



Yak genetic resources of India: distribution, types and characteristics

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ABSTRACT

In India, the yaks are reared by the people residing between 3,000 and 5,000 meters above mean sea level in the states of Jammu-Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh and West Bengal. Yaks thrive well in these extremely cold regions with hypoxic conditions providing milk, meat, hide, fibre, manure and draught power to the local population. They are able to withstand the fodder scarcity endemic to these regions in the winter months. The total yak population in our country is 0.76 lakhs. Jammu and Kashmir has the maximum population of yak (0.54 lakh), possessing about 71% of the total yak population of the country, followed by Arunachal Pradesh (18.34%) and Sikkim (5.26%). The milk yield per lactation in indigenous yaks is 250–500 kg in a lactation period of 260–300 days. The birth weight of indigenous yaks in males and females is 14.20 ± 0.33 and 13.20 ± 0.34 kg, which increases to 201.23 ± 4.79 and 178.13 ± 3.26 kg, respectively, at 2 years of age. Mainly, four types of Indian yaks have been described namely Arunachali, Ladakhi, Sikkimi and Himachali. Out of these, Arunachali yaks are the first and only recognized breed of Indian yaks. This review summarizes the population trends, attributes of indigenous yaks in general as well of specific types of indigenous yaks available in India.

Keywords: Attributes, Distribution, Genetic resources, Indian-yak, Types

Although, yak constitute a very small proportion of total livestock population of our country, they have their own importance to the local societies residing in high altitude regions in Himalayan ranges between 3,000 and 5,000 m (Pal 1993, Niranjana and Biswas 2013). They are well adapted morphologically and physiologically to survive in cold and hypoxic conditions of these regions providing milk, meat, hide, fibre, manure and draught power to the local population (Nivsarkar *et al.* 1997, Weiner *et al.* 2003). They are moved to high altitude alpine pastures (4,000–6,000 m) in summer months (May to October) for grazing. In winter months, they are brought back where they feed on the frosted and wilted grass, herbs and shrubs, lichens and tree leaves (Pal 1993). Yaks are also crossed with cattle to produce hybrids, the males of which are sterile whereas females are fertile and produce comparatively more milk than female yaks (Arora 1998). This article attempts to review the present status of yak genetic resources of India in terms of their population trends, their productive and reproductive attributes and their breeds or types found in our country.

Population trends and distribution

The total yak population in our country is 0.76 lakhs (Census 2012). Although, it has shown a decline of 7.6% from the previous census, it has shown an overall increase of 32.24% since 1992. Taking into consideration the trend

since 1992, their population is estimated to be 0.9 and 0.97 lakhs in 2020 and 2025, respectively. (Behl *et al.* 2018).

Only six states in India namely Jammu and Kashmir, Arunachal Pradesh, Sikkim, Himachal Pradesh, West Bengal and Uttarakhand, have the regions with the required environmental conditions that are suitable for yak rearing. Only Jammu and Kashmir, Arunachal Pradesh, Sikkim and Himachal Pradesh have more than 2000 yaks. Jammu and Kashmir has the maximum population of yak (0.54 lakh), possessing about 71% of the total yak population of the country, followed by Arunachal Pradesh (18.34%) and Sikkim (5.26%). In terms of population density, Sikkim has the highest density of 0.569 yaks per sq. km followed by Jammu and Kashmir (0.245) and Arunachal Pradesh (0.169). Besides yaks, sizable population of yak-cattle hybrids is also maintained in these regions.

Within these states also, the bulk of the yak population is confined to a few districts only. In Jammu and Kashmir, 61.94% of the total yak population of the state is confined to the two adjoining districts of Kargil and Leh-Ladakh. In Arunachal Pradesh, 84.57% of the state's total yak population is confined to the region comprising of Tawang and West Kameng districts. Similarly, 65.39% yak population in Himachal Pradesh is restricted to the districts of Lahaul-Spiti and Chamba. In Sikkim, 91.28% of the yak population of the state is located in the North district.

Kargil district in Jammu and Kashmir with 17397 yaks, has the maximum yak population in the country, comprising 22.69% yak population of the country and 31.93% yak

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population of the state, followed by Leh-Ladakh (16357) and Kishtwar (15964) districts of Jammu and Kashmir and Tawang (7943) district of Arunachal Pradesh (Behl *et al.* 2018).

Attributes/characteristics of indigenous yaks

The physiological, biochemical, cytogenetic, productive and reproductive characteristics reported in various studies on indigenous yaks are summarized below.

Physiological and immunological characteristics of indigenous yaks: The temperature in the natural habitat of indigenous yaks in summer is 4° to 6°C and in winter the temperature may reach –30°C or below. Yak can withstand temperate climate up to –50°C. Besides thick coat of hair and undercoat, the subcutaneous fat is well developed as compared to cattle and other related species, which helps the yaks to withstand the extreme cold conditions (Prasad 1997). The normal body temperature of indigenous yaks is 101.4±0.19 (98–104) °F. The pulse rate and respiration rate are 54.15±0.87 (45–68) and 54.59±1.65 (38–86) per minute, respectively (Arora 1998). Pal (1993) had also reported similar values for these parameters. Krishnan *et al.* (2009) studied the diurnal and annual variation in the physiological parameters of rectal temperature, respiration rate and pulse rate in indigenous yaks. The physiological responses were minimum in the early morning and maximum during late afternoon. The physiological responses of calves were significantly ($P<0.05$) higher than adult bulls and lactating yak cows during late afternoon. In all the three groups of yak, the physiological responses were significantly higher ($P<0.05$) during summer than winter.

Based on the study conducted at NRC Yak, Arora (1997) had reported the following hematological parameters for the indigenous yaks. The hemoglobin level in the indigenous yaks is 10.23±0.18 (8–12.4) g/dl which is not very different from other bovines. The packed cell volume is 25.37±0.70 (20–32)%. The red and white cell count in blood is 5.20±0.14×10⁶/μl (4.36–7.75×10⁶/μl) and 9.90±0.25×10³/μl (8.02–13.35×10³/μl), respectively. The mean corpuscular volume is 49.31±1.29 (38.19–81.26) fL. The mean corpuscular hemoglobin is 19.98±0.38 (14.9–24.52) pg. The mean corpuscular hemoglobin concentration is 40.96±0.74 (25.55–52.50) g/dl. The erythrocyte sedimentation rate is 1.08±0.26 mm/h (0.46–2.04). Among white blood cells, neutrophils, lymphocytes, eosinophils, monocytes and basophils are 29.98±1.59 (23.26–42.4)%, 53.79±2.23 (42.14–66.86)%, 10.09±1.34 (2.44–16.32)%, 5.54±0.53 (3.2–8.87)% and 0.50±0.17 (0.0–1.52)%, respectively. Other Researchers had also reported similar values for these hematological parameters for indigenous yaks (Pal 1993, Barari *et al.* 1995, Mondal *et al.* 1998). The WBC count is lowest at birth (3.3×10³/μl) and then continues to increase with age (Mondal *et al.* 1998, Sarkar *et al.* 1999), unlike cattle, sheep, goat and pig, where it is highest at birth followed by a gradual reduction with age (Moberg 1955).

Immunogenetic studies carried out to investigate the characteristics of yak erythrocyte antigens revealed the

presence of A₂, Y, X₂, J and Z antigens in high proportion. Twenty-nine bovine red cell antigens were detected on yak erythrocytes (Prasad 1997).

Biochemical profiling of indigenous yaks: The total serum protein in male and female indigenous yaks is 7.54±0.18 and 7.71±0.22 g/dl, respectively. Other serum biochemical parameters such as glutamate oxaloacetate transaminase (SGOT), glutamate pyruvate transaminase (SGPT), alkaline phosphatase and acid phosphatase in male indigenous yaks are 34.14±3.27, 22.16±5.19, 124.53±8.31 and 2.93±0.698 IU/L, respectively. These parameters in females indigenous yaks are 32.40±3.54, 16.56±0.99, 129.37±10.27 and 2.73±0.371 IU/L, respectively (Chatterjee *et al.* 2004). The total serum proteins are 4.33±0.09 g/dl with albumin/globulin ratio of 1.02±0.05. The albumin is 2.21±0.09 and globulin is 2.14±0.02 g/dl (Nath *et al.* 2000).

Cytogenetic characteristics of yaks and their hybrids: Yak has 29 pairs of acrocentric autosomes which are not significantly different from the autosomes of cattle. All autosomes in yaks have been found to be telocentric or subtelocentric (Guo 1983). Unlike in zebu cattle (*Bos indicus*) the Y chromosome of yak is submetacentric and resembles to that of *Bos taurus*.

Yaks are frequently crossed with cattle to produce hybrids. In the crosses of yak with *Bos taurus* and *Bos indicus*, the F₁ hybrid females are usually fertile but the F₁ males are sterile though features of the external genitalia appear to be normal. The F₁ males have normal libido and mounting behaviour comparable to their male parent (Eldridge 1985). Similarly, crosses of yak with mithun produce F₁ males which are sterile but exhibit normal sexual behaviour (Steklenev 1969). The hybrid males has 58 (diploid) autosomes and XY sex chromosomes, yet the spermatogenesis did not proceed beyond spermatocyte stage since there is inhibition of meiotic division which arises due to pairing of homologous chromosomes from different species (Gupta *et al.* 1996).

Growth and performance: The birth weight of indigenous yaks in males and females is 14.20±0.33 and 13.20±0.34 kg, respectively, which increases to 126.1±0.37 and 119.37±2.81 kg at 1 year of age and 201.23±4.79 and 178.13±3.26 kg at 2 years of age, in males and females, respectively. The weight of male and female yaks at various

Table 1. Body weight of indigenous yaks at different ages (Biswas *et al.* 2009a)

Age	Body weight (kg)	
	Male	Female
At birth	14.20±0.33	13.20±0.34
3 months	42.03±0.84	39.94±0.83
6 months	66.98±1.54	62.98±1.50
9 months	92.16±2.49	87.99±2.05
12 months	126.10±0.37	119.37±2.81
18 months	178.04±4.40	145.05±3.61
24 months	201.23±4.79	178.13±3.26

Table 2. Body measurements (cm) of indigenous yaks and their hybrids at different age groups

Parameter	Upto 2 years		2–4 years		4 years and above	
	Male	Female	Male	Female	Male	Female
<i>Yak</i>						
Height at withers	88.83±1.40	80.30±1.30	113.1±1.49	110.9±1.36	127.9±0.85	115.8±0.80
Body length	80.31±1.82	76.23±2.59	116.9±3.13	104.1±2.14	133.2±1.26	115.6±2.70
Heart girth	111.6±2.56	106.7±2.32	152.9±1.93	148.3±1.55	182.4±1.81	161.8±1.31
<i>Yak-cattle hybrids</i>						
Height at withers	92.33±0.88	89.00±1.39	116.0±1.79	88.80±1.59	129.4±1.13	118.4±1.51
Body length	80.69±2.08	78.70±2.50	120.5±2.62	104.4±2.07	135.3±2.55	117.3±2.31
Heart girth	101.8±4.12	109.6±4.34	179.9±2.78	155.4±3.68	192.6±1.53	163.4±0.91

Source: Ramesha *et al.* (2008).

age groups is given in Table 1 (Biswas *et al.* 2009a and b). The adult body weight is 250–400 kg (Pal 1993, Barari *et al.* 1999). In general, there is shortage of feed and fodder in the areas where the yaks are distributed. The intake of fodder by grazing decreases in winter months. Although, they are provided with the stored fodder and crop residues during winter months, it is reported that there is 17 to 25% decrease in body weight of yaks in the winter months in field conditions (Zhang 2000, Krishna *et al.* 2010). The mean height at withers of indigenous male and female yaks is 88.83±1.4 and 80.30±1.3 cm at 0–2 years of age. It increases to 113.1±1.49 and 110.9±1.36 cm at 2–4 years of age and 127.9±0.85 and 115.8±0.80 cm above 4 years of age in male and female animals respectively. The height at wither, body length and heart girth of indigenous yaks and their cattle hybrids is given in Table 2 (Ramesha *et al.* 2008).

Yak is also an important meat animal. In traditional yak keeping, male calves not finding place in the herd are castrated at the age between 1 and 3 years and raised for meat purpose. The castrated yaks in the age group of 3–4 years yield heaviest carcasses. Yak meat is tender, juicy and without marbling (red meat). The protein content in yak meat is about 20–22% and fat contents varies widely from about 1.5 to 18.5% depending on region, season and type of feed (Arora 1997, Prasad 1997, Nivsarkar *et al.* 1997).

The milk yield per lactation in indigenous yaks is 250–500 kg in a lactation period of 260–300 days. Fat percentage is 10.9 (Katiyar and Sinha 1982, Arora 1998). However, Jain and Yadav (1985) reported the milk production per lactation in the range of 129–281 kg in a lactation period of 90–215 days. They reported the fat percentage of 6.5 in yak milk. Nivsarkar *et al.* (1997) has also reported the fat, SNF, total solids, ash and protein content in the range of 5.8–7.9, 10.5–14.5, 16.2–20.7, 0.82–1.04 and 5.35–7.12%, respectively, in the yak milk. Highlanders convert fat into butter and rest into *churpi*, a wet yak milk cheese (Arora 1998).

Yak produces an undercoat of 0.4–0.6 kg annually, which is similar to mohair and is considered one of the luxurious fibres of the world. Coarse hair of the outer coat (0.5–3.0 kg annually) is utilized for making bags, floor mats, ropes, tents and hats. Hide could be processed into good-grained

durable leather. Tail hair are a ritual item of Buddhism, Sikhism and Hinduism (Pal 1993, Arora 1998).

Yaks are also used for draught and pack purposes at the high altitudes and are a sought-after animals for transportation in high altitude regions. The yaks are able to carry about 25% of the body weight as back pack in the tough high altitude regions without any fatigue symptoms and adverse effect on their health. If required, they are even able to carry up to 35% of their body weight. They are used in agricultural operations like ploughing and thrashing (Hanah *et al.* 2018).

Cattle yak hybrids produce comparatively more milk than female yaks. Yak crosses produce about 400 kg milk per lactation in a lactation period of about 200 days. The daily milk yield of these cattle-yak hybrids is 1.4 (0.8–4.4) litres compared to that of 1.1 (0.4–3.8) litres of yak and 1.85 (0.5–3.9) litres of hill zebu cattle. The milk of these cattle yak hybrid females (F_1) contains 7.6–9.1% fat and 18.51% total solids. In general, the milk of yak and its hybrids contain higher calorific values than that of cattle. F_1 males are sterile but useful draft animals. (Kalia 1975, Jain and Yadav 1985, Arora 1998).

Reproductive performance: Yaks are shy breeders, and there is difficulty in detecting oestrus. The prominent signs of estrus are swollen vulva, reddening of vaginal mucosa, mucous discharge and acceptance of the male by the female. The breeding season starts in July and peaks from September to November (Krishna *et al.* 2010, Bhuyan *et al.* 2013). The age of maturity is 3.0–3.5 years in males and 2.5–3.0 years in females. The age at first service is 4–5 years in males. The age at first mating is 3–3.5 years in females. The estrous cycle is of 21 (18–22) days and estrus period is 20–24 h. (Pal 1993). The mean gestation length of indigenous yaks reported in various studies is 255.32±0.34 days (Biswas *et al.* 2009b). Denisov (1958) had also reported the similar gestation period of 258 (224–284) days in Russian yaks.

Breeds or types of yaks found in india

Arunachali yak: It is the only recognized breed of indigenous yaks. These are mainly distributed in the West Kameng and Tawang districts in Arunachal Pradesh. The

estimated population of Arunachali yaks is about 14,000. Majority of the population in these districts is of Monpa community. Yak has been closely involved with the culture, religion and social life of the Monpa tribe. They are treated as an asset by the rural community. They are reared mainly under extensive system although they are provided with some amount of fodder, crop residues, maize grains, rice polish, flour and some salt especially in the winters. Like other yak rearing regions of India, the yak rearers of Arunachal Pradesh, also called Brokpa, migrate their herds during summer season to the higher ridges for grazing. One attendant stays all along at the pasture land for full time attending the herds as well as milking and preparing butter, *ghee* and *churpi* (fermented butter) for home consumption as well as commercial purpose. In winter when heavy snowfall occurs, the entire herd is brought back. Majority of the animals are black in colour. Some animals also have white forehead or white face or a white dorsal stripe running from hump to tail. Earlier Pal *et al.* (1995) have broadly divided the yaks of Arunachal Pradesh into four broad categories namely the smaller 'Common' type, 'Bisonian' type, 'Bare back' type and 'Hairy-forehead' type. The horns size is 28–35 cm in males and 18–24 cm in females. The ears are horizontal in orientation. Poll is prominent with convex head. The Arunachali Yaks are medium sized with compact body. The mean height at withers of these animals in males and females is 111 and 94 cm, respectively. The body length in the male and female animals is 160 and 135 cm. The heart girth in the male and female animals is 170 and 143 cm. The estimated weights of the male and female yaks are 416 and 262 kg. The body weight of both males and females is reduced by 20–30% during winter months due to fodder scarcity. Legs are short and stocky. Brisket, belly, ribs, lateral parts and legs are covered with long hair. Udder is mostly trough shaped with cylindrical teats. The milk yield per lactation is 185 (120–224) kg. The fat percentage in milk is 7.45 (4.5–9.8)%. Besides, milk and milk products, they also provide meat, hair, fibre and manure. They are also employed for transportation (NBAGR 2018, Niranjana and Biswas 2013). Ramesha *et al.* (2008) have reported the milk production per lactation by the Arunachali yaks to be 227.2±7.43 (127–284) kg in a mean lactation period of 255.2±14.93 (120–360) days. Annual coarse wool production by these yaks is 4.38±0.17 (3–6) kg. The cattle hybrids of these yaks produce 530.4±31.14 (400–800) kg milk in a mean lactation period of 294.2±8.8 (200–330) days.

Ladakhi yak: Yaks in the Ladakh region are reared by Buddhist community residing at higher altitudes for milk, meat, manure, hair-fibre and transport purposes. Ladakhi yaks are medium in size and moderate in temperament. Coat colour is dark brown to black with glossy sheen. Skin, muzzle, eyelids, tail switch are black, horns are grey to black. Few yaks also possess white patches on small to large part of the coat and switch. Occipital bone is prominent. Forehead and nasal bone are straight, hump is small. Dorsal ridge is prominent in males. Dorsal line is convex on withers

(ridge) and concave on back. Limbs are small and cylindrical. Horns are curved and placed laterally upward and backward with pointing tip. The horn length in male and female animals is 45.42±6.70 and 31.93±5.13 cm, respectively. Ears are medium and horizontal. Pelvis is wider than shoulder region. Flank, lower belly and thigh regions are covered with long hair. Tail is small with long hair and set high. Udder is very small and bowl shaped. The mean height at withers of these animals in males and females is 111.24±10.27 and 100.86±7.27 cm, respectively. Male and female attain sexual maturity at 3 years of age. Females start calving at about 4 years of age and calves every alternate year and produces 7–8 calves in life time. Open breeding is practiced. Males are castrated at the age of 7–8 years after completing about four years of breeding. The main breeding period is in the months of July and August. Calving occurs during the months of April and May. Females produce 0.5–1.0 kg of milk per day. Lactation period ranges from 6 to 8 months only. Hybrids of these yaks with cattle are preferred due to their high milk production (Niranjan 2018, Annual Report 2018). Ramesha *et al.* (2008) have reported higher milk production by cattle yak hybrids of Jammu and Kashmir at 812.8.4±43.96 (500–1,000) kg milk in a mean lactation period of 300.6±8.39 (280–365) days compared to 324.8±14.37 (150–450) kg produced by pure yaks in a mean lactation period of 305.4±11.05 (150–360) days. They had reported an annual coarse wool production by these yaks to be 4.78±0.16 (3–6) kg.

Sikkimi yak: The total yak population of Sikkim is around 4,000 (Census 2012). The mean height at withers, body length and heart girth of these animals is 118.86±3.60, 125.77±5.33 and 165.14±7.44 cm, respectively. The horn length is 44.57±3.16 cm (Pundir *et al.* 1996). The Sikkimi yaks produce 241.0±7.01 (150–300) kg of milk in a mean lactation period of 291.9±9.51 (130–365) days. Annual coarse wool production by these yaks is 4.45±0.18 (3–6) kg. The cattle hybrids of these yaks produce 542.9±32.25 (450–655) kg milk in a mean lactation period of 280.0±13.50 (130–335) days (Ramesha *et al.* 2008). The Sikkimi yaks are arbitrarily divided into two main types, viz. *Bho* and *Aho*, depending on the communities that rear them. The *Bho* yaks are mainly found in the Western part of the Sikkim. The *Aho* yaks are distributed in the Eastern part of the Sikkim. The *Aho* type is smaller and compact than the *Bho* types (Khera *et al.* 1978, Katiyar and Sinha 1983).

Himachali yak: These yaks are mainly found in the Lahaul-Spiti, Kinnaur and Chamba (Pangi valley) districts of Himachal Pradesh. The yaks of Himachal Pradesh are hardy animals with elongated but compact body. The forehead is wide and eyes are smaller. Black is the predominant coat colour. In many animals a line of white hair is present on dorsal line extending to forehead and tail. They also have thick glossy and bushy hair covering the face and forehead (Nivsarkar *et al.* 1997, Niranjana and Biswas 2013). On the basis of various studies on Himachali

yaks reared at HPKV Regional station, Sangla (Kinnaur), the mean height at withers, body length and heart girth of these yaks 106.63 ± 2.32 , 93.15 ± 3.43 and 153.42 ± 4.79 cm, respectively. The horn length is 32.93 ± 2.25 cm. The tail length is 39.28 ± 1.96 cm. The gestation period, lactation length and calving interval of these animals is 258.08 ± 2.38 , 172.35 ± 3.37 and 406.86 ± 9.99 days, respectively. The lactation milk yield and average daily milk yield is 125.57 ± 4.30 and 0.728 ± 0.017 kg, respectively. The percentage of fat, SNF and total solids in the milk of these yaks is 7.43 ± 0.08 , 10.01 ± 0.03 and $17.44 \pm 0.11\%$, respectively. The specific gravity of the milk is 1.0370 ± 0.0003 . The weight at birth, 3 and 6 months of age is 9.75 ± 0.22 , 28.37 ± 0.71 and 55.27 ± 1.11 kg, respectively. The weight of adult females at calving is 212.74 ± 3.12 kg (Pundir *et al.* 1996, 1997, Kailla *et al.* 1997). Ramesha *et al.* (2008) have reported the milk production per lactation by the Himachali yaks to be 267.7 ± 11.02 (130–335) kg in a mean lactation period of 259.1 ± 8.29 (180–330) days compared to 834.04 ± 49.85 (480–1,200) kg milk, produced by crosses of these yaks with cattle, in a mean lactation period of 306.8 ± 6.28 (270–365) days. They have reported an annual coarse wool production by these yaks to be 5.00 ± 0.13 (3–6) kg.

Genetic characterization of indigenous yaks

Some attempts have also been made to characterize Indian yaks using microsatellite markers. Ramesha *et al.* (2012) assessed genetic diversity of Indian yaks distributed across yak rearing states of India using a selected set of 11 microsatellite markers. The observed heterozygosity (H_o) in Indian yaks ranged from 0.369 to 0.819, while expected heterozygosity ranged from 0.413 to 0.732. The mean F_{IS} value observed was 0.296 ± 0.108 . Sharma *et al.* (2018) studied the genetic diversity of Arunachali yaks using a set of 25 microsatellite markers. The number of observed alleles ranged from 3–16 with an average of 9.32 ± 0.70 . Observed heterozygosity (0.552 ± 0.04) was less than the expected heterozygosity (0.648 ± 0.035). The F_{IS} index was 0.143 ± 0.043 . There was no indication of any recent bottleneck in this population.

Besides, microsatellites, RAPD and PCR-RFLP has also been employed to characterize them. Biswas *et al.* (2010) employed RAPD to identify genetic markers that are able to distinguish yak, mithun, buffalo, zebu and exotic cattle. They reported that yak shares highest genetic similarity with mithun (42%) followed by indicine cattle (29%), exotic cattle (27%), and buffalo (16%). Cluster analysis revealed that yak and mithun belong to same cluster, both the cattle species in a separate cluster and the buffalo found as an out group. Ramesha *et al.* (2010) studied the polymorphism of defensin genes in yak along with cattle, mithun, yak hybrids and buffalo by PCR-RFLP using *Taq-I* restriction enzyme. They observed five types of patterns in yak with $A_1A_2B_2B_2C_1C_1$ being dominant pattern with a frequency of 0.63. Initial studies indicated an association between defensin genotypes and somatic cell count in yaks.

Goyal *et al.* (2013) characterized the *TNF α* gene of yak that revealed high amino acid identity with cattle but variations in potential binding sites for transcription factors. A total of 14 putative transcription factor binding sites were predicted within 818 nucleotides long 5'-upstream region of yak *TNF α* gene. Interestingly, 2 potential binding sites for transcription factors Elk-1 and v-Myb were present in yak and indicine cattle but absent in taurine cattle due to an A-G transition within promoter at 526 nucleotides upstream to start codon.

In India, yaks are traditionally associated with people inhabiting the high altitude regions having little means available with them to adopt to the feeding and management required for intensive livestock farming. Indigenous yaks, reared mostly under the extensive system, are able to survive in the hypoxic conditions, extremely cold environment and fodder scarcity endemic to these regions providing milk, meat, hide, fibre and draught power. However, the population of the yaks in India have shown a declining trend during 2007–2012. Although, efforts have been made to characterize and register the breeds of indigenous yaks in India, efforts in scientific breeding strategies can further improve their productive and reproductive attributes.

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