

## Biodiversity and Conservation of Indian Sheep Genetic Resources - An Overview -

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**ABSTRACT** : Indian subcontinent is a rich source of diverse ovine germplasm, and only very few countries have such a large number of breeds with wide genetic diversity. This vast ovine biodiversity in India is being eroded rapidly and more than 50% of sheep breeds are currently under threat. It is noteworthy that the characterization of Indian sheep breeds was last done in the first half of the century since then no recent estimates are available and surveys in majority of the regions/breeds are far from complete. Starting in 1985 National Bureau of Animal Genetic Resources (NBAGR), Karnal, India, therefore, initiated activities aimed at determining the status and compiling information on indigenous farm animals including sheep. This report represents attempts made to date on the basis of field/literature surveys and additional activities on molecular characterization to ascertain their status including distribution, population changes, breed diversities and risk status. The need, mode and mechanisms of conservation are also described. Involvement of several agencies for evaluation, improvement, conservation programmes and recommendations made for effective characterization and conservation of sheep biodiversity are highlighted. This publication would promote action particularly at national level to improve the information base on domestic Indian breeds of sheep and provide input into national domestic sheep diversity conservation policy decisions. (*Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 10 : 1387-1402*)

**Key Words** : Indigenous Sheep, India, Biodiversity, Conservation

### INTRODUCTION

India is one of the few countries in the world, which has contributed richly to the international livestock gene pool and improvement of animal production in the world. Sheep biodiversity in India is characterized by high degree of endemism and variations in agro climatic conditions of the different regions has led to the development of various breeds/strains that are well adapted to specific set of environmental conditions. These breeds have generally been named after their place of origin and some based on their prominent characteristics. A few breeds have been evolved from the base populations created by crossing native and fine wool exotic breeds. Indigenous sheep contribute greatly to the agrarian economy, especially in areas where crop and dairy farming are not economical, and play an important role in the livelihood of a large proportion of small and marginal farmers and landless laborers. However, intermixing of nearby breeds, introduction of exotic breeds, and change in farming system have resulted in decline in purebred population and in dilution of genetic merit. No efforts could be made till ninety's for the conservation of sheep genetic resources in the country. Conservation of genetic resources in developing countries is far more complex, because, in a vast majority of the cases, information about available genetic resources, their usefulness and need for and methods of conservation are not clear. Determination of status and characterization of

indigenous sheep genetic resources is essential for planning domestic animal diversity conservation plans (DAD-IS, FAO). It is noteworthy worthy that some sporadic attempts initiated in the past few years, however, have resulted in sketchy information on physical and economic characters of most of the breeds only from the organized farms/institutional herds (Kaura, 1941; ICAR, 1945; Narayan, 1959; Bhat et al., 1981). Acharya (1982) described the Indian Breeds of sheep based on published literature and also on his personal surveys. Further, not much information is usually available on their genetic characteristics and phylogenetic diversity - a first guidance in making conservation decisions in ovines. The Indian Council of Agricultural Research (ICAR), India has established a National Bureau of Animal Genetic Resources (NBAGR) at Karnal to take up description, evaluation and conservation of the livestock genetic resources and suggest strategies for their long term conservation. Efforts are being made at NBAGR Karnal to determine the latest status by compiling information on characteristics of indigenous breeds of sheep through surveys on native tracts. Additional activities on molecular characterization of indigenous sheep breeds are also well under way at NBAGR (Arora and Bhatia, 2003; Sodhi et al., 2003) in view of worldwide recognition of the need for analysis of genetic structure and relationships of sheep populations/breeds to conserve ovine diversity (Arranz et al., 1998, 2001; Saitbekova et al., 2001; Sun et al., 2004). Conservation of sheep genetic resources, not only national but an international issue, therefore, needs more attention to the present status of sheep biodiversity and outlining measures that are necessary if the goals of

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**Table 1.** Census and growth rate of sheep in India

Year	Population (million heads)	Growth rate % per annum
1951	39.10	-
1956	39.30	0.10
1961	40.20	0.45
1966	42.00	0.88
1972	40.00	-0.97
1977	41.00	0.50
1982	48.76	3.53
1987	45.70	-1.29
1992	50.78	2.13
2001	58.20	-

sheep diversity conservation and self-reliance are to be combined.

**POPULATION DYNAMICS OF SHEEP**

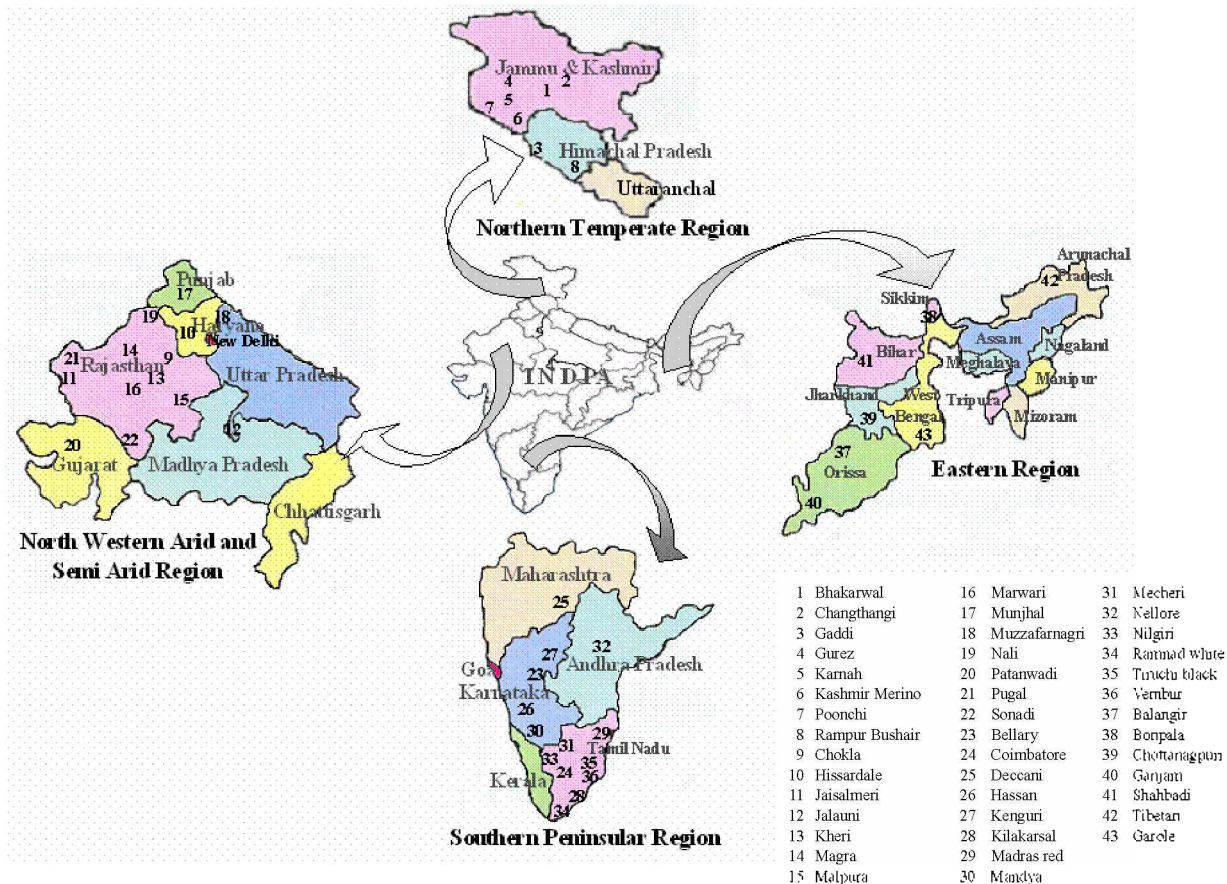
The sheep population dynamics is presented in Table 1. The sheep population in India is estimated to be about 50.8 million (1992 census) ranking sixth in the world and accounting for about 4.57% of the total population. Of late an increase to 58.20 million heads has been reported by FAO in 2001 (Arora and Prince, 2004). About five million households in the country are engaged in rearing of these

small ruminants and allied activities. It is estimated that about 169 m kg of mutton, 42.7 m kg of wool and 40 m kg of skins are produced annually from sheep in the country. According to the FAO World Watch List (2000), there are 60 breeds of sheep in India. This list includes both well-recognized and lesser known breeds along with some wild species. Although there are documented about 40-43 descript breeds of sheep. (Acharya, 1982; Kushwaha et al., 1999, Khan et al., 2001. Bhatia et al., 2004), majority of sheep population (around 75%) do not belong to any of the defined breeds. India's share to total number of breeds of world is 6.41 per cent.

**STATUS OF SHEEP BREEDS**

**Special characteristics of indigenous breeds**

The Indian sheep are derived both from Urial and Argali stock. They are thin tailed, medium to coarse wool type in North temperate and North Western regions and hairy type in Southern Peninsular and Eastern regions. The present day Indian breeds are the outcome of thousands of years of deliberate natural selection and field level cross breeding for adaptation to specific agro-ecological conditions. During the course of evolution these indigenous animals have developed superior heat tolerance as well as disease



**Figure 1.** Distribution of sheep breeds in different agro-ecological regions of India.

**Table 2.** Sheep breeds of Northern temperate region

SN	Breed	Location	Main uses	Characterization		Conservation	
				Morphological	Genetic	<i>In situ</i>	<i>Ex situ</i>
	Bhakarwal	J & K, migratory flock	Carpet wool	NATP-MM (J&K)	NATP-MM (Kamal)	-	-
	Changthangi	Changthang region of Ladakh	Carpet wool	NWP, NBAGR, Kamal (SKUAST Srinagar)	-	-	-
	Gaddi	Kulu, Kangra & Chamba districts of H.P.	Carpet wool	NATP-PSR (Palampur)	NATP-PSR (Kamal)	-	-
	Gurez	Gurez tehsil in northern Kashmir	Carpet wool	NATP-PSR (J&K)	NATP-PSR (Kamal)	-	-
	Kamah	Kamah in north Kashmir	Apparel wool	NATP-PSR (J&K)	NATP-PSR (Kamal)	-	-
	Kashmir Merino	Kashmir valley	Apparel wool	-	-	-	-
	Poonchi	Poonch & Rajori districts of J&K	Carpet wool	-	-	-	-
	Rampur Bushair	Rampur Bushair, Simla, Kinnaur, Nahan, Bilaspur & Lahaul Spiti districts of H.P.	Carpet wool	NWP, NBAGR, Kamal (HPKV, Palampur)	-	-	-

NWP-AGR: Network project on animal genetic resources, NBAGR, Kamal.

NATP-MM: National Agricultural Technology Project (Mission Mode), NBAGR, Kamal, (lead center).

NATP-PSR: National Agricultural Technology Project (PSR, NBAGR, Kamal).

resistance. Indigenous sheep breeds are hardy and are able to cover long distances during migration. They are relatively better adapted to local climatic conditions and can sustain extremely high temperature during summer season as compared to crossbred sheep. Hence the crossbred and exotic sheep have to be grazed during cooler hours as they start panting during hot summer months.

Further indigenous sheep have been found to have better resistance against endoparasites whereas crossbreds and exotic sheep are relatively more susceptible to diseases. There are substantial evidences for genetic variation between indigenous sheep and exotic crosses in resistance to internal parasites such as *Haemonchus contortus*, *Ostertagia circumcincta* and *Trichostrongylus colubriformis*. Studies conducted on some indigenous sheep and exotic crosses with respect to infection with gastrointestinal nematodes revealed that there is significant difference in fecal egg count, hematological and biochemical parameters between the breeds. Indigenous sheep excreted fewer worm eggs in faeces and had lower morbidity and mortality rates compared to exotic breed and their crosses. Garole sheep are naturally resistant to haemonchosis (Arora, 2004).

### Classification of breeds

The sheep breeds have been classified on the basis of agro-ecological regions viz. a) North temperate region, b) North-Western arid and semi arid region c) Southern peninsular region and d) Eastern region (Figure 1). Classification has also been based on major products i.e. a) apparel wool, b) carpet wool, c) meat and carpet wool and d) meat types. The description of most of breeds is based on physical conformation and body size with some indication of the major products obtained from breeds. Of the breeds

of sheep, Marwari in North West and Deccani in southern - peninsular are numerically the most important and may be the largest contributors to carpet wool and meat production in the country. Region wise classification for the development of sheep genetic resources based primarily on the information contained in the paper of Acharya 1982 and NBAGR survey reports (NBAGR, Annual Reports, 2000-2003) is being discussed below.

*The Northern temperate region* : The region comprises Jammu and Kashmir, Himachal Pradesh and hilly regions of Uttaranchal. The entire northern hilly region falls under the influence of the Himalayas.

Most flocks are small and stationary. However, about 20% of the flocks are migratory and are comparatively bigger in size. The stationary flocks graze in harvested fields, along the waterways, in forests and in permanent pastures on common grazing land. The migratory flocks graze on foothills and in the valleys in winter and move to high altitude forests and alpine meadows in summer.

This region has a sheep population of 6.42 m. The important sheep breeds are Rampur Bushair, Gaddi, Gurez, Kamah, Bhakarwal, Poonchi, Kashmir Merino and Changthangi (Table 2); most of these have been involved over the last few years in cross-breeding with exotic fine-wool breeds for increasing apparel wool production.

*The North-Western arid and semi arid region* : The region comprises the States of Punjab, Haryana, Rajasthan and Gujarat and the plains of Uttar Pradesh Madhya Pradesh and Chhattisgarh. The region consists of vast alluvial plains with scattered hills and sandy desert with undulating topography.

*Most sheep flocks are stationary* : In Gujarat 67% and in Rajasthan 86% are reported to be stationary, while in

**Table 3.** Sheep breeds of Northwestern and semiarid region

SN	Breed	Location	Main uses	Characterization		Conservation	
				Morphological	Genetic	<i>In situ</i>	<i>Ex situ</i>
	Chokla	Nagaur, Sikar, Churu and Jhunjhunu districts of Rajasthan	Carpet wool	NBAGR (Karnal)	NBAGR (Karnal)	-	-
	Hissardale	Hissar	Meat, carpet wool	-	-	-	-
	Jaisalmeri	Jaisalmer, Barmer & Jodhpur districts of Rajasthan	Meat, carpet wool	NATP-PSR (CSWRI Avikanagar)	NATP-PSR (Karnal)	-	CSWRI Avikanagar
	Jalauni	Jalaun, Jhansi & Lalitpur districts of U.P.	Meat, carpet wool	NBAGR (Karnal)	-	-	-
	Kheri*	Merta, Nagaur, Jodhpur, SawaiMadhopur, Tonk districts of Rajasthan	Meat, carpet wool	NBAGR (Karnal)	NBAGR (Karnal)	-	-
	Magra	Bikaner, Nagaur, Jaisalmer and Churu districts of Rajasthan	Carpet wool	-	NBAGR (Karnal)	NWP, NBAGR, Karnal (RAU Bikaner)	-
	Malpura	Jaipur, Tonk, Ajmer, Bhilwara, Bundi & SawaiMadhopur districts of Rajasthan	Meat, carpet wool	NATP-PSR (CSWRI Avikanagar)	NATP-PSR (Karnal)	-	-
	Marwari	Jodhpur, Jalor, Nagaur, Pali and Barmer, Ajmer and Udaipur districts of Rajasthan and Jeoria region of Gujarat.	Meat, carpet wool	NBAGR (Karnal)	NBAGR (Karnal)	-	-
	Munjal*	Hissar, Ambala and Karnal districts of Haryana, Patiala and Bhatinda districts of Punjab	Meat, carpet wool	CSWRI, Avikanagar	-	-	-
	Muzaffarnagri	Muzaffarnagar, Bulandshahar, Saharanpur, Meerut & Bijnor districts of U.P. and Dehradun district of Uttaranchal.	Meat, carpet wool	NBAGR (Karnal)	NBAGR (Karnal)	-	-
	Nali	Ganganagar, Churu and Jhunjhunu district of Rajasthan	Carpet wool	NBAGR (Karnal)	NBAGR (Karnal)	-	-
	Patanwadi	Saurashtra, Kutch, Patan, Kadi, Kalol, Sidhpur and Mehsana districts of Gujarat	Carpet wool	-	NWP, NBAGR, Karnal (GAU Anand)	-	-
	Pugal	Bikaner & Jaisalmer districts of Rajasthan	Meat, carpet wool	NATP-MM (Karnal)	NATP-MM (Karnal)	-	NATP-MM (Karnal)
	Sonadi	Udaipur, Dungarpur & Chittorgarh districts of Rajasthan	Meat, carpet wool	NBAGR (Karnal)	NBAGR (Karnal)	-	-

\* Breeds not included in the list recognized at the National level.

Haryana and Punjab, there is almost no migration except within districts. In Rajasthan about 0.5 m sheep, belonging to Merta and Nagaur tehsils of Nagaur district and Bilara and Jodhpur tehsils of Jodhpur district, are on permanent migration and not brought to their homestead at any time of the year.

This region has the second largest population of sheep of the four regions. The sheep population of 16 m constitutes over a third of the total sheep population of the country (1992 census, Dairy Year Book, 2000-01) and wool produced is mostly suited for manufacture of carpets, felts and blankets. Important breeds of sheep in this region are Chokla, Magra, Nali, Pugal, Marwari, Malpura, Sonadi, Jaisalmeri, Kheri, Patanwadi, Munjal, Muzaffarnagri, Jalauni and Hissardale (Table 3). This region is the most important in the country for carpet-wool production. Different breeding strategies have been adopted in different

regions for improving wool production, quality and body weight in sheep. In north western region emphasis is on improving carpet wool production.

*The Southern peninsular region* : This region is semi-arid in the central peninsula and hot and humid along the coast. It comprises the states of Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Kerala and other territories in the central area. The topography of this region is comprised of highlands, plateaus, fluvial deltas and planes, mountain ranges and sandy tracts.

There is very little migration of the kind observed in the northwestern region. In Maharashtra, about 80% of the sheep are stationary. Most flocks begin migration between October and February and return to their homestead by May to July, at or before the onset of monsoon. Only a few families move with their flocks; in most, one or more members of the family look after the flock during migration.

**Table 4.** Sheep breeds of Southern peninsular region

SN	Breed	Location	Main uses	Characterization		Conservation	
				Morphological	Genetic	<i>In situ</i>	<i>Ex situ</i>
	Bellary	Bellary, Davangere, Haveri and Chitradurga districts of Karnataka	Meat, carpet wool	NBAGR (Karnal)	NBAGR (Karnal)	-	-
	Coimbatore	Coimbatore & Dindigul districts of Tamil Nadu	Meat, carpet wool	NWP, NBAGR (Karnal) Vet. Coll., Namakkal	-	-	-
	Deccani	Semi arid areas of Maharashtra, Andhra Pradesh and Karnataka.	Meat	NWP, NBAGR (Karnal) BAIF, Urfikanchan	-	-	-
	Hassan	Hassan district of Karnataka	Meat	NBAGR (Karnal)	NBAGR (Karnal)	-	-
	Kenguri	Raichur district of Karnataka	Meat	NBAGR (Karnal)	NBAGR (Karnal)	-	-
	Kilakarsal	Virudunagar & Ramnathpuram districts of Tamil Nadu	Meat	-	-	NWP, NBAGR, Karnal TNVASU Chennai	-
	Madras red	Chingalpet & Madras districts of Tamil Nadu	Meat	-	-	-	-
	Mandya	Mandya and bordering Mysore districts of Karnataka.	Meat	NBAGR (Karnal).	-	-	-
	Mecheri	Salem, Erode & Namakkal districts of Tamil Nadu	Meat	NWP, NBAGR, Karnal TNUVAS, Chennai	-	-	-
	Nellore	Nellore, Prakashan, Ongole districts of A.P.	Meat	-	-	-	-
	Nilgiri	Nilgiri hills of Tamil Nadu	Apparel wool	-	-	NWP, NBAGR TNVASU Chennai	-
	Ramnath white	Ramnathpuram & Virudunagar districts of Tamil Nadu	Meat	-	-	-	-
	Tiruchi black	Tiruchy, Perambalur, Tiruvannamalai, Salem & Dharampuri districts of Tamil Nadu	Meat	-	-	-	-
	Vembur	Tuticorin & Virudunagar districts of Tamil Nadu	Meat	-	-	-	-

Most flocks remain within their districts or move only to neighbouring districts. In Andhra Pradesh, 94% of the flocks are recorded as stationary, the migration pattern being similar to that in Maharashtra.

This region has the largest sheep population of the country: 23.14 m. Important breeds of sheep of this area are Deccani, Bellary, Nellore, Chennai Red, Mandya, Tiruchy Black, Mecheri, Ramnath White, Nilgiri, Coimbatore, Kilakarsal, Kenguri, Hassan and Vembur (Table 4). Almost half of these produce no wool; the rest produce very coarse, hairy and coloured fleeces (Deccani, Bellary, Mandya, Coimbatore and Mecheri). Most sheep in this region, except the Nilgiri, are maintained primarily for meat. In this region selection among better indigenous mutton breeds such as Nellore and Mandya and upgrading of inferior mutton breeds with these has been adopted (Acharya, 1999).

*The Eastern region*: The region comprises the states of Bihar, Jharkhand, West Bengal, Orissa, Assam, Meghalaya, Arunachal Pradesh, Mizoram, Manipur, Tripura, Nagaland and Sikkim. It is mostly hot and humid, except for some parts of eastern states, which are sub-temperate and humid. The topography in this region represents vast variation

including hill ranges and valleys of northeastern areas, alluvial plains with uplands and downlands in some areas in Bihar and plateaus and table-land in Orissa. There is maximum rain in this part of the country and therefore the climate is humid during most part of the year. In the plains most of the flocks are stationary, migrating to neighbouring districts only in scarcity periods.

The total sheep population of this region is 5.26 m. The important breeds are Shahabadi and Chottanagpuri in Bihar, Jharkhand and part of West Bengal, Garole sheep in West Bengal, Ganjam and Balangir in Orissa, Bonpala in Sikkim and Tibetan sheep in parts of Arunachal Pradesh and Sikkim (Table 5). Most of the breeds are primarily maintained for meat and the animals produce extremely coarse and hairy fleeces. In eastern and northeastern regions, emphasis is on improving quality and quantity of carpet wool through grading with better indigenous carpet wool breeds and crossing with exotic fine wool breeds.

## DIVERSITIES IN BREEDS

Large and biologically diverse sheep population of India

**Table 5.** Sheep breeds of Eastern region

SN	Breed	Location	Main uses	Characterization		Conservation	
				Morphological	Genetic	<i>In situ</i>	<i>Ex situ</i>
	Balangir	Balangir, Sambalpur and Sundargarh districts of Orissa	Meat, carpet wool	-	-	-	-
	Bonpala	Southern part of Sikkim	Meat, carpet wool	NWP, NBAGR, Kamal State Animal Husbandry Department, Sikkim	-	-	-
	Chottanagpuri	Chottanagpur, Ranchi, Palamau, Hazaribagh, Singhbhum & Dhanbad districts of Jharkhand	Meat, carpet wool	NWP, NBAGR, Kamal BAU, Ranchi	-	-	-
	Ganjam	Koraput, Phulbani and part of Puri districts of Orissa	Meat, carpet wool	-	-	-	-
	Shahbadi*	Shahabad, Patna & Gaya districts of Bihar	Meat	-	-	-	-
	Tibetan	Sikkim and Kameng districts of Arunachal Pradesh	Carpet wool	-	-	-	-
	Garole*	Sundarban region of West Bengal	Meat	NBAGR, Kamal NATP-MM	NBAGR, Kamal NATP-MM	-	-

is comprised of sheep exhibiting more than one strains, phenotypically similar breeds from adjoining areas named as separate breeds, phenotypically similar breeds groups, sheep evolved in farmers flock, recently rediscovered sheep, least discussed sheep and breeds exhibiting unique characteristics.

#### Breeds exhibiting more than one strains

Some of the breeds exhibit more than one strains in some of the breeds namely Patanwadi, Deccani and Nellore. Patanwadi the red faced, roman nosed breed of Gujarat has three types (a) non-migratory; small bodied and fleeced Patanwadi, (b) migratory; with long tubular ears and relatively coarse fleeced-Kathiawadi and (c) low statured, meat type, having coarse fleece Charotari also called Sonadi in Rajasthan. However, looking to the phenotypic appearance of Sonadi and Patanwadi their genetic similarity needs to be verified.

The sheep of Deccani breed are not uniform and their coat colour varies from black to white and the mixture of the two. It has been estimated that about 57 percent of Deccani are black, 28 per cent white and 15 per cent have a mixed coat colour. The varieties of Deccani are Lonad, Sangamneri, Solhapuri (Sangola) and Kolhapuri. Sangamneri type sheep has a stronger body constitution and higher wool yield. Their wool is coarser and of longer staple. Sangola type sheep have higher proportion of black colour sheep and produce finer fleeces.

Nellore sheep in Andhra Pradesh has three varieties distinguished primarily on the basis of colour viz., Jodipi, Palla and Dora (a) Jodipi (also called Jodimpu) with black spots particularly around the lips, eyes and lower jaw and also on belly and legs (b) Palla completely white or white with light brown spots on head, neck, back and legs and (c)

Dora, completely brown. Differences between the strains at genetic level need to be looked into to name them as separate breeds.

*Phenotypically similar breeds from adjoining areas named as separate breeds* : Some of the breeds of the adjoining areas have been identified as separate breeds although they may be similar, to each other genetically. The phenotypic differences may be due to selection for adaptation to specific conditions. The Chennai Red in Tamil Nadu, Nellore in Andhra Pradesh and Ganjam sheep in Orissa identified, as separate breeds appear to be similar but their actual genetic differences are not known.

*Phenotypically similar breed groups* : In Rajasthan, the so-called Bikaneri sheep include brown faced Chokla, Magra and Nali breeds, whereas Marwari, Jaisalmeri and Kheri are black-faced sheep (Mason, 1981). The phenotypic differences among them might have been due to assortative mating. Genetic differences, if any, among similar groups need to be established.

*Sheep evolved by farmers/pastoralists* : Migratory pastoralists in Rajasthan had selected for, and helped to develop, a new breed of sheep, called Kheri, in response to the increasing drought incidence and declining pasture availability. Kheri sheep is considered to have originated from a crossbred base with unknown levels of inheritance of Marwari, Malpura and Jaisalmeri sheep. The Kheri sheep contributes substantially to the economy of the landless and original farmers in the arid zone where the crop production is unpredictable due to scanty and erratic rainfall. Animals of Kheri sheep are distributed largely in Nagaur, Jodhpur and Tonk districts of Rajasthan.

*Rediscovered sheep* : Recently rediscovered Garole sheep is found in the Sunderban area of West Bengal and is highly prolific, adapted to marshy areas and possibly has

**Table 6.** Some unique sheep breeds of India

Breed	Unique characteristics
Changthangi	Fiber fineness
Chokla	Fine carpet quality fleece
Magra	Lustrous carpet quality fleece
Mecheri Chennai Red	High quality skin and mutton
Mandya	Excellent meaty conformation, high quality and meat palatability.
Nellore	Tallest sheep breed of India.
Garole	High fecundity- twins and triplets common. Survival under saline conditions.
Marwari, Deccani Jaisalmeri	Hardy and capable of walking long distances during migration.

**Table 7.** Synthetic breeds/strains

New breed/strain	Location	Parent Breeds		Level of exotic inheritance %
		Indian	Exotic	
Bharat Merino	CSWRI, Avikanagar	Chokla, Nali	Rambouillet, Merino	75
Avivastra	CSWRI, Avikanagar	Chokla, Nali	Rambouillet, Merino	50
Nilgiri Synthetic (Sandyno)	SRRS, TANUVASU Sandynallah	Nilgiri	Merino	62.5/75
Patanwadi synthetic	GAU, Dantiwada	Patanwadi	Rambouillet, Merino	50
Avikalin	CSWRI, Avikanagar	Malpura	Rambouillet	50
Avimanns	CSWRI, Avikanagar	Malpura, Sonadi	Dorset, Suffolk	50
Indian Karakul	CSWRI, ARC Bikaner	Marwari, Malpura, Sonadi	Karakul	75
Kashmir Merino	J&K State	Gaddi, Bhakarwal	Delaine Merino, Rambouillet, Soviet Merino	50-75

contributed to development of prolific strains of Merino sheep breed in Australia (Turner, 1982).

*Least discussed breed* : Munjal sheep is the least discussed among Indian sheep breeds. Information on population and production performance of this breed is scanty. Munjal is one of the important mutton type sheep. Animals of this breed are quite big and tall. Average adult body weight is around 45 kg. In a survey conducted in 1999 by Kushwaha and his coworkers, it was observed that the population of this breed is 90,000. Animals of Munjal breed are found around Muktsar, Bhatinda, Firojpur, Faridkot districts of Punjab and Hissar, Ambala, Karnal districts of Haryana.

*Breeds exhibiting unique characteristics* : All the indigenous sheep breeds are known for adaptability under varied climate conditions, which is obvious from their long struggle against the natural forces. Some of the unique features have been identified in few indigenous breeds, which are summarized in Table 6.

#### Synthetic breeds/strains developed

Table 7 summarizes breeds/strains developed in this category as a result of attempts made for upgradation of indigenous animals with exotic breeds for improving wool production, wool quality and mutton in sheep species. Imported breeds used for crossing were (i) Australian/Russian Merino and Rambouillet for improvement in wool (ii) Suffolk and Dorset for improvement in meat quality and feed efficiency and (iii) Karakul for pelt production. The

flocks of these synthetic breeds have been developed in some pockets/government establishments and are being maintained at government organized farms. Kashmir Merino was, however, evolved in Jammu and Kashmir under field conditions. Most of these breeds/strains, have not done well with the farmers because of lack of input, poor health and management, expertise available under field conditions (Status paper NBAGR).

#### INDIGENOUS BREEDS AT RISK

##### When a breed is at risk

The endangered status of a breed can be determined by the size of breeding stock, which can be expressed by the number of breeding females, the number of breeding males, sex ratio, the percentage of females bred to males of the same breed, the trend in population size and effective population size under a particular production system. In FAO (1998), a working rule is that when population size approaches 5,000 breeding females (a total population of about 10,000 animals) the survival risk of the breed should be studied and appropriate action would be needed for its conservation. It is suggested that whenever the total number of animals falls below 10,000 one should start preserving semen and embryos. However, much will depend on the local circumstances of the breed, management system, extent of crossbreeding, rate of decline and overall utility of breed under local agro climatic conditions (Table 8).

Situation in India may be altogether different where not

**Table 8.** Number of females of a sheep breed for consideration of endangerment

Country	Population of pure breeding sheep females	References
England	1,500	Alderson (1981)
Germany	15,000	Simak (1991)
Europe	500	Majjala (1982)
General	5,000	FAO (1998)

even the preliminary surveys have been conducted on breeds and the breeding policies are framed generally on population estimates based on census reports of species. Under Indian conditions it has been suggested that sheep breeds with over 50,000 population with no serious declining trend, can be considered a normal population. Population of 30,000-50,000 animals with constant declining trend under insecure category, while population of 15,000-30,000 can be put under vulnerable and 8000-15,000 under endangered category. Less than 8,000 population can be considered as critical and needs immediate conservation (Nivsarkar, 1994). This information may be taken as guideline in determining the status of breeds/strains with respect to threat for extinction (Acharya, 1999).

#### Main causes of decline

It appears that a very serious situation has arisen which may lead to complete loss of the available indigenous breeds and immediate steps for taking concerted programmes for their conservation are required because: (I) unchecked increase is causing continuing deterioration due to inadequate inputs. (II) dilution of breeds is resulting from uncontrolled inter-mixing among them and infusion of exotic germplasm through crossbreeding for quicker improvement in the production potential of indigenous breeds. (III) absence of any planned strategies for conservation of indigenous breeds, and (IV) loss of breeds due to geographical reorganization. Breeding tracts and organized farms of some of the important sheep breeds have gone to Pakistan after partition (Basuthakur, 1988). Thus,

erosion of breeds is both qualitative and quantitative (Acharya, 1999). Table 9 presents breeds that are getting threatened for extinction and need immediate attention for conservation (Khan, 2001). Press Information Bureau, Government of India (<http://pib.nic.in/focus/fojan99/fo200199.html>) has also documented several other breeds of sheep viz, Marwari, Patanwadi, Gaddi, Nellore, Chennai Red, Hissardale in their list of threatened breeds of animals in India.

#### CONSERVATION AND ITS RATIONALE

Conservation is the management of human use of the biosphere, so that it may yield the greatest sustainable benefits to present generation while maintaining its potential to meet the needs and aspirations of the future generations (FAO, World Watch List, 2000). Following reasons for conserving the sheep breeds have been defined:

- Genetic insurance: We never know what might be needed in future.
- Scientific study: Molecular genetics selection and other aspects.
- Practical use: Production of useful components.
- Sentiment: Cultural and public interest.

#### APPROACH TO CONSERVATION OF SHEEP GENETIC RESOURCES

Approach to conservation of sheep genetic resources must combine a number of integrally related components:

- Monitoring and describing of existing animal genetic resources.
- Breed characterization at the molecular level to assess between breed diversity in order to maximize cost effectiveness of management.
- Accessible documentation.
- Informed use:
- Appropriate conservation, *in situ* and/or *ex situ*;
- National watch list;

**Table 9.** Breeds/strains of Indian sheep considered at risk

Breed/strain	Location	Risk status	Main causes for decline
Bhakarwal, Gurej, Karnah, Poonchi	Jammu & Kashmir	Endangered	Indiscriminate crossbreeding with exotic fine wool breeds
Changthangi	Ladakh	Endangered	Smaller flocks scattered in large area of fragile ecology
Rampur Bushair	Himachal Pradesh	Endangered	Indiscriminate crossbreeding
Tibetan and Bonpala	Sikkim	Endangered	Smaller flocks scattered in large area of fragile ecology
Muzaffarnagari	Uttar Pradesh	Declining	Small grazing area
Malpura, Chokla	Rajasthan	Declining	Introduction of Marwari inheritance through migratory flocks
Magra	Rajasthan	Endangered	Crossing with Marwari/Kheri
Pugal	Rajasthan	Declining	Crossing with Marwari/Kheri
Jaisalmeri	Rajasthan	Declining	Intermixing with Chokla
Mandya	Karnataka	Endangered	High incidence of cryptorchidism
Nilgiri	Tamilnadu	Endangered	No demand of wool in Tamil Nadu and their indiscriminate slaughter
Kilakarsal	Tamilnadu	Endangered	Crossing with Vembur/Ramnad white.



**Table 10.** Minimum number of animals required for conservation

	Male sheep	Female sheep
Size of breeding unit	22	60
No. of breeding animals entering/year	22	12

- Early warning system;
- Appraisal of links with wild ancestors and
- Evaluation of emerging biotechnologies.

### ACTION PROGRAMME FOR CONSERVATION OF ANIMAL GENETIC RESOURCES

An effective programme must be global in scope with an aim to overcome the erosion of Animal Genetic Resources and to ensure the better development and use of these resources, integrating both improved use and conservation. To be effective, national programmes should be planned as part of a regional or global strategy while taking account of local issues. There is also a need for the creation of institutional infrastructures to provide support and direction for national plans. In addition, both national and global components need support through training, publications, finance, surveys and evaluation.

### CONSERVATION METHODS

#### *In situ* conservation

The *in situ* conservation involves the maintenance of live populations of animals in their adaptive environment, and animal populations continue to evolve and develop for more sustainable use. The active *in situ* conservation is equivalent to breed development by conducting well-designed animal breeding programmes, while the passive *in situ* conservation is concerned with the maintenance of live animal populations of breeds at risk of loss within their agro-environment. Therefore, a well laid-out national action plan has to be prepared not only to preserve the live animals within their native environment but also to make them self-sustainable under the given agro-ecosystem. *In situ* or live animal conservation has several advantages as the breeds can gradually adapt to changing environmental conditions besides improvement by selective breeding may be approached through genetic improvement and sustainable management, institutional flocks, farmer's flocks, pastoralists flocks, and through stock-holder's involvement.

*Genetic improvement and sustainable management* : Improvement of the breed through selection and breeding can help in making it self-sustainable. There are a number of biotechnological tools (MOET and embryo transfer technology), which can help in development of a highly productive population of sheep genetic resources, capable of sustaining the economic pressures. Nevertheless, ram selection for weights and wool are the accepted and proven

methodologies for achieving desired genetic gains (Taneja and Bhat, 1999).

*Institutional flocks* : Institutional flocks managed under scientific lines can maintain a minimum breedable population required in recreation of breed for future and also supply superior rams for conservation of the breed. Smith (1984) provides estimates of the minimum size of a breeding unit and the replacement rate for sheep species if inbreeding levels are to be kept at about 0.2 percent per year (Table 10). A tolerable inbreeding level is 1% per generation for which a herd size of hundred animals is necessary (Hodges, 1991). Replacement is one of the most important factors in deciding the minimum number. The replacement must be regulated to preserve the gene structure of the given population as far as possible and the males and females must serve this main purpose.

The rule for placement are given below:

- Every breeding animal must be replaced by his/her progeny.
- The percentage of the known or visible characteristics must be kept approximately around the foundation frequency.
- Possibly the immunogenetics characteristics and DNA levels polymorphism data should also be taken into consideration to the extent possible.
- The generation interval must be kept as long as possible according to the breed or species.
- The number of males in consecutive years must be as many as possible.

In India, a large network of infrastructural facilities in terms of Research Institutes/Universities/Central and State Animal Breeding Farms and Artificial Insemination (AI) Centres exist. They have population of some important indigenous breeds. However, until recently their main emphasis was only on improvement of productivity by crossbreeding. There are some pure breeding herds also, however, the population size is too small to carry out effective selection for improvement. These institutional herds need to be strengthened both in terms of superior germplasm as well as modern tools and techniques.

*Farmer's flocks* : Involvement of the farmers who have been keeping a particular breed for years may be desirable. The most important case against preservation is the cost and the modern society may be reluctant to fund project like conservation from which little economic or financial return can be expected in near future. Under Indian farming system a number of indigenous breeds are to stay in for long run due to zero input requirement and disease resistance etc. Progressive farmers need to be identified and encouraged to conserve these breeds and compensate them for the low returns, as a national obligation for maintenance of sheep biodiversity. Besides financial assistance to the farmers, increased extension services, provision of

improved breeding rams, public awareness and mass movement, incentives and awards are suggested to meet the challenge (Khan, 2001).

*Pastoralists flocks* : As people "who keep animals on natural graze and for whom animal breeding is economically and culturally dominant", pastoralists usually have a highly complex indigenous knowledge system in regard to animal breeding. They inhabit marginal areas characterized by low and unreliable rainfall or situated at high altitudes. The elaborate breeding strategies of pastoralists result in animals that are not only able to survive and reproduce in hostile environments, but are also fairly productive under the given constraints. Because they largely present closed gene pools, these animals can be very distinct and their distribution range corresponds with that of ethnic groups. Pastoral breeds are often viewed as genetically superior by farmers (George, 1985). Because pastoralists keep animals under conditions very close to those obtaining in the wild and without much protection against the elements and climatic extremes, their breeds may carry fitness traits of potential interest for maintaining the vitality of high-performance breeds.

Pastoralists play an important role on the conservation of indigenous livestock breeds (such as the humped camel, Toda buffalo, Nari and Malaimadu cattle, Deccani sheep) ([www.fao.org/DOCREP/006/Y3970E/Y3970E00.HTM](http://www.fao.org/DOCREP/006/Y3970E/Y3970E00.HTM)). For many pastoralists, these farm animal genetic resources are the basis of their cultural identity and they have a moral and social attachment to them.

#### Stack-holder's involvement

In India, sheep are raised by farmers and no data recording system is followed in field. Therefore, proper evaluation of indigenous animals for further improvement is not feasible at present. It may be very important to form the Breed Societies in India for the conservation of indigenous breeds. Moreover, the improvement of sheep breeds through selection of outstanding animals true to their breed types from the larger population maintained in the breeding tract can be simultaneously taken up in collaboration with these Breed Societies (Acharya, 1999). Dairy co-operative network in India has greatly helped in making large number of animals for initiating breed improvement programmes in cattle and buffaloes for milk, besides marketing their products at reasonable costs. This model is being replicated for sheep and goats also (Taneja and Bhat, 1999).

#### Ex situ conservation

*Ex situ* conservation involves conservation of genetic material out of the environment in which it developed (FAO, 2000).

*In vivo* methods : *Ex situ* conservation of live animals in the form of organized herd maintained in a research

institution, state owned sheep farm, zoo and breed safari comprises *in vivo* conservation. Keeping of large flock, especially of relatively less productive breeds is not feasible on economic grounds. In small populations, animals suffer from inbreeding and appearance of deleterious genetic defects. In such cases, it is very important to maintain the breeding population in such a manner that the inbreeding rate is kept at minimal level and production performance can be improved over the years to make the breed self-sustaining. The effective population size of breeding females and males either through natural mating or through AI can be maintained either under scientifically managed farms of organized sector or with the farmers in their native breeding-tract or under breed safari/parks. The biggest limitation of conservation of breeds outside their home-tract is the population size avoiding the ill effects due to inbreeding. The effective population size is very important consideration and depends upon the ratio of male and females under different systems of selection.

*Livestock breed safari* : It has been globally recognized that there may be a place for the animal resources on the pattern of wild animals. This may help preserving the natural habitats, which include all species of plants, animals and other organisms. If managed appropriately, this type of natural system can be an ideal example for conserving the precious germplasm of domestic breed of livestock including sheep. Moreover, it should be self-sustaining unit. This approach in the form of amusement parks, is gaining popularity in developed countries with a tourist industry. They give opportunity to urban people to get an impression of diverse population of distinct breeds of livestock species.

*In vitro* methods : Cryo-conservation of wide variety of living cells or tissues for long periods of time viz., sperms, oocytes, embryos and DNA etc. comprises *in vitro ex situ* conservation.

- i) The basic objectives of *in vitro* conservation are:
- ii) Regeneration of endangered breed
- iii) New breed development
- iv) Supporting the *in vivo* populations
- v) Research for determining the effect of single major gene
- vi) DNA studies and genome mapping

*Sperms and oocytes* : In sheep the deep-freezing of semen in various forms has been standardized. For the successful conservation of breed, a minimum of 30 rams each contributing around 500 doses of semen would be essential. The semen should be stored in frozen conditions at least in two locations to avoid any risk. It has been documented in several studies that sheep oocytes like oocytes of other farm animals can be stored and fertilized *in vitro* after thawing as usual (Khan, 2001).

*Embryos* : This is an excellent tool of conservation as all the genetic information is stored in one diploid zygote,

which can give rise to a new progeny. Embryos are usually frozen between 30 and 120-cell stage in 0.25 ml straws. These straws can be stored at  $-198^{\circ}\text{C}$  for long-term storage and can be implanted successfully in the recipients. With limited resources in terms of facilities and trained manpower at some places this technique can be utilized for the *ex situ* conservation of only declining/endangered breeds of sheep. However, it is still relatively expensive to obtain embryos, and their cryo-preservation technique needs further refinement for economical use.

**Cloning** : Currently cloning has created revolutionary opportunities in both animal breeding and research by development of procedure for nuclear transfer in sheep, where unlimited number of cloned animals are bred by nuclear transfer, using somatic cells cultured *in vitro*. This technology shall hold for conservation of available genetic diversity of threatened genetic resources (Anon. 1998; Cunningham, 1999). Cloning can be used to produce identical copies of elite stud rams or ewes, more rapidly than conventional breeding. Scientists are using the technique to improve the quality of wool and meat.

**DNA** : A new method of preservation now emerging is the preservation of sequences of catalogued DNA in perpetuity. Storage of DNA for conservation of breeds though has the advantage of disease free transportation across the countries, but it too has problems, which are preventing it from becoming the normal method of preservation. One is the fact that genome maps are not yet available to identify which sequences of DNA are responsible for specific traits in the live animal. The second is that the use of stored DNA to recreate an animal with specific traits is not yet possible as DNA reinsertion techniques with animal cells still produce random results.

A few new methods of conservation now emerging include establishment of embryonic stem cell lines and conservation of somatic cells. When fully developed these techniques will offer an alternative approach to the preservation of genetic variation of endangered breeds in developing countries.

The other important aspects of conservation of sheep genetic resources involve establishment/strengthening of National Animal Data Bank, National Gene Bank, National Animal Conservation Board, Regional Gene cum Data Bank and Global Data Bank.

#### **AGENCIES FOR IMPROVEMENT AND CONSERVATION PROGRAMMES**

Several agencies including private farmers must be involved in facilitating the various steps of conservation and mobilization of individual enthusiasts.

- i) National focal point
- ii) Central government

- iii) ICAR Institutes and Agriculture Universities
- iv) State government
- v) Non governmental organizations (NGOs)
- vi) Private companies

#### **National focal point**

National Bureau of Animal Genetic Resources has now basic infrastructure to meet all the requirements of becoming the national focal point for the conservation programmes on all domesticated livestock and poultry breeds and has recently developed and submitted country report on the guidelines of Intergovernmental Technical Working Group on Animal Genetic Resources (ITWG on AnGR, FAO, 2000).

#### **Central government**

The overall responsibility and control for the conservation of domestic livestock breeds is within the purview of Department of Animal Husbandry and Dairying, Ministry of Agriculture, Government of India (<http://dahd.nic.in/sheep.htm>). Other ministries, such as Environment and Natural Resources or Industry keep necessary liaison and coordination with other related ministries and member government to realize effective policy, planning and operations. The government influences conservation programmes through budget allocation, they can mandate the state farms to keep the breeds at risk besides the money making commercial flocks or herds in order to maintain national heritage. The population of some of the purebred small ruminants, equines, pigs and pack animals has come down considerably and has come to the category of threatened breeds in the country. The farms or farmers unit in their respective breeding tract are to be established with 100% central assistance for breeds of these animals wherein their population is less than 10,000, with active participation of State Governments and NGOs etc.

A new centrally sponsored scheme for conservation of such threatened breeds has been started by Government of India during Tenth Five Year Plan with a budget outlay of Rs. 1,500 lakhs and a sum of Rs. 295.50 lakhs has been released to the State of Gujarat, Karnataka, Punjab, Rajasthan and Tripura during 2002-03 for scheme implementation.

#### **State government**

As the development activities mainly maintenance of livestock in the state, implementation of breeding programmes and providing health to all the animals are chiefly looked after by State Governments, they should develop and implement technically sound breeding programmes for the improvement of these indigenous breeds. The Artificial Insemination network of the Animal Husbandry Department should be effectively strengthened

to provide extensive breeding services to cover the zebu breeds using semen from genetically superior rams for the improvement of animals under field conditions. Survey in the breeding tracts of indigenous breeds to know the present status, demographic and geographic distribution may also be entrusted with State Animal Husbandry Departments. NER Databank (<http://databank>) brought in association with Nation Informatics Centre, Assam and North Eastern Council by North Eastern Development Finance Corporation Ltd provides information on sheep population, facilities available and production in entire North Eastern state as a whole.

#### **ICAR Institute and Agriculture Universities**

Universities and research institutes as public institutions could be entrusted with the conservation of endangered breeds maintaining them as control populations for research, teaching/training and development aspects.

#### **Non governmental organizations (NGOs).**

Sheep related activities are an important component of NGO activities in India. In order to reach indigenous communities and to establish linkages between them and the national bodies responsible for domestic animal diversity, intermediary NGOs are necessary and play a crucial role. Voluntary or non governmental organizations like Neighbors, Dharwad, PETA, India, Mumbai, Livestock Heritage of India have an important role to play in assisting farmers in keeping rare breeds, in extension of appropriate technologies, upgradation of skills, improvement in the livelihood of marginalized farmers and shepherds by creating awareness in simple improved sheep husbandry practices, raising financial assistance for solving the problems of shepherds like high mortality amongst sheep and to enforce animal protection laws. One NGO-based initiative is the LIFE Network/Movement for Peoples' Conservation of Domestic Animal Diversity, which approved the Sadri Declaration (2000) at a recent workshop in India. The League for Pastoral Peoples is an advocacy and support group for pastoralists who depend on common property resources and are engaged in researching and working with pastoral communities. Several breed associations like Andhra Pradesh Sheep and Goat Rearing Association, Kurma sheep Breeders and Vembur sheep Breeders have been launched by active involvement of NGOs for leading and motivating the farmers movements. (Alsipura Statement, 2002).

#### **Private companies**

Commercial breeding companies, produce processing companies and agriculture support services may become more interested and increasingly involved in conservation activities. The role of these organizations is considered

more important in poultry, sheep and goat keeping, which are related with commercial production of meat and meat products. They can provide the necessary research and development support, financial assistance and marketing of products.

### **EVALUATION, CONSERVATION AND IMPROVEMENT PROGRAMMES IN SHEEP GENETIC RESOURCES**

Various programmes being carried out in India are as under:

#### **Projects at NBAGR**

During last 20 years concerted efforts have been made to create awareness among all the developmental organizations in the country about the usage of indigenous animal genetic resources including phenotypic and genetic characterization and strategies outlined for their conservation and sustainable management as given below:

#### **National Agricultural Technology Programmes (NATP)**

##### *Animal genetic resource biodiversity :*

- Systematic survey to generate information on population status, breed utility, management practices and farming system.
- Conservation of the breeds in their native tracts.
- Preservation of germplasm for posterity using cryopreservation.
- Molecular characterization of the breed using microsatellite molecular markers.
- Characterization of commercially and economically important genes.

##### *Genetic characterization and conservation of important sheep and goat breeds of arid zone :*

- To generate information on population trends, management practices, socio-economic importance, performance levels, breed utility and farming system from the breeding tract of the breed.
- To identify the microsatellite markers specific for each species for genetic characterization.
- To identify the unique characteristics of the breed.
- To develop the complete breed descriptor of each breed.
- To develop the technology for conservation of endangered/declining breeds of sheep and goats for posterity

##### *Integrated national agricultural resources information system :*

- To integrate the existing database on animal genetic resources in the country.
- To design and develop database on animal genetic resources in the country

- To develop resource map on animal genetic resources in the country through GIaS.
- Molecular marker based pilot genetic test for fecundity genes in indigenous sheep and goat breeds
- To standardize/optimize the microsatellite/molecular marker based genetic test (PCR based) for fecundity gene(s).
- To screen DNA markers linked to prolificacy gene(s) in indigenous sheep and goat breeds.

#### ICAR's SRC project at NBAGR

*Molecular genetic characterization of indigenous breeds of farm animals-sheep species :*

- To characterize and establish genetic relationships among various breeds of sheep using microsatellite markers.

#### Network project on animal genetic resources at NBAGR

The project aims at genetic characterization and conservation of indigenous breeds of livestock and poultry. The project has been in operation since VIII plan involving various agencies such as SAUs, State AH Departments, NGOs with the coordinating unit at NBAGR. Two core laboratories stationed at TNUVAS, Chennai and GAU, Anand were identified to carry out the genetic characterization/distancing work based on microsatellite markers for the southern and western zones, respectively while, NBAGR was identified to cater the needs of the northern zone. The objectives of the project are

- To characterize the breeds in terms of both qualitative and quantitative traits.
- To study the molecular genetic characterization of the breed.
- To develop breed descriptors.
- To conserve the germplasm of elite/unique animals/birds.

#### Network project in sheep improvement at Central Sheep and Wool Research Institute (CSWRI), Avikanagar

All India Coordinated Research Project (AICRP) on sheep breeding was converted into Network Project on Sheep Improvement (NWPSI) with effect from 1.4.90. The breeding policy for NWPSI is selective breeding in indigenous breeds. There are five farm based cooperating units and two field based cooperating units of project in addition to project coordination cell situated at CSWRI, Avikanagar.

#### National ram/buck production programme

The centrally sponsored scheme of National Ram/Buck Production Programme provides scope to states of strengthening farms of indigenous sheep and goat breeds and for distribution of rams and bucks of such breeds to the

farmers for breeding purposes. Breeding policy advocated by the Government for sheep envisages selective breeding of indigenous breeds for their improvement (Botabyal, 1999).

#### EFFORTS MADE SO FAR AT NBAGR FOR EVALUATION AND CONSERVATION OF SHEEP GENETIC RESOURCES

Data Base Management: Data bank on census, literature, germplasm resources and breed characteristics has been developed in ovines.

#### Phenotypic characterization

Twenty eight breeds of sheep covered for phenotypic characterization include:

Bandur, Bellari, Bhakarwal, Bonpala, Changthangi, Chokla, Coimbatore, Chottanagpuri, Deccani, Gaddi, Garole, Gurej, Jalauni, Jaisalmeri, Hassan, Karnah, Kenguri, Kheri, Magra, Mandya, Malpura, Marwari, Mecheri, Muzzafarnagri, Nali, Pugal, Rampur-Bushair and Sonadi.

#### Molecular genetic characterization

Nineteen breeds covered under this program are: Bandur, Bellary, Bhakarwal, Chokla, Gaddi, Garole, Gurej, Hassan, Jaisalmeri, Kenguri, Karnah, Kheri, Magra, Malpura, Marwari, Muzzafarnagri, Nali, Pugal and Sonadi.

#### Ex situ conservation

Preliminary work on conservation of animal genetic resources has been taken under the Network Project on Pugal sheep breed. Under this programme, the male progenies are being procured and reared. These males will be trained for donation of semen in the later phase of the project.

#### In situ conservation

The work in Magra, Kilakarsal and Nilgiri is under progress. These units are engaged in registration of elite females in the breeding tract in the first phase of technical programme of Network Project.

#### RECOMMENDATIONS

The following recommendations are made for the evaluation of sheep bio-diversity and conservation of sheep genetic resources:

i) Livestock census gives information on sex ratio, population of different age groups and production status. The breed improvement policy can be framed properly if information on the status of breed is available. The animal census therefore, should be conducted on breed basis so that the population of sheep breeds showing declining trend can

be monitored and conservation programmes are undertaken.

ii) Periodic publications about the status of indigenous sheep and their performance should be brought out in the form of newsletters. A web page about indigenous breeds breeds may also help in popularizing these breeds.

iii) Efforts should be made to bring out National Watch List, which should be updated periodically with additional and latest information sent by other related agencies. This would ensure better use of information on both genetic characterization and census data, in addition to restriction on repetitive work.

iv) The gigantic task of characterizing the indigenous sheep genetic resources using FAO recommended markers should be accomplished on priority basis in a time bound frame, which could prove to be of utmost importance in deciding priorities and further planning strategies for conservation.

v) Breed societies be created and should get patronage, funding and scientific support for the conservation and sustainable utilization of sheep genetic resources.

vi) Communities that have developed sheep breeds with unique genetic properties must become directly involved in decision-making, planning and implementation of projects. They need to be provided with legal support and assistance for intellectual property issues and should be entitled to subsidies for their role in protecting environments and landscapes by maintaining low-input breeds instead of switching to more profitable high-input and high-residue production systems.

vii) Survival trusts need to be established by conservationists and voluntary agencies to generate awareness and interest in rare breeds.

viii) A breed improvement committee for each breed should be established with representatives from Breeder's Association, Government and Non-government and R&D organizations, State Agriculture Universities, Developmental Agencies and farmers to closely monitor the programs aimed at the improvement of indigenous breeds breeds. This committee should also be entrusted with powers to modify breeding objectives from time to time, keeping in view the changes in the farming practices, cropping patterns and economic needs of the farmers and formulate appropriate breeding programs to achieve them. Through periodical surveys, this committee should also identify problems faced by farmers and interact with RD Institutes to evolve suitable solutions. Establishment and updating of data bank target breeds of cattle should be under the purview of this committee.

ix) An expert panel should be appointed at national level to determine the basic norms for a breed registration.

x) Law while introducing exotic breeds must ensure security of minimum population size of pure indigenous breed.

xi) The live animal gene-banks (*in situ* conservation) should be established in the native ecology of the breed.

xii) There is a strong case for positive incentives to farmers and pastoralists who play an important role on the conservation of indigenous sheep breeds (Deccani sheep). Incentives could be both monetary and non-monetary, and would help to ensure that villagers do not switch to crossbred sheep, under the lure of superior (even if of short-term) economic gains.

xiii) Financial support and capacity-building must be extended to appropriately qualified rural development NGOs so that they can assist indigenous communities in conservation/development and facilitate interaction between them and scientists, bureaucrats and policy-makers.

xiv) It is predicted that the consumption of meat and milk in developing countries will rise exponentially until 2020 and that this demand will be met by the expansion of industrialized livestock production into these countries (IFPRI, 2000). If unchecked, this so-called "livestock revolution" will have negative consequences for all marginal livestock keepers and also for domestic animal diversity. The rush by livestock companies to become established in the opening markets of the developing countries must be stopped (Blair, 1994), or the effects will be drastic, especially on pig, poultry and cattle genetic diversity.

AnGR conservation must be approached holistically and not pursued as an isolated intervention. Indian Council of Agricultural Research, State Animal Husbandry Department, Agricultural Universities and Non-government Organizations have initiated genetic improvement and conservation programme for the small ruminants. Strong linkages, however, need to be established for achievement of conservation goals. Moreover timely and infrastructural facilities should be made available to make the conservation a success.

## CONCLUSION

There is a rich biodiversity among the indigenous sheep breeds of India reflected by more than forty listed breeds of sheep. On the basis of phenotypic/major products and geographical locations four types/groups have been recognized. Molecular genetic characterization, currently underway will help to characterize and clarify the relationships among the breeds of existing ovine biodiversity - a major prerequisite in deciding priorities for their conservation and improvement programmes. The future of sheep in India lies in the appropriate approaches to conservation combining a number of integrally related components and effective action programmes approached holistically for successful conservation of sheep genetic resources at national level.

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