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Goat and sheep genetic resources of Jammu and Kashmir: A review

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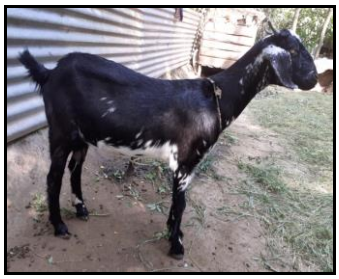
Abstract
Jammu and Kashmir (J&K), a region in the Indian Himalayas, is home to diverse animal genetic resources. These breeds are adapted to harsh environments and play crucial roles in agriculture, transportation, and livelihoods. However, their populations are declining due to cross-breeding, road construction and lack of conservation efforts. The region's sheep and goat breeds, such as Bakarwal, Changthangi and Purgi, are prized for their valuable fiber, meat, and adaptability. Conservation efforts are necessary to protect these unique and valuable breeds, including the establishment of breeding farms, open nucleus breeding schemes, and community-based conservation programs. This review highlights the importance of preserving genetic diversity and promoting sustainable breeding practices to ensure the long-term survival of these animal genetic resources.

Keywords: Conservation, diverse, goat, Jammu and Kashmir and sheep

Introduction
Livestock rearing is a cornerstone of the rural economy in J&K, providing livelihoods, nutrition, and economic stability to a large segment of the population. Jammu and Kashmir, a region known for its diverse geography and cultural heritage, also holds significant importance in India's livestock sector. The total livestock population in Jammu and Kashmir is approximately 11.10 million and the goat and sheep population in J&K is approximately 2.5 million and 3.5 million, respectively (20th livestock census 2019) [1]. As per the 20th Livestock Census, sheep rank first and goats rank second in terms of population among livestock in Jammu and Kashmir. Sheep rearing is particularly significant in the region, with a substantial population that supports the livelihood of many rural communities. The favorable agro-climatic conditions of the state, including its varied landscapes from high mountains to low hills, make it ideal for sheep and goat husbandry. Jammu and Kashmir ranks second in wool production, contributing 22.55% of the total wool production in India (Basic Animal Husbandry Statistics, 2023) [16]. The native livestock breeds of J&K are multipurpose, possessing unique genetic traits that set them apart from other Indigenous breeds. These characteristics include their ability to adapt to harsh, extremely cold, arid and dry climates, efficient utilization of poor-quality feed, and enhanced resistance to tropical diseases. This distinct superiority makes them invaluable for sustaining livestock productivity in challenging environments (Kour *et al*. 2018) [28]. However, without decisive action, the native animal genetic resources could be permanently lost. Key reasons for the decline or dilution of native breeds include the use of non-adapted exotic germplasm through indiscriminate crossbreeding, often stemming from improper recommendations and biased, misleading comparisons between native breeds and crossbreeds. Consequently, the Kashmir Valley breed has already been completely lost, and other genetic resources are now endangered (Shanaz *et al*., 2022) [38].
Therefore, this review aims to examine the current status of livestock in J&K, the threats to native genetic resources and the necessary measures for conservation and sustainable development.

Goat genetic resources of Jammu and Kashmir: Goats are important species in the small ruminant category, ranking second in the livestock population and contribute significantly to livestock population (26.40%) and milk production after cattle and buffaloes (Anonymous, 2019) [9]. In Jammu and Kashmir, goat rearing is a traditional practice, with tribes like Bakerwals, Gaddies, and Changpas exhibiting exceptional expertise (Alam *et al*., 2019) [3]. Goats are primarily raised for their meat, milk, fiber (Pashmina and Mohair), hide and skin. Goat often referred to as 'the poor man's cow,' play a vital role in improving the socio-economic conditions of rural communities, who rely on them for sustenance. Marginal farmers with limited grazing land rear goats as a source of livelihood. Notable goat genetic resources in J&K including Changthangi (Shanaz *et al*., 2020) [37], Malra (Ganai *et al*., 2016) [20], Kashir goat (Rather *et al*., 2020; Rather *et al*. 2022a) [31, 33], Purgi (Alam *et al*. 2019; 2023) [3-4] and Bakerwal (Rather *et al*., 2022b; Sarma *et al*., 2024) [34, 36]. However, several Himalayan goat breeds, such as Lubdi, Gurezi, Belori, Lamdi, Goodri, and Kilan, have become extinct (Puri, 2007) [30].


Kashmiri: The Kashmiri goat, also known as the Kashir goat, a medium-sized goat having body length, chest girth, body height and adult body weight of 55.50±0.99 cm, 70.87±1.50 cm, 65.41±1.55 cm and 38.15±1.85 kg, respectively. The head profile is convex and face is long and tapering with a convex nasal bridge. Ears are variable, ranging from leafy to tubular, rudimentary to long and droopy, horns are present in both sexes, with an average length of 12.31±0.71 cm and teats are conical and variable in length (Rather *et al*., 2022a) [33]. This goat is distributed in the hilly tracts of Kashmir valley and is reared as multipurpose animals, with promising potential for both milk and meat production (Rather *et al*., 2020) [31]. The goat is well adapted to the agro-climatic conditions of the region, with an average milk yield of 1.50 kg/day and an average lactation length of 8.22 months. The goats are reared under a mixed crop-livestock farming system, using a combination of grazing and stall feeding. During winter, they are housed in sheds with other livestock species and fed a diet of paddy straw, oats, dried tree leaves and natural growing grasses, supplemented with concentrates like maize, rice bran and oil cakes. Bucks and surplus females are typically sold for meat at 1-2 years of age. Both males and females reach sexual maturity at 9-18 months and breeding is practiced throughout the year except during winter. The gestation period ranges from 146-152 days, and the kidding interval ranges from 210-365 days, with an incidence of twinning of 45% (Rather *et al*., 2020) [31].




Bakarwal: The Bakarwal goat is a large and robust breed, characterized by its long, upwardly and laterally directed spiral horns. Their coat consists of long, coarse hairs, and they are typically white, brown and black in color, although grey, cream and mixed colors are also observed. Patches of white with black are not uncommon. Most Bakarwal goats are horned, and both sexes have long and drooping ears. Adult goats attain significant body weight, even under low-input systems (Sarma *et al*. 2024) [36]. The Kaghani Goat is a mountain goat breed that thrives in high-altitude, rocky, hilly landscapes. They can adapt to small to medium-sized farms with pastures offering ample greenery. Originating from the Hazara district valley, they were also found in abundance in the North West Frontier Province, Pakistan. Their primary habitat is the Kaghan valley, from which they derive their name. The presence of long hair on the abdomen, hind legs, and horn distance are distinctive features of Bakarwal goats. They excel in harsh conditions and possess excellent mutton conformation. Bakarwal goats are taller and more massive than other goats in J&K, with good feed conversion and reproductive efficiency. They are distributed in the hilly tracts of Poonch, Rajouri, Udhampur and Kathua in Jammu and Kashmir, as well as the Hazara district valley in Pakistan. The nomadic communities of Gujjar, Bakerwals and Pahari primarily rear them in Poonch and Rajouri districts (Anonymous, 2021b; Sarma *et al*. 2024) [10, 36]. Bakarwal goats migrated from central Asia with nomads and established themselves in Pakistan's Kaghan Valley, where they are sometimes referred to as Kaghani goats. Bakarwal goats have a narrow face, mobile lower lip and long, drooping ears. Both sexes are horned with long, strong horns that bend backward and upward, averaging 24.74±1.82 cm in males and 19.89±2.35 cm in females. They have a beard and a short tail with a tuft of hair. Their legs are long and stout. Bakarwal goats are primarily reared for their nutritious meat (chevon) and milk. Random mating is practiced and the goats produce enough milk to feed their kids, with an average daily yield of around 0.7 kg (Anonymous, 2021b) [10].


Malra: The Malra goat, a non-pashmina goat native to Ladakh (Ganai *et al*., 2016) [20], warrants documentation and characterization to safeguard the genetic integrity and distinct characteristics of this valuable goat genetic resource.

Purgy: The Purgi goat is a small-sized breed found in Ladakh, with an adult body weight ranging from 15.5 to 23.5 kg valued for their chevon production which has a good market demand in the area. They are primarily raised for meat production and are known for their active and alert nature. The breeding tract of Purgi goats is Kargil, the second-largest town in Ladakh, covering an area of 14,086 sq. km. They are uniformly distributed across the Chiktan block to the Sankoo block of Kargil and farmers raise this goat under semi-intensive and mixed livestock agriculture farming system. Natural random mating is practiced for Purgi goats. The physical characteristics of Purgi goat include (Alam *et al*., 2019; 2023) [3-4]. Coat color of this goat is highly variable, ranging from black, white, and mixtures of both. Ears are small to medium in size. Horns are present in both males and females, turned backwards. Head profile is convex (Alam *et al*., 2019) [3].

Changthangi: The Changthangi goat is a renowned breed native to Ladakh, prized for its valuable pashmina production. Adapted to the cold desert region, this breed is named after its natural habitat in Changthang of Leh district in Ladakh. The breeding tract spans 24,000 sq. km, covering the cold arid region between the Karakoram and Greater Himalayas. The terrain is mountainous and denuded, with elevations ranging from 3,340 to 4,560 m above MSL. The breed is mainly reared for the precious fiber (commonly called '*Cashmere wool)* the pashmina (12.72µ FD) used to manufacture good quality woven garments and meat (Shanaz *et al*. 2020) [37]. The pashmina is harvested once a year, generally in June/July, either by shearing or by combing. Average production is 214 gm (68 - 500 gm). Changthangi is a medium sized goat (Shanaz *et al*. 2020) [37]. Ears are small, erect and stumpy. It is predominantly white but admixtures of brown and black also seen. Horns are large and corkscrew-like, turned outward, upward and inward in form of a semi-circle. The average live weight of buck is 22-30 kg (Shanaz *et al*. 2020) [37] and average birth weight is 2.1 kg. The breed is reared mainly by Changpas on natural pasture during summer while as during winter season they are provided with hay fodder. Kidding takes place once a year, normally single; the average age at first kidding is 20 months.

Gaddi: The Gaddi goat breed is a versatile and resilient breed, primarily used for meat and fiber. This goat is capable of carrying up to 8 kg of merchandise. The goat is named after the Gaddi tribe, who rear these animals; they are well-suited for a migratory system due to their sure-footedness. They thrive in challenging terrain and can adapt to different environments. The coat color is white (dominant), with some black individuals. The animals possess long, directed upward and backward, occasionally twisted horns. Skin remains covered with very tough, coarse and long hair (17-25 cm). Ears are pointed and drooping (12 cm). During summer, Gaddi goats migrate to high altitudes in search of lush green grass.

Sheep genetic resources of Jammu and Kashmir: J&K ranks 6th in India with a sheep population of 3.2 million (Anonymous, 2019) [9]. However, the native sheep genetic resources are being constantly crossed with fine wool breeds like Kashmir Merino and Rambouillet, without consideration for conservation. This cross-breeding practice, if continued, poses a significant risk of losing the native precious ovine germplasm. It is essential to strike a balance between improving wool quality and preserving the native breeds to maintain genetic diversity and prevent their extinction (Anonymous, 2013) [6].

Kashmir Merino: Kashmir Merino is a synthetic sheep developed around 1960 at Sheep Breeding and Research Farm, Reasi, Jammu by crossing native ewes *viz*; Gaddi, Poonchi, and Bakerwal with Australian Merino Rams and F1 ewes so produced were bred to Delain rams (imported from U.S.A). Inter-se mating of F2 was done and continued till a Kashmir Merino sheep with stable and uniform characters evolved (Anonymous, 2018; Kour *et al*., 2018; Rather *et al*., 2019) [8, 28, 35]. Kashmir Merino sheep is found in every nook and corner of Kashmir Valley (Rather *et al*., 2019) [35]. The Kashmir Merino is highly variable and has 75% exotic blood. The sheep is found in Anantnag, Badgam, Bandipora, Kulgam, Shopian, Pulwama, Srinagar, Ganderbal, Baramulla and Kupwara districts (Anonymous, 2018) [8]. The population of Kashmir Merino sheep in valley is more than 11 lakhs (Rather *et al*., 2019) [35]. The sheep is being used by the Department of Sheep Husbandry-Kashmir for up gradation of native sheep genetic resources of Kashmir to improve their production potential for wool and growth traits (Anonymous, 2004) [5]. The breeding of Kashmir Merino sheep at Government Breeding Farms is well designed. Ewes are mated in the late summer and early autumn after flushing and screening for Brucellosis. The maiden ewes at age of 18 months having body weight less than 30 kg are abstained from breeding. The average birth weight of Kashmir Merino ranges from 21.20±0.47 kg to 3.66±0.05 kg (Das *et al*., 2014; Rather *et al*., 2021; Rather, 2019) [17, 32, 35]. Average yearling body weight of Kashmir Merino ranges from 21.20±0.47 kg to28.41±0.13 kg (Rather *et al*., 2021; Rather, 2019; Want, 2016) [32, 35, 40]. Kashmir Merino is a fine wool sheep. The overall least squares mean (20.33±0.05 µ) for fiber diameter reported in Kashmir Merino indicates that this sheep is at par with finest Merino sheep breeds of the world, whose average FD is 18-22 µ (Das *et al*., 2014; Rather *et al*., 2019; Baba *et al*., 2013) [17, 15].

Gurez: The Gurez sheep breed, registered and exclusive to the Gurez valley of J&K, is well adapted to the local agro-climatic conditions. As the largest among Kashmir breeds, it yields coarse wool and is also used for dairy purposes. Primarily raised for mutton and carpet wool, the Gurez sheep has a white coat with occasional brown or black coloration, and some animals may have more than two horns (up to six horns), a phenomenon known as Polyceros condition. Their wool yield ranges from 1.250 to 1.500 kg per annum, with medium-fine wool and measuring around 6 inches in length. Originating from the Gurez area of Bandipora district, the breed is reared using a combination of stall feeding from December to March, semi-stall feeding in April and grazing alone from summer to late autumn (Ganai *et al*., 2010) [21]. Despite its adaptability to the local environment, the breed is classified as vulnerable due to its small population size of less than 30,000 heads, crossbreeding with other breeds particularly Merino, unrestricted intermixing and interbreeding during summer migration, changes in socio-economic profile of farmers, shrinking grazing areas and lack of planned conservation approach. To conserve the breed, it is essential to keep it at Government Sheep Breeding Farms for genetic improvement and conservation under open nucleus breeding system, halt crossbreeding in Gurez valley and incentivize farmers to keep this valuable breed. This will help to protect the breed's unique characteristics and ensure its survival for generations to come.

Bakerwal: The breed is entirely migratory, with no distinct breeding tract, but is mainly found in Udhampur and Rajouri districts of Jammu. The Bakarwal tribe rears these sheep on grazing alone, and they are primarily raised for mutton and carpet wool production. Random natural mating and crossbreeding with Rambouillet sheep are common practices. Physically, the Bakarwal breed has a typical Roman nose, spotted fawn or grey colour and curved horns in rams. Ewes are polled, with broad, long and dropping ears. They produce colored coarse wool, used locally for manufacturing small blankets. Adult ewes weigh between 29-36 kg, while rams can reach up to 55 kg. The breed yields an average of 1.600 kg of coarse wool per annum, measuring 6 inches long and 1/679 inch thick. Despite its unique characteristics, the Bakarwal breed faces significant threat owing to crossbreeding with Rambouillet sheep as breeding policy in place to increase production parameters of native sheep breeds without giving any consideration to conservation. Interventions similar to those recommended for the Gurez sheep are necessary, along with further research and surveys to fully understand and conserve this breed (Anonymous, 2021e; 2021f) [12-13].

Poonchi: The Poonchi sheep is an indigenous breed of J&K, similar in appearance to the Gaddi breed but lighter in weight. They are predominantly white with spotted animals also common and are locally known as Pahari and Desi sheep. The breeding tract of Poonchi sheep is mainly in Poonch district and adjacent districts of Rajouri and Reasi in Jammu province. With a scanty population status of 2,643 sheep in 2013, Poonchi sheep are mainly reared by the nomadic communities of Gujjar, Bakerwals, and Pahari in J&K districts. This migratory sheep population is raised on rich summer pastures and stall-fed during winter on stored grasses and fodders. They are primarily reared for mutton and carpet wool production with random crossbreeding with Rambouillet and Kashmir Merino breeds. Physically, Poonchi sheep are small to medium-sized with white, black and various shades of white and black body color. They have a flat nose and forehead, medium-sized drooping ears and a body covered with white, medium to coarse fleece. The belly is particularly covered, while legs and face are devoid of wool. These sheep are mostly hornless, with short tails thick at the base and are renowned for their wool production. The Poonchi sheep breed faces a critical risk status due to its scanty population and the main threat of crossbreeding with Rambouillet sheep. The level of crossbreeding, intermixing of flocks and the distribution of Rambouillet breeding rams by the District Sheep Husbandry Organization, Poonch, over four decades have led to the questionable existence of this breed. Currently, over 300 Rambouillet-inheritance sheep are distributed among farmers for crossbreeding, further threatening the Poonchi breed's survival. The author observed to over 100 community sheep flocks in Poonch during downward migration revealed existence of only few animals in Poonch in Mandi area. The widespread crossbreeding and distribution of Rambouillet sheep have likely led to the displacement of the Poonchi breed, making its conservation and survival highly unlikely. The wool of this breed is carpet type of fibre diameter 24.99±0.13µ (Taggar *et al*., 2018) [39]. Further, the adult body weight of Poonchi sheep at birth, weaning, six month and 12 months is 2.8±0.02, 7.6±0.06, 21.1±0.56 and 21.3±0.79, respectively.

Gaddi: Gaddi sheep is a medium sized sheep breed, generally white, although it is occasionally found in mixed tan, black and brown color. Synonyms of Gaddi sheep include Bhadarwah, Chamba Gaddi and Kashmiri (Anonymous, 2021) [11]. The breed, in spite of its special adaptation features developed over the years for survival and sustained production under the agroclimatic conditions of its habitat and migratory production system, is categorized as low producing (Anonymous, 2016) [7]. The Gaddi breed is used as a means of transport in the high terrains. Besides Gaddi, Bakarwali breed is also hardy and sturdy, proving to be the best climber on the mountains despite of its bulky size. These sheep are small in size but have sturdy legs with short ears and tails. Their fleece is generally white with brown hair on the face. Rams are horned and ewes hornless. The wool yield is about 0.817 kg per annum and wool quality is medium fine with average fiber diameter of 34.90 µ and staple length of 10.10 cm (Anonymous, 2016) [7]. The wool is lustrous and under coat is used for the manufacture of Kulu shawls and blankets (Gupta, 2000) [24]. Gaddi and Rampur Bushair are two prominent breeds with their home tracts in Himachal Pradesh but extending in distribution to J&K and hilly areas of Uttar Pradesh (Gupta, 2000; Anonymous, 2016) [24, 7]. The breeding tract of Gaddi sheep is mainly Billaspur, Chamba, Kangra, Kullu and Lahul and Spiti districts of Himachal Pradesh and Bhadarwah of J&K. This breed is mainly reared by the nomadic called "Gaddi". Extensive, stationary and transhumane system in managing Gaddi sheep is adopted by farmers with grazing as main source of nutrition (Anonymous, 2021) [11]. The sheep is mainly reared by the people for mutton and carpet wool production (Anonymous, 2021) [11]. Random natural mating along with crossbreeding and crossbreeding with exotic fine wool breeds mainly Rambouillet and Merinos of different origins (Russian and Australian). Gaddi sheep are generally white although tan, brown, black and mixtures of these shades are also common. Horns are present in both ewes and rams. Horns are curved, medium sized in rams (18.5cm) and small in females (6.4cm). The ears of Gaddi sheep are small. Fleece is relatively fine and dense (Anonymous, 2021) [11]. Its risk states are normal owing to population of more than 50000 in country. The crossbreeding of Gaddi with exotic fine wool breeds for improving wool traits should be stopped as the wool has lost its market value.

Karnah: Karnah is a registered sheep breed, native to Kupwara district of North Kashmir reared mainly for wool and mutton. The breed is well acclimatized to the local agro-climatic and management conditions of Karnah valley, Kupwara district of North Kashmir. The elevation of the area varied sharply from 1260 m to 2630 m above MSL (Ganai, 2009) [19]. Unique ability of this sheep is to walk long distances in hilly terrains. The animals are robust, have a long face and prominent nose. Rams have big curved horns whereas ewes are polled (Anonymous, 2021) [11]. The population status of Karnah breed is scanty with only 2,946 numbers (Anonymous, 2013) [6]. The breed reared mainly by 'Phari' and 'Gujjar' tribal communities inhabiting the Karnah tehsil (Ganai, 2009) [19]. They are reared on natural pasture during summer and during winter season they are provided with hay fodder. Further, from April to December only night shelter is provided whereas from end of December to end of March 24 hour shelter is provided. However, from May to ending September no housing and indoor feeding is required as animals are at high land pastures (Ganai. 2009) [19]. Natural random breeding and crossbreeding with Kashmir Merino are breeding methods adopted by breeders in Karnah. The females lambed once in a year with an average litter size of 1.04 and the age at first lambing varied from 2 to 2.5 years. On an average, the females conceive 6 to 7 times in their life span (Ganai, 2009) [19]. The animals of Karnah breed are white (predominant), brown and black in colours. The Karnah breed possesses convex head profile with pendulous ears. Males are horned whereas females are polled. The wool produced by Karnah sheep is course wool (Ganai, 2009) [19]. Their fleece is relatively fine though shorter than that of Gurez breed of sheep. Wool yield varies from 1.000 to 1.250 kg per annum. The quality of wool is medium fine wool and has an average fiber diameter of 29.70 µ and staple length of 9.36 cm. Karnah is an important sheep breed of J&K as it yields long white fleece which is usable both under hand spinning and by machine (Anonymous, 2016) [7].

Crossbreeding with Kashmir Merino is main threat. Considering overall population of 2,946 (Anonymous, 2013) [6]. Its risk status is critical and needs immediate conservation. The crossbreeding in Karnah valley should be stopped and farmers should be encouraged with incentives and subsidies on feed and fodders for rearing of Karnah sheep breeds. Further, flock of Karnah sheep should be maintained and improved under open nucleus breeding system at Government Sheep Breeding Farm, Poshnaar to avoid inbreeding depression.

Purik: Purik is an important small sized sheep, limited to Ladakh, much prized for the flavor and delicacy of its mutton along with comparatively carpet wool production (Khan *et al*., 2017b) [26]. The breeding tract of Purky sheep is Kargil of Ladakh. The word 'Purky' is derived from two different words "Pot" means 'Tibetan' and "Riks" means 'Race.' Hence, this local sheep is recognized as 'Purky' by the name of the community responsible for rearing the sheep (Khan *et al*., 2017b) [26]. The sheep is reared on natural pasture during summer and winter season and they are provided with hay fodder or storage fodder but no commercial feeding is practised (Khan *et al*., 2017b) [26]. Natural random breeding is practiced in Kargil. Further, all sheep genetic resources are being crossed with Merinos and Karakul to increase production of wool, mutton and pelts (Khan *et al*., 2017b) [26]. Purky sheep is medium sized sheep with stumpy legs. Four different body colours i.e. white, black (predominant), brown and black and white were reported in purik. Males are horned whereas females are polled indicating that horn trait in Purky sheep is probably sex-influenced (Khan *et al*., 2017b) [26]. Flock size of Purik sheep is 5-20 per house hold (Khan *et al*., 2017b) [26]. Crossbreeding with Karakul and Kashmir Merino sheep for improvement of wool traits is main threat (Khan *et al*., 2017b) [26]. Crossbreeding with Karakul and Kashmir Merino sheep is main threat. Registration of Purik sheep with National Bureau of Animal Genetic Resources (NBGAR) is highly recommended.

Purgy: Purgi is a small-sized, indigenous undocumented sheep found in Kargil. Purgi sheep is predominantly white in colour

with long pointed flat head, short and slightly tubular ears and curved downwards horns. Purgi sheep are hardy, able to tolerate harsh winters of cold arid region and good source of genetic resource under the prevailing environmental conditions (Baba, 2013) [15] The breeding tract of Purky sheep is Kargil of Ladakh (Baba, 2013) [15]. Purgi sheep were reared under range system in summe rs and semi-intensive system in winters. Purgy sheep is reared for mutton and carpet wool production. Natural random breeding is practiced in Kargil. Further, all sheep genetic resources are being crossed with Merino and Karakul to increase production of wool, mutton and pelts (Baba, 2013) [15]. The Purgy sheep is variable in colour pattern ranging with white as predominant colour followed by white and brown and black. Purgi sheep is predominantly white in colour with long pointed flat head, short and slightly tubular ears and curved downwards horns (Baba, 2013) [15]. Overall adult body weight, body length, body height and chest girth of Purgy sheep is 25.98±0.55 kg, 62.14±0.55 cm, 55.18±0.87 cm and 77.23±0.93 cm, respectively (Baba, 2013) [15].


Changthangi: Animals are large sized and usually yield coloured coarse wool. Wool yield is 1.5 kg per annum and it is coarse and long (Anonymous, 2021) [11]. The sheep locally known as Changluk, is a potential breed found in the Changthang area of Leh district of Ladakh (Anonymous, 2021) [11]. Overall population of 65,115 numbers of Changthangi sheep were reported (Anonymous, 2013) [6]. Changpa tribe is responsible for maintaining this breed (Ganai *et al*., 2011) [22]. Changthangi sheep are reared under range system in summers and semi-intensive system in winters (Malik *et al*., 2021; Ganai *et al*., 2011) [29, 22]. It is a multiple purpose sheep producing mutton, wool and pelt. Changpas use the wool locally to manufacture rugs, socks, sweaters, quilts (Rstkotul), mattresses (Rstdhan) etc. (Malik *et al*., 2021) [29]. The Changpas also use the pelts as clothing as well as flooring material, which keeps their tents warm in the freezing temperature (Malik *et al*., 2021) [29]. Changthangi sheep are seasonal breeders and the major breeding season is from July to December. Natural flock random mating is practiced by farmers to maintain Changthangi sheep breed (Ganai *et al*., 2011) [22]. The coat colour of Changthangi sheep is white. However, black or brown animals are also common. The ears are pendulous and the tail is short to medium in length. Both horned and polled animals are observed. Smaller flocks scattered in large areas of fragile ecology which resulted in inbreeding depression. Owing to population of 65,115 (Anonymous, 2013) [6] numbers the status of breed is normal. Overall adult body weight, body length, body height and chest girth of male Changthangi sheep is 38.64±0.57 kg, 69.0±0.71 cm, 55.18±0.87 cm and 97.5±1.28 cm, respectively (Acharya, 1982) [2]. Similarly the estimates reported in females for body weight, body length, body height and chest girth are 34.0±0.62 kg, 75.2±0.89 cm, 67.0±0.65 cm and89.0±0.80, respectively (Acharya, 1982) [2].

Imported sheep breeds: Corriedale and Rambouillet are two important imported breeds used to improve growth and mutton traits in orchid areas of temperate and subtropical region of J&K, respectively. In Jammu and Kashmir the crossbreeding programme was started during 1938 by importing Merino and Corriedale rams from New Zealand (Gupta, 1994; Acharya, 1982) [23, 2]. Later on, several other exotic breeds were imported from USA, USSR, UK, Spain and West Germany. The studies from different breeds showed that crossbreds of Rambouillet and Merino types of sheep adjusted favorably in adaptability as well as productivity under the agro climatic conditions of these states. Rambouillet is maintained at all sheep breeding farm in Jammu whereas Corriedale is maintained at Sheep Breeding Farm, Zawora, Shopian and also at Mountain Sheep and Goat Research Station, SKUAST-K, Shuhama, Kashmir.

Corriedale: Corriedale breed was imported around 1970s which is known for its good mutton, conformation, good wool characteristics, relative early maturity and having good range characteristics. The overall mean (kg) birth weight, weaning weight, six months body weight, yearling body weight, eighteen months body weight and age at first lambing (days) of 3.20±0.091, 11.05±0.408, 16.06±0.452, 21.69±0.722, 33.425±0.776 and 882.50±11.33, respectively in Corriedale sheep. The overall estimates of 683.46±1.19 g/kg, 21.20±0.05 µ, 3.88±0.05 cm, 4.16±4.37 cm and 0.24±0.06% for CWY, FD, SL, crimps and medullation, respectively in Corriedale sheep (Baba *et al*., 2020) [14].


Rambouillet: The Rambouillet sheep is renowned for its exceptional maternal ability, strong flocking instinct, and production of high-quality meat and fine wool. Originating in France as a wool breed, it was developed into a dual-purpose

breed in the United States in the mid-1800s (Hultz and Hill, 1931) [25] after importation in the mid 1800s (Dickson and Lush, 1933) [18]. Its adaptability to various arid range conditions makes it an ideal choice for crossbreeding programs aimed at improving native sheep productivity. The breeding strategies from 1947 adapted for improving sheep productivity in Jammu region had focused on crossbreeding of native germplasm with Rambouillet breed to improve wool quality and yield per animal. In India, Rambouillet sheep have been used intensively in crossbreeding programs since 1947 to enhance wool quality and yield. The breed exhibits desirable traits such as a greasy fleece weight of 1.49±0.009 kg, staple length of 5.52±0.02 cm and fiber diameter of 21.25±0.01 µ. Additionally, Rambouillet sheep demonstrate a relatively early age at first fertile service of 727.17±2.03 days, age at first lambing of 877.04±2.01 days, litter size at birth of 1.05±0.00 and inter-lambing period of 368.34±0.22 days. These traits make Rambouillet sheep an excellent choice for improving the productivity of native sheep breeds (Khan *et al*. 2017a) [27].

Kashmir Valley: These animals were small in size with mainly coloured fleece yielding an admixture of medium fine and coarse wool. They were having short tails and males have small horns. Wool yield is about 0.860 kg per annum. Wool quality consists of an admixture of coarse and medium fine. Fiber diameter and staple length vary from 28 to 34 µ and 8 to 10 cm, respectively (Anonymous. 2016a). Kashmir Valley sheep hardly exists and as per (Puri, 2007) [30] is now extinct.

Australian Merino: Recently about 419 Australian Merino sheep (120 Rams and 399 ewes) were imported in year 2020 to improve growth traits and control the inbreeding among Merino sheep of Kashmir. The overall adult body weight of rams and ewes were 76.20±0.06 kg and 53.76±0.02 kg, respectively and the overall fiber diameter of wool was 18.88±0.09 µ (Rather *et al*., 2020) [31].

Conclusion

In conclusion, the sheep and goat genetic resources of J&K are a valuable treasure that requires immediate attention and conservation efforts. The region's unique breeds of goat and sheep, adapted to harsh environments, are an essential part of its cultural heritage and play a crucial role in the livelihoods of local communities. The decline of these breeds poses a significant threat to the region's biodiversity and food security. Therefore, it is essential to establish effective conservation programs, including breeding farms, open nucleus breeding schemes and community-based initiatives, to protect and preserve these genetic resources for future generations. By doing so, we can ensure the long-term survival of these unique breeds and maintain the region's rich cultural and biological heritage.

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