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Uniqueness of Animal Genetic Resources Adapted to High Altitude Environment of Leh-Ladakh

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In difficult terrain of Ladakh region, where land resources are meager, animal wealth plays an important role in the life of the local people. Common native livestock genetic resources in Ladakh include yak, cattle, dzomo, dzo, goat, sheep, donkeys, horses, double hump camel, *etc*. For adaptability at cold as well as hypobaric hypoxic condition of Leh-Ladakh, the native animal genetic resources have developed certain physical and physiological adaptations. The physical changes include small statured body, large hair fur, and thick skin while physiological changes include unique circulatory adaptability with enlarged lungs, heart and larger concentration of red blood cells to accommodate the hypobaric-hypoxic environment. These unique traits make these livestock thrive and perform at under low oxygen and temperature; high ultraviolet exposure, and scarce nutrition in lean period.

Introduction

Ladakh, land of many high passes, (La means passes and Dhak means many) is one of the world's highest inhabited regions surrounded by snow-capped Himalayan, Zanskar and Karakoram ranges. This is a newly formed union territory in the northern most region of India bordering China and Pakistan. It lies on the rain shadow side of the Himalayan, and combines the condition of both arctic and desert climate and hence often called "COLD DESERT". This cold-arid desert at over 3000-meter mean see level has very harsh climate characterized by extreme temperature (-40^{o}C in winter and 35^{o}C in summer); low humidity (25-40%), precipitation (80-300 mm) and oxygen level (nearly 60-70% of the oxygen concentration at sea level); high UV radiations and wind erosion. As per 20th livestock census and departmental census of UT Ladakh (2021), Ladakh has 0.842 lakh cattle, 0.203 lakh yak, 2.44 lakh sheep, 3.33 lakh goat, 0.038 lakh horse, 0.066 lakh donkey and 0.029 double hump camel (Fig. 1). Ladakh is one of the most sparsely populated regions and has huge barren lands without vegetation and assured water supply. The soil of the area is sandy loam and slit clay. The cropping season is from April to October with possibility of only single crop annually. The major field crops in the area are barley, wheat, pulses, oil seed, peas and millets while horticulture crops are apricot, apple, walnut, pear and peach. The irrigation is mainly through channels from the glacier.

In past decade, ICAR-NBAGR has accomplished comprehensive characterization of several livestock species of Ladakh such as Ladakhi cattle, Ladakhi yak, Ladakhi donkey and Zanskar ponies in their breeding tract. The information gathered during several years of research has not only helped to understand the uniqueness of these well adapted livestock species but have also helped the policy makers, stake holders to realize the potential of these livestock breeds. In this article, summarized information collected during years of field survey and research by our team along with available information on livestock species of Ladakh is presented.

Ladakhi Cattle: Native Cattle of Leh-Ladakh

The total cattle population in Leh & Ladakh region is around 84,201 out of which, 45,432 are indigenous and 38,778 are cross-bred cattle. The preference for native cattle over crossbred cattle is more in Leh than in Kargil district. The local cattle from Leh and Ladakh region, is a unique germplasm having excellent adaptation potential

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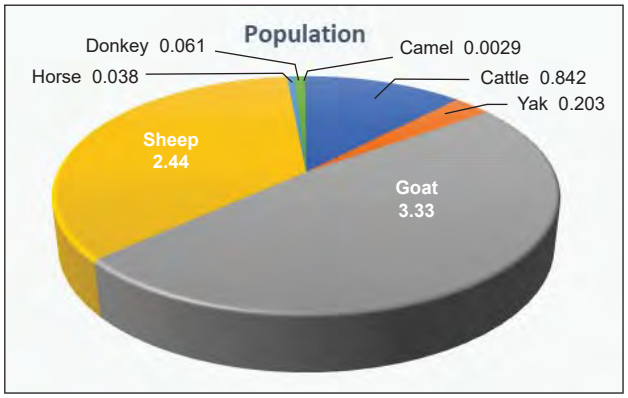

Fig. 1. Population size of different livestock species of Leh-Ladakh region

to high altitude hypobaric stress. Most of the households in villages of Ladakh, irrespective of land holdings, maintain the Ladakhi cows as an alternate source of income or livelihood. The typical native Ladakhi cow and bull are depicted in Fig. 2.

In spite of harsh conditions and meagre feed resources, these cows provide 2.5-4.5 kg of milk and are good source of milk, butter and churpi (local home-made product from curdled milk with long shelf life). They serve as an important animal protein source for local people, particularly during lean winter period. The milk of Ladakhi cow is consumed as such or converted into products like ghee, butter or churpi for personal as well as commercial use. The Ladakhi cattle is a short stature animal with body length of 88.48± 0.56, and height at wither of 91.27± 0.41. The morphometric data along with microsatellite and SNP marker data showed genetic distinctness of native cattle from other native cattle breeds of India. Considering its uniqueness, the native cattle populations of Ladakh was recognized in 2018 as 42 cattle breed of India, and named as "Ladakhi cattle".

Ladakhi Yak – A Multi-utility Species of Ladakh

The yak (*Bos grunniens*), a large ruminant of the bovidae family is genetically adapted through natural selection over millennia and presents the best example of high-altitude adaptation. Yak defends cold by conserving rather than generating the heat, through its compact body structure, thick outer long hairs and a fine down undercoat in winter. In addition, their physiological and anatomical traits such as large lungs and a large heart with thin-walled pulmonary arteries lack of pulmonary vasoconstriction and high energy metabolism enables them to survive easily at high altitude hypoxic condition. The Ladakh has sizeable population of yak and is mostly reared by nomads for multi-faceted utility. These yaks are reared in alpine region over 4000 m mean sea levels. It provides milk, meat, fibre, manure, draft power, and transportation in highly challenging areas of high altitude, where other kind of species might not survive. The typical Ladakhi yak male and female are shown in Fig. 3.

The chrupi and butter made up of yak milk is quite popular amongst nomads and local Ladakhi people. Apart from source of quality milk, yak is also reared for hair fiber. Additionally, its utility as a pack animal for snow-bound areas has also been widely recognized. Apart from Ladakh, the yak population in India is also present in Sikkim, Arunachal Pradesh and Himachal Pradesh. In addition to pure yak, yak-cattle hybrids

Fig. 2. Typical Ladhaki Cow and Typical Ladhaki Bull

Fig. 3. Typical Ladakhi yak male and Typical Ladakhi yak female

are generally reared at mid region of Ladakh (3500 to 4000 m msl). Most of the hybrids are produced as yak as male and native cow (Ladakhi cattle) as a female parent. Cross hybridization of yak and cattle is an age-old practice being used by yak herders. They are preferred due to higher milk production, their better adaptability to warm climate of lower region, without any need to shift to higher altitude during the summer.

Zanskari Ponies – Native Horse of Zanskar Region

Ladakh is also endowed with local equine population called Zanskari ponies due to their major distribution in the Zanskar valley of Ladakh. The body height ranges between 132–147 cm. These ponies look like a small horse with stocky body, exhibit thicker manes, shorter legs, wider barrels heavier hair coat, long tail and heavier bones. The predominant colors are grey, brown and bay. The body confirmation of ponies is most suitable for balancing while riding and load carrying. These ponies have proved their stamina as hardy pack animals with minimum maintenance, during operation Vijay and are called as 'trucks of the mountains. Hence, due to their suitability as pack animals, these ponies are valuable for deployment as all-terrain vehicles in Ladakh-sector and other high mountainous areas. A typical animal of Zanskari pony is shown in Fig. 4.

Fig. 4. Typical Zanskari pony

Ladakhi Donkey – A Neglected Species of Ladakh

The Ladakhi donkey is reared as a pack animal for transportation of various materials by Buddhist communities – Tsering, Tashi, Sonam, Namgyal, Tundup, Dorje. These animals are also being for food-logistics supply by Indian Army manure and to some extent for ploughing of fields during cultivation season. Typical male and female animal of Ladakhi donkey is shown in Fig. 5. The coat colour of Ladakhi donkeys varies from light brown to dark brown/black, though majority of animals are dark brown or black. Many animals have white markings around muzzle and eyes and few animals have white leg markings and zebra markings. The mean height at withers is 94.27±3.75 and 93.85±3.8 cm in male and female animals, respectively. The body length in the male and female animals is 95.53 ± 5.66 and 97.46 ± 7.37 cm, respectively. These donkeys are able to carry upto 50 kg of load in rugged terrain and can travel about 20 Km in 8-10 hours.

Fig. 5. Typical Ladakhi donkey-male

Typical Ladakhi donkey-female

Changthangi Goat – World Famous Pashmina Goat

The Changthangi goat is another important livestock species that is native to high altitude of Leh-Ladakh. This is also being referred as Changpa goat as these are reared by Changpa nomads of Changthang region of Ladakh. These goats survive by grazing the local grasses in vast natural grassland of Changthang area. The Changthangi goat is a medium sized goat with 50 cm height at the withers, and a body weight of about 29 kg. Due to extreme cold environmental conditions prevalent in its ecological habitat, these goats possess double hair coat; outer coat of long course hair and inner coat of shorter fine hair. The inner fine hair is used to produce world's finest pashmina fibre and most costly animal fiber with an average fineness of 11–13 micron. The colour of the hair is generally white but other variants such as black or brown also exist in some animals. These goats play major role in sustaining the economy of local nomadic people as these provides fine quality wool to make famous pashmina shawls which is of high demand both in national as well as international market. These goats are also used as a source of meat, skin and manure. A typical moving herd of Changthangi goat is shown in Fig. 7.

Fig. 6. Typical herd of Changthangi goat in Changthang area of Ladakh

Changthangi Sheep – Dual Purpose Breed

The Changthangi sheep is also a very important livestock species found in Changthang area of Ladakh. Locally, this is also known as Changluk sheep (Chang-Northern, Thang Plateau/Pfain, Luk-Sheep). Similar to Changthangi goats, these sheep are also reared by local nomads of Changpa tribe. This is a dual-purpose breed mainly reared for mutton, and wool production. The wool of Changthangi sheep is mainly used locally by the changpa nomads for preparing many types of items such as rugs, socks, sweaters, quilts, mattresses *etc*. Changthangi sheep is a double coated animal with a marked difference in diameter and surface characteristics of primary and secondary fibres. The average fibre diameter, medullation percentage, staple length, number of crimps, fibre length, scouring yield and burr content were 31.19±0.71 µm, 11.37±0.97 %, 11.34±0.55 cm, 4.13±0.36, 134.58±3.56 mm, 81.06±0.94 % and 3.19±0.65 %, respectively. Changthangi wool is a medium type wool suitable for making finer textured fabrics. Further, the undercoat having finer diameter can be utilized for making luxurious fabrics next only to pashmina.

Double Hump Camel

Double hump camel (*Camelus bactrianus*) is another important and unique livestock species which is very well adapted to high altitude environments. The double hump camels are even-toed ungulate animal with a unique characteristic like two humps at its back and has long woolly hairs on its body. The body size and shorter in height as compare to single hump camel. These animals are only living remnants of India's connection with famous silk route. In India, Bactrian camels first appeared in Ladakh in 1870, were brought by travelers and traders from Yarkand in Xinjiang province of modern-day China. These double hump camels thrive in the high-altitude cold desert (+30°C to − 40°C) region of Nubra Valley, Partapur, Leh-Ladakh and survive hypoxic and hypobaric condition. As per the estimate in 2020, there are about 298 double camels in Ladakh. The photo of typical double hump caamel in nubra valley is shown in Fig. 7. The total lifespan of Bactrian camel is between 20-38 years. An adult Bactrian camel stands up to 63-69 inches with the body length of 52-71 inches. These camels are known for their ability to endure long periods of travel without water and food for a week, even in harsh desert conditions. These camels have the ability to carry weight up to 200 to 250 kgs on the hilly rough terrain. With the development of tourism industry in Leh-Ladakh, this camel has become a source of tourist attraction in the region especially in Nubra valley.

Conclusion

It is expected that the Ladakhi cattle, yak, donkey, pashmina goat, changthangi sheep, double hump camel and zanskari ponies, the multifunctional local breeds well adapted to high altitude will continue to play a role in the livelihoods of poor people and marginal areas of Leh-Ladakh. As a part of mission towards zero non-descript,

Fig. 7. Typical double hump camel

ICAR-NBAGR efforts are underway to characterize non-descript populations of Ladakh such as Changkhi dog, Malluck sheep and Malra goat populations. The cataloguing, documentation and characterization of remaining non-descript populations will have wider impact on the local tribal communities of Ladakh whose livelihood is dependent on these genetic resources.

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