



Figure 1. a, Mixed cultivation of taro and paddy in jhum. b, Leaves and petioles. c, Marketing of corm.

(Figure 1 b and c) are used for preparation of many ethnic foods, such as anishi, tungkungsui, tungrhak, tunguhok, phalougan, phalou, etc. The leaves, petioles and damaged tubers are fed to the pigs after cooking with local edible grasses.

As of now, little or no attention has been given for the conservation of taro in the region. This has resulted in loss of many valuable genetic resources. The continuous loss of genetic diversity might be attributed to *Phytophthora* leaf blight, corm borer, introduction of high-yielding varieties, changing food habits of the youth, practice of shifting cultivation and such other factors. Therefore, urgent measures need to be initiated for collection, characterization, documentation and conservation of these valuable

germplasm, either *ex situ* or *in situ*. To begin with, ICAR Research Complex for NEH Region, Nagaland Centre has initiated collection, characterization and documentation of these vast germplasms under a project approved by the Protection of Plant Varieties and Farmer's Right Authority, New Delhi.

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Climate change and high-altitude wetlands of Arunachal Pradesh

The high-altitude wetlands (HAWs) are an important category of natural wetlands found mainly in the higher reaches of the Himalayas. HAW is a generic term to describe areas of swamp, marsh, meadow, fen, peat-land or water bodies located at an altitude higher than 3000 m amsl, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or saline. In general, HAWs are areas located at altitudes between the continuous natural forest border and the permanent snow-line¹ (Figure 1).

Arunachal Pradesh is ranked second in India after Jammu & Kashmir with 1672 HAWs covering a total area of 11,864 ha, accounting for about 7.6% of total wetland area of the state. Most of the wetlands are small in size (below

10 ha), there are no large-sized wetlands (above 500 ha) in the state. Only three wetlands having an area of 100–500 ha have been observed². However, very little information is available for most of these wetlands due to the remoteness, harsh climatic condition and inaccessibility of the terrain of the region. None of the HAWs of the state is considered under the Ramsar site.

The HAWs of Arunachal Pradesh play a significant role in maintaining hydrological and ecological balance in the upstream and downstream regions. They are the source of many major rivers like Tawangchu, Nyamjangchu, Kameng, Subansiri, Siang, Dibang and Lohit, all important tributaries of the Brahmaputra³. They support rich diversity of gymnosperms, rhododendrons and rare

medicinal plants species and provide suitable habitat for rare and threatened high-altitude fauna like red panda (*Ailu-*rus fulgens**), takin (*Budorcas taxicolor*), Chinese goral (*Nemorhaedus griseus*), red goral (*Naemorhedus baileyi*), wild dog (*Cuon alpinus*), snow leopard (*Panthera uncia*) and musk deer (*Moschus chrysogaster*)⁴. HAWs are considered as sacred by the Buddhist community, especially in Tawang, West Kameng, West Siang and Lohit districts of Arunachal Pradesh. They are also considered as carbon sinks.

The Indian Himalayan Region (IHR) is sensitive to climate change. According to the Indian Network for Climate Change Assessment report, the annual mean surface air temperature is projected to increase from $0.9^\circ \pm 0.6^\circ\text{C}$ to $2.6^\circ \pm 0.7^\circ\text{C}$



Figure 1. *a*, A panoramic view of Sangetsar Lake; *b*, Nagula Lake situated at 4120 m amsl; *c*, Frozen Sela Lake during winter season at Tawang district, Arunachal Pradesh.

in the 2030s in IHR⁵. The Arunachal Pradesh State Action Plan on Climate Change has projected that maximum temperature will increase by 2.2°–2.8°C during 2030s compared to the baseline, i.e. 1961–1990 and towards 2080s the increase is projected to be 3.4°–5°C. Minimum temperature is projected to increase by 1°–2.6°C during 2030s and by 2.8°–5°C during 2080s. Water resource, forest and biodiversity are projected to be adversely impacted by climate change by the 2030s in Arunachal Pradesh⁶.

The fragile ecosystem and unique climatic conditions of HAWs are more vulnerable to the effects of climate change. They are characterized by extreme cold, dry and alpine climate conditions, particularly due to low air temperature and higher ultraviolet radiation. Researchers have also predicted hydrological and ecological response of HAWs to climate change in the Himalayan region^{1,7}.

Climate change impact on HAWs can be visualized as the most significant because they provide numerous ecological services, support unique biodiversity, are

important for carbon sequestration, maintaining hydrological balance, livelihood benefits to dependent populace and have religious significance among indigenous communities. Therefore, there is an urgent need to undertake in-depth studies for sound database and formulate comprehensive climate change mitigation and adaptation strategies for conservation and management of pristine and vulnerable ecosystem of HAWs in Arunachal Pradesh. Education, awareness programmes, traditional ecological knowledge and community participation may also be encouraged to combat the climate change impact on HAWs of the state.

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Conflicts, motivation and conservation

Traditional agro-pastoral activities in rural Uttarakhand (Western Himalaya), a hill state in India predominantly depend on the surrounding forests for fodder, fuel wood, dry leaves for animals bed. Approximately 64.80% geographical area of Uttarakhand is under forest cover, out of which 71.11% is reserve forest, 28.52% is protected forest and 0.35% is categorized as unclassified forest¹. The unclassified forest also termed as civil forest area is open for biotic

activities like grazing, lopping of trees for fodder and collection of fuel. But these areas are subjected to overexploitation by the villagers and result in conflicts related to utilization of their resources. The Van Panchayats in Uttarakhand have actively involved the local people in conserving the unclassified forest areas and resolving conflicts for several years.

The first Van Panchayat was formed in 1921 in Kumaon division of Uttara-

khand². Since then, over 12,000 Van Panchayats have been established in the state. These Van Panchayats were born out of rising conflicts around the forest areas. In 1980, one such conflict was reported between two villages of Bairagna Gram Panchayat (an administrative unit or council of few villages), namely Kunkuli and Siroli in Chamoli district, Uttarakhand over the lopping of *Quercus leucotrichophora* (Banj oak). At that juncture a few villagers from Kankhuli