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Sikkimese yak: Characterization of a yak population in Peril

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ABSTRACT

Yak population of Sikkim currently stands at 5,219 heads and is reared by the nomadic pastoral community called *Dokpa*. This population has not been characterized till date and further, if not conserved, this valuable germplasm may become unavailable for utilization. In an attempt to address this issue, a survey was conducted in order to enable phenotypic characterization of the population and to judge its eligibility as a distinct breed. Sikkimese yaks generally have black body coat with broad convex head and upward pointing curved horns and are reared in a typical transhumant fashion. The daily milk yield in the animals averages around 1.44±0.09 kg with peak yield of 1.95±0.15 kg and lactation length of seven (6.77±0.39) months. Average age at first mating and first calving in females is 42.60±0.92 and 51.55±0.93 months, respectively whereas average age at first mating in bulls is 47.82±0.37 months. These animals can work for 5.5 h per day and are extremely tolerant to cold and drought conditions. Due to the pastoral nature of this occupation, winter feed crisis, climate change events and unscientific husbandry practices threaten the existence of this unique population. Hence, characterization and registration of yak population would be the first step for conservation and sustainability of this unique germplasm.

Keywords: Characterization, Pastoral, Sikkimese yak,Vulnerable

Yak, often dubbed as "Ship of the Plateau" is a unique animal genetic resource owing to its physiological and adaptive capabilities in the high-altitude trans-Himalayan region (Kour *et al*. 2022). It is highly revered by tribal highlander communities due to its cultural, religious and socio-economic significance (Das *et al*. 2022). It is a rich source of good nutrition and stable income for the transhumant tribal population of India (Joshi *et al.* 2020).

However, the yak population of India is declining rapidly over the last decade (20th Livestock Census 2019) which is a serious cause of concern for sustaining livelihood of these trans-Himalayan nomadic communities. This is particularly alarming considering the fact that till date, only one yak population, viz. Arunachali yak has been characterized and registered as a breed (Kour *et al.* 2022). Interestingly, yak population of Sikkim currently hovers around 5200 animals (20th Livestock Census 2019) and falls in the vulnerable category, as per the classification by ICAR-NBAGR (2016). Sikkimese yak population is mainly concentrated in the North Sikkim and East Sikkim districts and is reared by nomadic pastoral *Dokpa* community of Sikkim at an altitude of 4000-6000 m above mean sea level. *Dokpas* follow a particular migration regime based on pasture availability, seasonal change and snowfall pattern (Sharma *et al*. 2016). However, subsistence economy and climate change mishaps are contributing to the decline of *Dokpa* transhumance and Sikkimese yak population (Luxom *et al*. 2022). In the absence of phenotypic documentation of this germplasm, Sikkimese yak conservation and subsequently, socio-economic upliftment of *Dokpas* will not materialise.

Phenotypic distinctiveness is the basis to characterize a population and further to determine its suitability as a breed (ICAR-NBAGR 2016) as phenotypic variability between populations usually translates into genetic differences (Rahim *et al.* 2008). The rich biodiversity of Sikkim Himalayas combined with varying migration patterns and scope of genetic intermingling with yak germplasm of Nepal, Bhutan and Tibetan autonomous region necessitates the characterization of Sikkimese yak and to determine its uniqueness vis-à-vis other yak populations of the country (Sharma *et al*. 2016; www.icimod.org). Keeping the above view in perspective, this study was conceived to phenotypically characterize the yak population of Sikkim and to document its production systems in order to pave the way for its registration as a yak breed in the near future.

MATERIALS AND METHODS

Data collection: A survey was conducted to record the phenotypic data of 2,123 Sikkimese yaks from *Lachen*, *Lachung* and *Lashar* valley in North Sikkim and *Kupup* in East Sikkim districts. The data was further categorized on

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the basis of sex and age as given in Table 1.

Table 1. Classification of the survey data

Classification based on sex (no.)	
Females	1345
Males	778
Classification based on age (no.)	
Calves (<1 years of age)	144
Young stock (1-2 years of age)	522
Adult males (≥3 years of age)	479
Adult females (≥3 years of age)	978

The survey recorded the morphological, milk production, fertility, adaptation and drought traits in the sampled population. The description of recorded traits is presented below.

Morphological traits: Coat colour, skin colour, muzzle colour, eyelids colour, tail switch colour, hoof colour, horn colour, horn shape, horn orientation, ears orientation, forehead shape, general head description, hump size, dewlap size, naval flap size, penis sheath flap size, udder shape, fore-udder size, rear-udder size, teat shape, teat tip, milk vein and basic temperament.

Milk production traits: Daily milk yield (kg), peak milk yield (kg) and lactation length (months).

Fertility traits: Age at first estrus (months), estrous cycle length (days), estrus duration (hours), age at first mating (months), no. of services per conception, gestation length (days), age at first calving (months), interval from calving to conception (days), calving interval (days) and no. of lifetime calvings in females and age at first mounting (months) and age at first mating of bull (months) in males.

Growth, adaptation and draught traits: Body weight at 1, 2 and 3 years of age, body weight at sexual maturity and body weight at first calving (in females) was recorded. Adaptation traits comprised of drought tolerance score and cold tolerance score. Draught traits includes average duration of work per day (h).

Statistical analysis: Morphological data was compared based on percentages, whereas the phenotypic data on production, fertility and draught traits was statistically analyzed using descriptive statistics including mean, standard error and other parameters. All the analysis was performed using SPSSv28.0 (IBM Corp. Released 2021).

Production system: Data on general background of yak herders, viz. no. of family members, members engaged in dairying, annual income, average herd size etc. was recorded to get an overview of the socio-economic status of the herders. Data regarding animal shelters, feeding management, milking management, disease incidence and treatment and other husbandry practices was also collected for greater insights on Sikkimese yak production systems.

RESULTS AND DISCUSSION

Morphological traits: Sikkimese yaks (Fig. 1A and 1B) are generally black in color with an existing wide variation ranging from pure brown, grey and white to dual colored

Fig. 1. A. Sikkimese yak male; B. Sikkimese yak female.

black and white, brown and white, etc. Black is also the predominant color in Arunachali yaks (Das *et al*. 2022) and in the wild yaks of China as well (Chen *et al*. 2009). Animals have a broad convex head with curved horns usually pointed upwards and horizontally placed ears. Black coloured, upward pointing horn is an important feature in the wild yaks of Tibetan plateau and forms a component of self-defense in the species (Rhode *et al.* 2007). Tail switch colour is also predominantly black in Sikkimese yak. Animals have a small dewlap and naval flap and are generally docile in temperament. In females, udder is usually small, round in shape with cylindrical teats and rounded teat tips. Milk vein is not prominent. Smaller udders in comparison to other bovines is, in fact, a physiological adaptation to reside in the hostile high-altitude environments (Anzai *et al*. 2017; Jing *et al*. 2022). The complete description of the morphological traits in Sikkimese yak is presented in Table 2.

Milk production traits: The average daily milk yield in Sikkimese yak is 1.44±0.09 kg with peak yield reaching around 2 kg (1.95±0.15 kg). The lactation length of the animal extends to about 7 months (6.77±0.39). In terms of milk production parameters, Sikkimese yak performs better than Arunachali yak as the average daily milk yield, peak yield and lactation length in the latter is 1.01±1.12 kg, 1.29±0.15 kg and 6±0.5 months, respectively (Das *et al*. 2022). Effective regulation of rotational grazing by *Dzumsa* or indigenous local institution in Sikkim may be contributing to the better productivity as the strict regulation ensures that grazing regimes offer inclusive access to the yaks belonging to all herders (Feroze *et al.* 2019). However, milk yield in Sikkimese yak is still quite less compared to some yak breeds of China, probably due to intensification and mechanization in yak farming systems

Table 2. Morphological traits in Sikkimese Yak

Feature	Categories	Percentages
Colour		
Coat colour	Black	56.83
	Black and White	25.18
	Brown	10.23
	White	2.92
	Grey	2.81
	Brown and White	2.02
Skin colour	Black	98.18
	Brown	0.81
	White	0.62
	Black and White	0.33
	Grey	0.05
Muzzle colour	Black	89.55
	White	7.51
	Black and White	1.88
	Grey	0.72
	Brown	0.34
Eyelids colour	Black	93.69
	White	2.98
	Brown	2.21
	Grey	0.67
	Black and White	0.43
Tail switch colour	Black	64.40
	Black and White	13.25
	White	10.42
	Brown	8.49
	Grey	2.17
	Brown and White	1.27
Hoof colour	Black	89.44
	White	6.96
	Black and White	2.32
	Grey	0.87
	Brown	0.35
	Brown and Grey	0.06
Horns		
Horn colour	Black	82.22
	Black and Grey	9.73
	Grey	7.71
	Brown	0.14
	White	0.09
	Black and White	0.09
Horn shape	Curved	71.82
	Straight	28.18
Horn orientation	Upwards	53.31
	Forward	20.07
	Outwards	17.47
	Backwards	9.07
	Downwards	0.07

Feature	Categories	Percentages
Head and Ears		
Ears orientation	Horizontal	90.46
	Diagonal	9.54
General description of head	Broad	74.84
	Normal	25.16
Forehead shape	Convex	40.93
	Straight	36.87
	Concave	22.21
General body description		
Hump size	Small	66.17
	Medium	23.41
	Large	10.42
Dewlap size	Small	86.59
	Medium	12.50
	Large	0.91
Naval flap size	Small	64.88
	Medium	25.65
	Large	9.46
Penis sheath flap size	Small	94.66
	Medium	3.88
	Large	1.46
Udder shape	Round	56.59
	Bowl	33.79
	Trough	4.85
	Pendulous	4.77
Fore-udder size	Small	63.79
	Medium	23.72
	Large	12.49
Rear-udder size	Small	65.88
	Medium	22.64
	Large	11.48
Teat shape	Cylindrical	70.41
	Funnel	20.88
	Pear	8.45
	Flap	0.25
Teat tip	Round	71.86
	Flap	17.79
	Pointed	10.18
	Cylindrical	0.17
Milk vein	Not Prominent	84.21
	Prominent	15.79
Temperament		
Basic temperament	Docile	68.59
	Aggressive	31.41

Table 3. Descriptive statistics of milk production traits in Sikkimese yak

Trait	Mean±S.E.	Range	Coefficient of variation (%)
Daily milk yield (kg)	1.44±0.09	1-3	37.22
Peak milk yield (kg)	1.95±0.15	0.5-5	51.44
Lactation length (months)	6.77±0.39	3-12	33.58

in the latter (Dong *et al.* 2007). The descriptive statistics of the milk production traits have been described in Table 3.

Fertility traits: In females, age at first estrous and first mating is co-synchronously exhibited at the age of 42 months (41.93±0.93 and 42.60±0.92 months) and the average age at first calving is 51 months (51.55±0.93). Estrous cycle length extends to about 27.5 days (27.52±0.27) and the duration of estrous is 25 h (25.18±0.58). Service period, gestation period and average calving interval are 90 days (90±0.00), 270 days (269.50±0.35) and 392 (391.88±4.58) days, respectively. On an average, a female yak required 2 services per conception and give birth to 6-7 offspring's in her lifetime. Since the production system is mainly pastoral, the bulls are not being trained for semen collection. Hence, the average age at first mounting in bulls is 43 months (43.29±1.55), whereas the age at first mating is 48 months (47.82±0.37).

Contrastingly, Arunachali yaks exhibit superior fertility parameters and age of sexual maturity in males and females is 24 and 34 months, respectively (Das *et al*. 2022). This may be indicative of the underlying genetic relationship between production and fertility in the sense that higher milk production negatively impacts the fertility traits in animals (Strucken *et al*. 2012; Oliveira Junior *et al.* 2021). Hence, delayed sexual maturity and first calving can be listed as one of the major challenges for scientific yak husbandry in Sikkim (Sapkota *et al*. 2022). A summary of descriptive statistics of fertility traits in Sikkimese yak is presented in Table 4.

Table 4. Description of fertility traits in Sikkimese Yak

Trait	Mean±S.E.	Range	Coefficient of variation (%)
Females			
Age at first estrous (months)	41.93±0.93	34-48	14.68
cycle length (days)	27.52±0.27	21-28	6.48
Estrous duration (h)	25.18±0.58	12-28	15.16
No. of services per conception	1.93±0.15	1-3	50.11
Age at first mating (months)	42.60±0.92	36-50	14.38
Gestation length (days)	269.50±0.35	260-270	0.78
Age at first calving (months)	51.55±0.93	45-59	11.98
Interval from calving to conception (days)	90±0.00	90-90	0.00
Calving interval (days)	391.88±4.58	365-450	7.39
No. of lifetime calvings	6.64±0.28	5-11	27.59
Males			
Age at first mounting (months)	43.29±1.55	36-60	23.70
Age at first mating (months)	47.82±0.37	36-58	5.15

Growth traits: Based on body measurements, the detailed estimates of growth traits have been reported in Table 5. Estimated body weights at 1, 2 and 3 years of age are 162 (161.88±2.98), 196 (196.42±4.13) and 236 (235.58±5.39) kg in females and 169 (169.12±1.24), 216 (216.01±3.57) and 284 (284.49±4.03) kg in males, respectively. Similarly, the estimated weight at sexual maturity in females is 250 kg (250.41±4.81) and weight at first calving is 271 (270.66±5.36) kg. In males, weight at sexual maturity is estimated to be 364 (364.08±7.69) kg. Arunachali yak weighs less than Sikkimese yaks at all ages and physiological stages (Das *et al*. 2022). Since body weight has direct positive correlation with milk production, it may be the reason for the higher milk yield in Sikkimese yak (Handcock *et al*. 2019).

Table 5. Growth traits in Sikkimese yak

Traits	Females (Mean±S.E.)	Males (Mean±S.E.)
Weight at one year of age (kg)	161.88±2.98	169.12±1.24
Weight at two years of age (kg)	196.42±4.13	216.01±3.57
Weight at three years of age (kg)	235.58±5.39	284.49±4.03
Weight at sexual maturity (kg)	250.41±4.81	364.08±7.69
Weight at first calving (kg)	270.66±5.36	-

Adaptation and draught purpose traits: More than 9 3 per cent of responders submitted that their animals were very highly tolerant to drought and cold events. However, climate change hazards like unprecedented snowfall and avalanches still pose a great threat to the yak production systems of Sikkim (Krishnan *et al*. 2016). The 2019 tragedy of starvation deaths of hundreds of yaks in North Sikkim district due to unprecedented snowfall is a grim reminder of the seriousness of the issue (https://www.thehindu.com/news). Strategies like fodder conservation, weather alerts and yak insurance could be important steps to mitigate the consequences arising from climate change (Ning *et al*. 2016; Amare *et al*. 2019).

The draught potential of the males was gauged from the average number of hours for which they were put to work. It was found that, on an average, 5.5 hours per day was spent on draught-related work (Table 6). In Arunachal Pradesh, yak-cattle crossbred males called *Dzo* are commonly used for draught purposes (Das *et al*. 2022). However, in Sikkim, yaks are purely bred and not cross-hybridized with cattle. Since yak-cattle hybrids are also counted as 'yaks'

Table 6. Descriptive analysis of the draught-related trait in Sikkimese yak

Trait	Mean±S.E.	Range	Coefficient of variation (%)
Average duration of work per day (h)	5.48±0.31	4.5-11	26.35

in the livestock census, this may be contributing to the less population of yaks in Sikkim.

Sikkimese yak production system: An average yak herding family in Sikkim usually comprises of five (5) members out of which two (2) are engaged in rearing and tending to yaks. These families generally are landless and are engaged in yak rearing as major occupation. They derive an annual income of ₹ 1.2 lakhs from the occupation which further hints at the mainly subsistence nature of the yak herding economy in Sikkim. Yak rearers are nomadic and pursue seasonal migration along with their animals in a typical transhumant fashion.

The average herd size of Sikkimese yak is 51 and animals are purchased directly from the fellow herders. Herd generally consists of 5 breeding bulls and 31 breeding females leading to a mating ratio of 1:6 which is quite healthy. They are generally reared for milk production and draught purposes and hold immense cultural and religious significance for the nomadic herders.

Animals are housed during night in separate half-walled stone enclosures and are let out for grazing during the day time. These houses are kutcha in nature and are not hygienic due to lack of concrete drain for let out of animal wastes. Animals are usually bred through natural mating and are fed with green fodder along with concentrates, salt and mineral supplements. During summers, locally available grasses are also a rich source of nutrition, whereas during winters, oats and fodder conserved as hay form an important component of winter feed. Fodder is usually fed unchaffed and nearby river or stream form the main source of water supply. As far as the milking management is concerned, animals are milked once a day. Although milking utensils are thoroughly washed before milking, washing of udders before milking is not prevalent. Sometimes, animals are fed during milking time for higher milk yield. Foot and Mouth disease (FMD) is the predominant disease and most of the yak rearers regularly perform deworming and vaccinate their yaks against FMD.

Winter feed scarcity extreme climatic events and unscientific breeding are some of the major challenges faced by yak husbandry in Sikkim. Preparation of complete feed blocks and ensiling of fodder can be potential solutions to ward off winter fodder crisis (Bakshi *et al*. 2018). Climate-smart yak farming using weather-alert systems along with robust insurance products can help in making this nomadic undertaking more resilient and sustainable (Amare *et al*. 2019; Matere *et al*. 2020). Also, a planned breeding programme for selection and genetic improvement of the economic traits in the population is critical for higher returns and profit (Haile *et al*. 2019; Brito *et al*. 2021). Further, government support for exploiting the eco-tourism potential of Sikkimese yak will alleviate the livelihoods and help in socio-economic upliftment of the herders (Gurung and Seeland 2011; Karst and Nepal 2021).

Sikkimese yaks, although fewer in numbers, are phenotypically distinct from the yaks found in other parts of the country. It is a lifeline for the nomadic pastoral community who depend on it for their social, economic, cultural and religious needs. Documentation and registration of the population as a breed will be a huge step towards the conservation and genetic improvement of the unique pastoral germplasm of India.

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