

Yak farming: Sustainable practice from the eastern Himalayan

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Yak farming is a low-input, sustainable and eco-friendly livestock system practiced in India's high altitude Himalayan regions. Yaks adapt well to cold temperatures with harsh environments, requires minimal inputs and exerts low ecological footprints. The present article highlights green innovations in yak production focusing on sustainable housing, climate-resilient feeding strategies, effective reproductive strategies and conservation-oriented pasture management. This article also contains a farmer level case study from Dirang circle, West Kameng district of Arunachal Pradesh demonstrating how integrating indigenous knowledge with scientific interventions and institutional assistance can enhance livelihood security, encourage the genetic conservation of native yak breeds, and support the sustainable development of high-altitude pastoral communities.

Keywords: Arunachali yak, Climate-resilient livestock, Environment sustainability, Green innovations, Sustainable feeding, Zero waste farming

HIGH-ALTITUDE pastoralism in the eastern Himalayas is one of the world's vital ecologically sensitive regions characterised by rich biodiversity, fragile mountain ecosystems, and strong dependence of local communities on natural resources. Livestock farming in these regions requires sustainable approaches that address the needs of the people and the requirements of preserving the environment. Among the iconic species contributing to these fragile landscapes, the yak (*Bos grunniens*) stands out as a resilient, climate-adapted, and nature-friendly livestock.

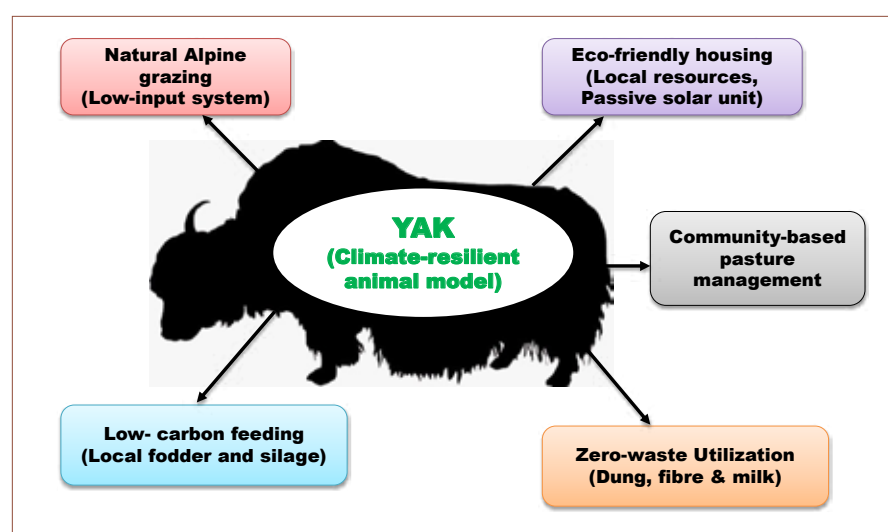
Yak is often termed as the 'lifeline of the highlanders' and 'epitome of pastoral resilience'. It has sustained high-altitude tribal communities across Arunachal Pradesh, Sikkim, Ladakh and the trans-Himalayan belt, providing milk, meat, fibre, transport, and social and economic security. In recent times, climate change poses a major threat to high-altitude livestock systems. In this context,

yak-based production systems offer valuable pathways towards environmentally sustainable and low-carbon livestock production.

Climate-smart species for ecologically sensitive mountains

Yak thrives where few livestock species can survive. Its thick insulating coat, compact body frame, and efficient thermoregulation

allow it to live comfortably in temperatures as low as -40°C. Since yaks graze on natural alpine pastures with minimal inputs, they have a significantly lower environmental footprint compared with several traditional livestock systems. Due to their extensive grazing behaviour, overgrowth of shrubs is always under control which helps maintain grassland health, and supports



Climate smart yak production system

biodiversity. Yak populations are often maintained under migratory or free-range systems that heavily rely on naturally available grasses, herbs, shrubs and lichens. Such systems reduce the need for cultivated feed, irrigation or artificial inputs, making yak production inherently suitable for Himalayan dwellers.

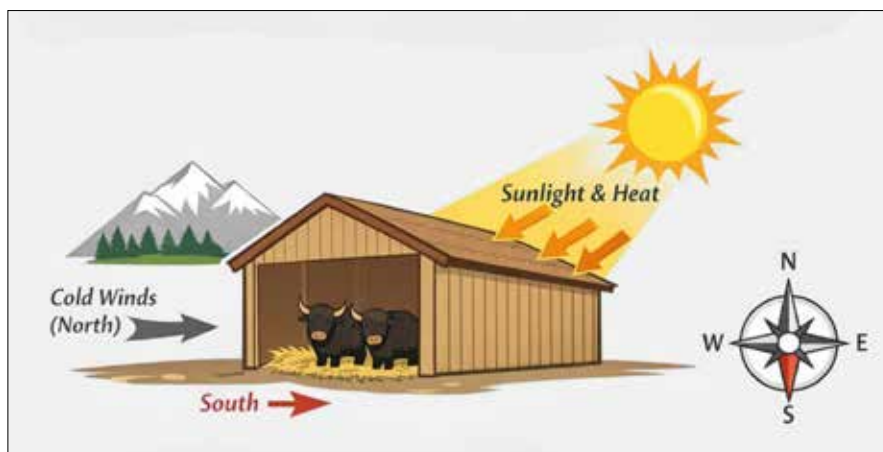
Sustainable housing: Integrating tradition with modern needs

Although yaks possess physiological adaptations to low temperatures, emerging patterns of climate variability are intensifying the occurrence of heavy snowfalls and lengthening the period of sub-zero temperatures. Traditional yak shelters are now being improved through green design innovations. Environmentally sustainable housing designs, comprising of stone sheds, timber enclosures, and passive solar units, offer effective protection while limiting environmental impact to the animals. Incorporation of locally available shelter materials such as stone, wood, and bamboo contribute to lowering carbon footprint as well as construction costs.

Eco-friendly innovations such as Trombe wall heating systems (a passive solar heating system in which sun facing thick wall acts like a slow release heat battery that absorbs sunlight during the day and passively radiates warmth into the animal shelter), insulating roof with straw-mud composite or wooden plank with sawdust filling, strategic windbreak installations using locally available vegetation and wooden fencing that reduces heat loss. Climate responsive housing with south facing orientation facilitate indoor thermal regulation without any external energy inputs. Such green housing interventions not only enhance animal welfare and productivity but also significantly contribute to community livelihoods centred on locally available resources.

Low carbon feeding systems

Yak feeding system is predominantly based on natural grazing, heavily rely on alpine



Yak housing facing south direction (AI generated)

grasses, sedges and herbs making it an inherently low-carbon system. However, forage availability is very low in winter. Sustainable eco-friendly interventions including complete feed blocks, silage preservation from local grasses, winter fodder plots using locally adaptable grasses and legumes, and conservation of legumes improve nutrition without depending on exogenous feed resources. In extreme weather conditions, low-cost hydroponic fodder serves as an alternative feeding strategy during heavy snowfall events. These locally adaptable technologies ensure reliable feed with minimal water use and ecological footprint.

Eco-friendly pasture and rangeland management

High-altitude grasslands are fragile ecosystems prone to soil erosion and degradation. Traditional yak rearing tribal communities particularly 'Monpa tribe' follow rotational grazing patterns that allow pastures to rest and regenerate. By preventing overgrazing and providing long-term productivity, this sustainable technique, when paired with community-managed grazing rights, contributes to biodiversity conservation.

In recent years, simple innovations like improved alpine grass species, fodder banks, and forage reserves have been developed in recent years to increase year-round feed availability. These interventions help minimise pressure on natural pasturelands

while improving resilience against harsh winter events.

Sustainable reproductive management in yak farming

The foundation of sustainable yak farming, particularly in the high-altitude, resource-scare environments is the effective reproductive management. Seasonal breeding and low reproduction rates are characteristics of yaks that are greatly impacted by husbandry practices, nutritional status, and climate factors. Thus, maintaining herd productivity, protecting genetic diversity, and ensuring long-term viability largely depend on the adoption of low-input, and climate-resilient reproductive strategies.

In free-range or semi-migratory settings, traditional yak breeding depends on natural service which substantially increases the chance of inbreeding. Since time immemorial, breeding bulls were selected based on growth, body conformation, adaptability and soundness by the herders. In recent years, scientific interventions through assisted reproductive technology (ART) such as artificial insemination (AI), embryo transfer technology (ETT), *in-vitro* fertilisation (IVF), etc. have revolutionised the livestock sector and significantly supplemented traditional farming practices. With the institutional backing from ICAR-National Research Centre (NRC) on Yak, Dirang, it has made possible to use AI for genetic improvement in certain herds while maintaining the preservation of native breed. Hence, the use of AI enables dissemination



Mr. Sang Dorjee with his herd



Animal shed of Mr. Sang Dorjee

of superior germplasm, minimise the need for rearing multiple breeding bulls and improve reproductive efficiency. Additionally, this practice will mitigate inbreeding depression within the herd.

Zero-waste yak farming

Every component of yak can be utilised sustainably. Yak dung is an excellent source of organic manure improving soil fertility in mountain agriculture, and is an important traditional and renewable fuel in high-altitude villages. Its use reduces dependence on firewood and forest resources. Yak hair and fibre are used for weaving ropes, tents, textiles and handicrafts, promoting eco-friendly cottage industries. Milk and milk products such as *churpi*, *churkam*, ghee and butter are widely valued and contribute extensively to local food security, income generation and enhance eco-tourism. By promoting a circular and zero waste production system, yak husbandry contributes directly to Sustainable Developmental Goal (SDG)-12 (i.e. Responsible Consumption and Production).

Supporting Himalayan communities and biodiversity

Sustainable yak farming is not only an environmental strategy but also a socio-economic lifeline. The livelihood of 'Monpas' (*Brokpa*) and other tribal communities rely heavily on yak rearing. Conservation of yak populations supports cultural heritage, safeguard indigenous

knowledge, and preserve high-altitude rich biodiversity. The grazing patterns of yak herds maintain the open habitats required by various wildlife species including the snow partridge, Tibetan gazelle and Himalayan marmot. Thus, yak production systems blend seamlessly with conservation needs in some of the world's most ecologically sensitive zones.

Case study: A Monpa herder in West Kameng, Arunachal Pradesh

An excellent example of sustainable and conservation-focused yak farming in the eastern Himalayas is Mr. Sang Dorjee, a progressive yak farmer from Lubrang village, Dirang, West Kameng district of Arunachal Pradesh. He is a member of the Monpa community, a primitive tribal group whose primary source of income is livestock. He has been raising yaks for over five decades, carrying on a four-generation family heritage. The Arunachali yak, a recognised indigenous breed that

is well suited to the severe, cold, and hypoxic environments at high-altitudes between 3,000 and 6,000 m, has been preserved by Mr. Dorjee. At present, he maintains a herd of about 120 pure Arunachali yaks along with yak × cattle hybrids (Dzo and Dzomo). His herd is managed using a free-range, semi-migratory system that rotates between mid-altitude winter grazing regions and alpine summer pastures. Feeding is mostly dependent on natural forage resources with very little external inputs. Breeding animals are carefully chosen based on their performance, growth, and physical health. Mr. Dorjee frequently exchanges breeding bulls with other yak herders to prevent inbreeding, and in recent years, he has adopted artificial insemination from the support of ICAR-NRC on Yak, Dirang using superior germplasm.

Mr. Dorjee has also shown willingness to adopt semi-intensive yak farming. As part of the transition towards semi-intensive and climate-resilient yak farming, he has constructed a new south-facing yak housing shed. The orientation of the shed allows maximum sunlight exposure and passive warming inside the housing during winter, thereby reducing cold stress, improving animal comfort and enhancing overall herd performance. His openness to scientific practices, combined with deep indigenous knowledge such as traditional herbal treatments and controlled breeding has made



Herd of Arunachali Yak in free range grazing system

Table 1. Augmentation of productive and reproductive efficiencies of yak by scientific interventions

Parameters	Traditional farming system	Semi-intensive farming system (Improved)
Daily body weight gain (g/day)	95–120	Increased to 400–500
Age at attaining puberty (years)	3.5–4.5	2.0–2.5
Calf production by a yak	One calf per 2.5 years	One calf per year
Reproduction	Yaks are showing seasonality in breeding	Yaks comes into estrus regularly throughout the year
Milk yield	400–500 g/day	1.5–2.5 kg/day
Adult body weight	Male: 250–300 kg; Female: 150–200 kg	After nutritional interventions, Male: 450–550 kg; Female: 250–350 kg

him a role model for neighbouring and traditional yak farmers. He has created awareness regarding scientific yak breeding and husbandry and subsequently improved his farm productivity through scientific interventions.

Yak rearing is the cornerstone of both household income and food security for Mr. Sang Dorjee. He uses traditional methods to add value to yak milk by processing it into culturally significant milk products including indigenous *churpi* (fermented wet cheese), butter (*maar*), and ghee. Due to their high local demand and high prices, these value-added food items contribute about ₹2.0 lakh to household income each year. Additionally, surplus animals are occasionally sold to generate additional revenue; each

animal fetch between ₹40,000 and ₹50,000. Additionally, he employs a zero-waste and circular bioeconomy strategy which reduces reliance on natural resources and external inputs by effectively using yak dung as organic manure for agricultural fields and biofuel for domestic energy needs.

Mr. Dorjee not only promoted sustainable farming system in eastern Himalayas but due to his persistent and tireless efforts, the precious Arunachali yak breed population has now moved out of the vulnerable category. In sensitive Himalayan ecosystems, this specific case clearly demonstrates how integrating indigenous knowledge, scientific backing, and low-input management could ensure ecological sustainability, resource

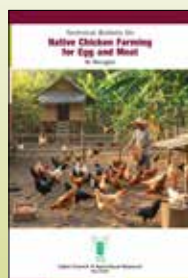
use efficiency, genetic conservation, and livelihood stability.

SUMMARY

As India accelerates its continuous efforts towards climate-smart agriculture, yak-based pastoralism farming offers an inspiring model of sustainability. Yak rearing is a naturally climate-smart and sustainable animal production system for the delicate ecosystems of the eastern Himalayas. The sustainability of yak farming is further strengthened by the adoption of green housing technologies, climate-resilient feeding methods, enhanced pasture management, and zero-waste utilisation. Integration of passive solar housing, locally available feed resources, fodder conservation techniques and community-based rangeland management can enhance productivity while conserving fragile mountain ecosystems and supporting sustainable livelihoods. Developing climate-resilient and low-input technologies, and promoting value-addition through milk products, fibre and eco-tourism can further enhance the sustainability and profitability of yak farming in fragile mountain ecosystems.

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Pages: vi + 110; Price: ₹ 500.00, US\$ 80.00; Postage: ₹100

ISBN No.: 978-81-7164-311-0

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