a diameter 11-13 micron. It has more than 40mm staple and is a very suitable fibre for hosiery and knit wear fabrics.

7.3 Nature of Ladakhi Pashmina

Ladakhi Pashmina does not have a stable colour. The colour of pashmina ranges from complete white to dark grey exhibiting almost a black hue depending upon the coat colour of goats. About 20% goats are pied. Off white animals also produce white pashmina and dark grey goats produce very light grey pashmina. The white pashmina remains in great demand and fetches the highest price. Grey Pashmina has been found to fetch about 80% of the price of white Pashmina in the world market whereas brown pashmina fetches about 66%. The production from an individual goat in Ladakh ranges from 75gms to 565gms of raw pashmina as reported by various workers (table 5).

Table 5. Average Pashmina yield (g) in Changthangi goats.

Male	Female	Castrated buck	Average	Reference
-	-	-	180	Khot and Jaiswal, 1963
-	-	-	208	Acharya and Sharma, 1980
-	-	-	75	Darokhan and Tomar, 1983 ^b
-	-	-	78-195	Acharya, 1992
268	115	-	191	Arora, 1992
402	248	-	-	Bhattacharya et al., 2000
433	350	565	411	Wani et el., 2004



Male produces more pashmina than female but the fiber is coarser than that of female's of the same group. Castrated males produce more pashmina than uncastrated males. The production level goes down after the 5th combing (Fig 17, 18). The pashmina quality and quantity are influenced by various factors such as sex, age, body weight, availability of nutrients, temperature, degree of atmospheric dryness, ratio of secondary follicles and colour of pashmina (Wani et al., 2004).



Fig 17 Combing in operation



Fig 18 A comb

7.4 Fiber characteristics

Pashmina fibers are non-medullated and are devoid of climps. They grow from secondary follicles. The average fiber length ranges from 4.95 cm. to 6.0 cm. as reported by different workers (Table 6). The average fiber diameter is 12.0 μm (Misra et al., 1998).

Table 6. Average Fiber length (cm) of chanthangi Breed

Average Fiber length	Reference
4.95	Darokhan and Tomar, 1983 ^b
4.95	Acharya, 1992
4.95	Arora, 1992
5.0-6.0	Gupta & Arora, 1992
4	Patil, 1992
5	Misra et al., 1998
4.02-4.25	Bhattacharya et al., 2000

8. Genetic studies

8.1 Molecular genetic variations

Microsatellite markers are best suited for assessing the genetic variability at DNA level because of their high mutation rate, large number, distribution throughout the genome, co-dominant inheritance and neutrality with respect to selection (Boyce *et al.*, 1996). Hence, these markers have been used to investigate the measure of genetic variability in indigenous goat population (Aggarwal *et al.*, 2006).

Methodology

Blood samples of 48 unrelated Changthangi goats from different villages of Changthang region in District Leh of Jammu and Kashmir were collected and genomic DNA utilized to generate genotypic data using a battery of 25 microsatellite markers (Table 7) based on the guidelines of ISAG & FAO's DADIS programme. Each forward primer was tagged on 5' end with one dye out of four dyes (FAM, PET, VIC, NED) as supplied by Applied Biosystems, U.K. The microsatellite genotyping was carried out using AVANT 3100 automated DNA sequencer (Applied Biosystems) with LIZ 500 as internal lane standard. The data was collected and analyzed using Gene Mapper Software (Version 3.0, Applied Biosystems). For 25 microsatellites loci analyzed, observed and expected heterozygosity estimates were calculated as per Levene (1949) and Nei (1973) and as implemented in POPGENE software (Yeh *et al.*, 1999). The observed and effective numbers of alleles (Kimura and Crow, 1964) were also calculated using POPGENE software.

The tests for deviation from Hardy-Weinberg equilibrium were derived using the F statistics of F-STAT programme. Tests for pair wise linkage (genotypic) disequilibrium among the microsatellite loci were also done using FSTAT version 2.9.3, an updated version of 1.2 (Goudet, 1995) for 24 microsatellite loci whose genotypes were determined directly. Polymorphic information content was calculated as per Botstein (1980). Finally the bottleneck hypothesis was investigated using BOTTLENECK 1.2.01 (Cornuet



Table 7. Microsatellite markers, their sequences, type of repeat, size range, location and accession numbers.

S. N.	Locus	primer sequence	Type of repeat	Size Range	Chr. No.*	Gene Bank Acc.No.**
1.	ILST008	gaatcatggatttctgggg tagcagtgagtgaggtggc	(CA) ₁₂	167-195	14	L23483
2.	ILSTS059	gctgaacaatgtgatgttcagg gggacaataactgtcttagatgctgc	(CA) ₄ (GT) ₂	105-135	13	L37266
3.	ETH225	gatcacctggccactatttct acatgacagccagctgctact	(CA) ₁₈	146-160	14	Z14043
4.	ILST044	agtcacccaaaagtaactgg acatgtgtattccaagtgc	(GT) ₂₀	145-177	Ann	L37259
5.	ILSTS002	tctatacacatgtgctgtgc cttaggggtgaagtgacacg	(CA) ₁₇	113-135	Ann	L23479
6.	OarFCB304	ccctaggagcttcaataaagaatc ggcgctgctcaactgggtcaggg	(CT) ₁₁ (CA) ₁₅	119-169	Ann	L01535
7.	OarFCB48	gagtagtacaaggatgacaagaggca cgactctagaggatcgaaagaaccag	(GT) ₁₀	149-181	17	M82875
8.	OarHH64	cgtccctcactatgaaagtatatatgc cactctattgtaagaattgaaatgagagc	-	120-138	4	212 ^a
9.	OarJMP29	gtatacacgtggacaccgctttgtac gaagtggcaagattcagaggggaag	(CA) ₂₁	120-140	Ann	U30893
10.	ILSTS005	ggaagcaatgaaatctatagcc tgtctgtgagttgtaagc	(nn) ₃₉	174-190	10	L23481
11.	ILSTS019	aagggacctatgtagaagc actttggaccctgtagtgc	(TG) ₁₀	142-162	Ann	L23492
12.	OMHC1	atctggtgggctacagtccatg gcaatgcttctaaattctgaggaa	-	179-209	Ann	228 ^b
13.	ILSTS087	agcagacatgatgactcagc ctgcctctttctgagagc	(CA) ₁₄	142-164	Ann	L37279
14.	ILSTS30	ctgcagttctgcatatgtgg cttagacaacaggggttgg	(CA) ₁₃	159-179	2	L37212

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15.	ILSTS34	aagggtctaagtcactggc gacctggttagcagagagc	(GT) ₂₉	153-185	5	L37254
16.	ILSTS033	tattagagtggctcagtgcc atgcagacagtttagaggg	(CA) ₁₂	151-187	12	L37213
17.	ILSTS049	caattttctgtctctcccc gctgaatctgtcaaacagg	(CA) ₂₆	160-184	11	L37261
18.	ILSTS065	gctgcaaagagttgaacacc aactattacaggaggctccc	(CA) ₂₂	105-135	24	L37269
19.	ILSTS058	gccttactaccattccagc catcctgactttggctgtgg	(GT) ₁₅	136-188	17	L37225
20.	ILSTS029	tgtttgatggaacacagcc tgatttagaccaggggtgg	(CA) ₁₉	148-191	3	L37252
21.	RM088	gatcctctctgggaaaagagac cctgtgaagtgaaacctcagaa	(CA) ₁₄	109-147	4	U10392
22.	ILSTS022	agtctgaaggcctgagaac ccttacagtcctgggggtgc	(GT) ₂₁	186-202	Ann	L37208
23.	OarAE129	aatccagtggtgaaagactaatccaggt agatcaagatatagaatattttcaacacc	(CA) ₁₄	130-175	7	L11051
24.	ILSTS082	ttcgttctcatagtctgg agaggattacaccaatcacc	(GT) ₁₇	100-136	2	L37236
25.	RM4	cagcaaaatatcagcaaacct ccacctgggaaggcctta	(CA) ₁₃	104-127	15	U32910

*Chr.No.-Chromosome number; ** Acc. No. – Accession number; ^a- Accession number of Arkdb data base (<http://www.thearkdb.org>).

and Luikart, 1996). The BOTTLENECK tests for the departure from mutation drift equilibrium based on heterozygosity excess or deficiency and requires only measurement of allele frequencies from 5-20 polymorphic loci in a sample of approximately 20-30 individuals. The bottleneck compares heterozygosity expected (H_E) at Hardy-Weinberg equilibrium to the heterozygosity expected (H_{eq}) at mutation drift equilibrium in same sample that has the same size and the same number of alleles. The strict one stepwise mutation model (Ohta and Kimura, 1973), the infinite allele model (Kimura and Crow, 1964) were used to calculate H_{eq} .

Genotypic information

Various measures of genetic variation in Changthangi goat population are presented in Table 8. The number of alleles observed across the studied microsatellite loci varied from 5 (Oar JMP 29) to 19 (Oar FCB 304, ILSTS 34 and ILSTS 058) with an overall mean of 10.67 ± 4.02 . The observed number of alleles was more than effective number of alleles, which ranged from 1.57 (Oar JMP 29) to 10.69 (ILSTS 058). The average observed heterozygosity (0.60) was lower than expected heterozygosity (0.74). Shannon's information index and Polymorphic information content (PIC) showed that most of the loci were highly informative indicating the high polymorphism across the loci with an overall mean of 1.724 and 0.762 respectively, thus suggesting suitability of these markers for genetic diversity studies in goats.

The Changthangi goats had substantial genetic variation based on its gene diversity and average number of alleles per locus. The average genetic variation (0.602) in Changthangi goats was comparable with genetic variation found in Black Bengal ($H_o = 0.69$) and Chegu ($H_o = 0.66$) breeds of Indian goats and was higher than in other indigenous goats (Barbari, Jamnapari, Sirohi and Marwari : H_o ranging from 0.45 to 0.54).

Within population inbreeding estimate (F_{is}) for investigated loci was 0.176, which suggests moderate level of inbreeding in Changthangi goats. This moderate level of inbreeding may be due to the fact that few bucks are used for the whole and nearby villages in the breeding region. Significant linkage disequilibrium could not be detected at any of the loci pairs located on the same chromosome after applying Bonferroni corrections in deriving the level of significance ($p = 0.00017$).

The different tests of bottleneck hypothesis under TPM and SMM models indicated significant deficiency of heterozygosity, possibly caused by introduction of unique/rare alleles by immigrants and population does not seem to have severe reduction in its size in its recent past.

Table 8. Number of alleles (observed, n_o , effective, n_e), heterozygosity (observed, H_o , expected, H_e), polymorphic information content (PIC) and inbreeding estimate (F_i) for each of microsatellite loci and mean estimates of different parameters for Changthangi goat

Sr. N.	Locus	No	Ne	Ho	He	PIC	Information index	F _i
1	ILST008	6.00	2.52	0.27	0.61	0.562	1.194	0.550
2	ILSTS059	8.00	2.81	0.61	0.65	0.617	1.435	0.053
3	ETH225	10.00	4.89	0.73	0.80	0.768	1.793	0.078
4	ILSTS044	15.00	4.10	0.79	0.76	0.727	1.870	-0.047
5	ILSTS002	10.00	4.68	0.85	0.80	0.765	1.866	-0.086
6	OarFCB304	19.00	8.93	0.98	0.90	0.846	2.487	-0.102
7	OarFCB48	14.00	6.80	0.50	0.86	0.832	2.185	0.414
8	OarHH64F	9.00	3.64	0.63	0.73	0.685	1.539	0.138
9	OarJMP29	5.00	1.57	0.24	0.37	0.343	0.775	0.346
10	ILSTS005	9.00	4.24	0.63	0.77	0.736	1.715	0.175
11	ILSTS019	9.00	4.02	0.70	0.76	0.713	1.613	0.074
12	OMHC1	11.00	6.90	0.30	0.88	0.839	2.136	0.649
13	ILSTS087	8.00	4.07	0.72	0.76	0.713	1.565	0.048
14	ILSTS30	9.00	2.45	0.39	0.60	0.563	1.321	0.339
15	ILSTS34	19.00	12.27	0.65	0.93	0.861	2.673	0.290
16	ILSTS033	10.00	2.40	0.61	0.59	0.559	1.358	-0.047
17	ILSTS049	9.00	2.48	0.39	0.60	0.563	1.319	0.338
18	ILSTS065	6.00	2.17	0.43	0.55	0.505	1.092	0.200
19	ILSTS058	19.00	10.69	0.91	0.92	0.848	2.621	-0.005
20	ILSTS029	11.00	6.16	0.89	0.85	0.818	1.996	-0.067
21	RM088	10.00	5.02	0.64	0.81	0.774	1.824	0.205
22	OarAE129	13.00	3.87	0.46	0.75	0.718	1.812	0.382
23	ILSTS082	6.00	3.33	0.22	0.71	0.660	1.401	0.689
24	RM4	11.00	4.42	0.90	0.78	0.749	1.868	-0.163
	Mean	10.67	4.77	0.60	0.74	0.762	1.727	0.176

9. Conclusion and recommendations

The Changthangi goats of Ladakh is highly adapted to the environmental conditions prevailing there. The animals are sturdy and can walk long distances each day in search of fodder. These goats are of great importance for vitalising the economy of farmers in breeding tract. However genetic characterization indicates moderate level of inbreeding in these goats, which suggests unplanned and indiscriminate breeding in these goats. The following points may be taken care for improvement of Changthangi goats.

1. Selective breeding within the breed for qualitative and quantitative improvement of Pashmina to bring about colour stability.
2. Identification of major disease of Changthangi goats, its infestation and proposition of measures for diseases control.
3. Buck and Ram exchange programme in public flock in order to reduce the chances of inbreeding.
4. Pasture Improvement/Fodder development.
5. Creation of feed/fodder banks in Changthang for management of possible crisis as a result of snowfall or drought.
6. Treatment and vaccination and dozing of livestock.
7. In order to improve the pashmina production qualitatively and quantitatively production multipronged genetic improvement, feed and fodder improvement, animal health and value addition of primary produce followed by proper market organization is cardinal to harvest maximum benefit from pashmina (Ganai and Sheikh, 2004).

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Published by : Director, NBAGR

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