



Conservation and Management of Biodiversity in North East Hill Region of India

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Abstract

The Northeastern States of India are endowed with a diverse range of physiographic and ecoclimatic conditions, and they serve as a geographical 'gateway' for much of India's indigenous flora and fauna. It is home to 17 crop species, accounting for 47 percent of the country's crop species diversity. The region receives around 10% (42.5 mhm) of the country's total precipitation of 420 mhm, with an annual average rainfall of 2000 mm. The region's forest cover is 14.2 million ha, or around 54.16 percent of total geographical area, which is greater than the national average (19.39%). The region is marked by fragility, marginality, inaccessibility, cultural heterogeneity, ethnicity, and biodiversity. Floristically, the region has 43 percent of all plant species found in India. The percentage of indigenous species is likewise large (39%). Sikkim has also identified two primitive maize varieties, Sikkim Primitive 1 and 2. The area is rich in medicinal plants as well as several rare and endangered taxa.

1. Introduction

Biodiversity refers to the variety and distinctions among living species from various habitats, including terrestrial, marine, and other aquatic ecosystems, as well as the ecological complexes to which they belong. This encompasses genetic diversity within and between species, as well as genetic diversity within and between ecosystems. Thus, biodiversity essentially symbolises all life. India is one of the world's big biodiversity hotspots, with two of the world's 18 'biodiversity hotspots' located in the Western Ghats and the Eastern Himalayas. The North East India region, which includes the states of Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim, and Tripura, has a total geographical area of 262180 km² with a population of over 40 million people. It accommodates numerous living forms due to its huge diversity in soil, slope, altitudes, and ecological circumstances, and plant biodiversity essentially constitutes the basis of human life on Earth, which concerns agriculture production systems operating among farming communities. The WWF has designated the entire Eastern Himalayas as a priority global 200 ecoregion, while Conservation International has expanded the Eastern Himalaya Hotspot, which originally included the states of Arunachal Pradesh, Sikkim, Darjeeling Hills, Bhutan, and Southern China,

to include all eight states of North-East India, as well as the neighbouring countries of Bhutan, southern China, and Myanmar. Northeast India is geographically located in one of the world's most biodiverse regions. During the past three decades, the region has been through several priority-setting processes on the initiative of the national and international conservation agencies. These have highlighted the species and sites of conservation concern. The region is not a homogenous entity but a highly diverse mosaic of ecological, social and physiological landscapes and thus needs intensive analysis and attention to conservation. The region is rich in economic plants of many types. Because of the occurrence of such variability, interspecific diversities among the numerous crops are also too high; possibly the region has been classified as a 'HOT SPOT' of India. Recent discoveries of new species and range extensions of many others suggest that previous efforts must be strengthened, especially now that the region is under enormous pressure to unleash its resources in order to pave the way for development. However, the region offers its stakeholders an enormous chance to demonstrate a strong determination to balance conservation and development in order to reflect the sustainable use of its resources and promote livelihood stability.

**Table 1: One of the 12-mega biodiversity hot spot areas**

Abundant natural resources	
Forest	17.11 (million ha)
Agricultural land	3.91 (million ha)
Rivers	19976 km
Indigenous crop germplasm	3000 Nos.
Orchids	600 (175 rare spp.)
Medicinal plants	119 Species belonging to 09 genera
Aromatic plants	05 genera
Livestock population	22.62 million
Fish germplasms including ornamental	247 fish species

Source: Vision 2025, ICAR Research Complex for NEH Region, Umiam, Meghalaya.

2. Introduction to North East India and its biodiversity significance

The Northeast area of India, which includes the states of Arunachal Pradesh, Assam, Meghalaya, Manipur, Tripura, Mizoram, Nagaland, and Sikkim, is divided into three sections: the Eastern Himalayas, the Northeast highlands, and the Brahmaputra and Barak Valley lowlands. The NE region, located at the junction of the Indian-Malayan, Indo-Chinese, and Indian biogeographical realms, is remarkable in that it offers a diversified biota with a high level of endemism. The region is also home to around 135 of India's 450 tribes, the culture and customs of which play a crucial part in determining the fundamental concerns pertaining to biodiversity protection.

The north-eastern region has received attention because to its great biodiversity, and it has been designated as a priority for investment by the world's largest conservation organisations. The WWF has designated the entire Eastern Himalaya as a priority habitat. Conservation International upgraded the Eastern Himalaya's 'hotspot' to Indo Burma Hotspot, which now comprises all eight states of North-East India. The region is an endemism hotspot, an important subcenter for the genesis of cultivated crops, and home to an IUCN endemism centre. The region's lowland and montane moist to wet tropical evergreen woods are thought to be the world's northernmost authentic tropical rainforests (Proctor et al 1998). With around 836 of the 1200 bird species known from the Indian subcontinent, North East India has the highest bird

diversity in the Orient. The diversity of habitats associated with a vast altitudinal range is reflected in the region's avifauna. The region limits the global distribution of 24 species, and the Eastern Himalaya and Assam Plains are designated as Endemic Bird Areas (ICBP 1992)

The Indian Council of Agricultural Research (ICAR) classified it as a rice germplasm centre, while the National Bureau of Plant Genetic Resources (NBPGR), India reportedly highlighted the region as being rich in wild relatives of agricultural plants. Even the Jhum, the primitive agricultural economy practised by local tribes, indicates the use of 35 distinct species of crops. The Tawang Macaque, Leaf Deer, Chinese Goral, and, most recently, the Scimitar babbler (The Auk, Journal of the America Ornithologists) have led the path for the discovery of new species for this region.

Some of the facts that highlights the biodiversity significance of the region:

51 Forest types are found in the region broadly classified as six major forest types viz., Tropical moist deciduous, tropical semi evergreen, tropical wet evergreen, subtropical, temperate and Alpine forests.

Out of the 9 important vegetation types of India, six are found in the North Eastern Region. These forests harbour 80000 out of 15,000 species of flowering plants, 40 out of 54 species of gymnosperms, 500 out of 1012 species of Pteridophytes, 825 out of 1145 species of orchids, 80 out of 90 species of rhododendrons, 60 out of 110 species of bamboo, 25 out of 56 species of canes, In terms of species richness. (Table 2)

Table 2: Flowering plants in terms of species richness



State	Species richness (flowering plants)
Arunachal Pradesh	+5000
Sikkim	+ - 4500
Meghalaya	+ - 3500
Assam	+ - 3010
Manipur	+ - 2500
Nagaland	+ - 2250
Mizoram	+ - 2200
Tripura	+ - 1600

Out of the 315 species recorded in North East India, all of these species belong to approximately 200 plant families. Some families, such as the Nepenthaceae, Illiciaceae, and Clethraceae, are unique in the globe. According to the Indian Red Data Book (BS!), 10% of all blooming plants are threatened. North East India is

home to 800 of the 1500 species. The region's faunistic richness has been stressed in the report's succeeding sections. Because the distribution of the mega fauna is better established, a sperte write up on faunal variety is added to this study. Table 3 shows the forest area as reported by the Forest Survey of India in 2003:

Table 3: Scenario of Forest Area in North East India (Area in km²)

N.E States	Geographical Area of the state	Forest Area(Total)	Percentage Forest Cover
Arunachal Pradesh	83,743	51,540	61.55
Assam	78,438	27,018	34.45
Manipur	22,327	17,418	78.01
Meghalaya	22,429	9,496	42.34
Mizoram	21,081	16,717	79.30
Nagaland	16,579	8,629	52.05
Tripura	10,486	6,293	60.01
Sikkim	7,096	5,841	82.31
	2,33,878		

Source 1: State of Forest Report, 2003, Forest Survey of India, Ministry of Environment and Forests, Govt. of India

2. Hegde (200) Arunachal Forest News. State Forest Research Institute. Arunachal Pradesh

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. Biodiversity in NEH Region

Diverse Agro-climatic conditions

The region has the climatic situation between tropical to alpine environment ranges, the soil is rich in organic meter having pH in between 4.5 to 5.0.

1. Alpine Zone (□ 3500m)
2. Temperate Sub-Alpine (1500-3500 m)
3. Sub tropical Hill Zone (1000-1500 m)
4. Sub Tropical Plain Zone : (800-1000 m)
5. Mild Tropical Hill Zone : (200-800 m)
6. Mild Tropical Plain Zone : (0-200 m)

Rice diversity of the region

This region's staple food is rice. There are various

cultivars of the indica and japonica races in this region, and some of them exhibit unique characteristics. Some examples are given below based on the exploration and collecting of rice germplasm diversity.

Rice is the main crop in Arunachal Pradesh, which grows up to 2000 m, after which millets, buckwheat, and other temperate fruits and Cole crops are cultivated. Indigenous water collecting and irrigation technologies were observed on the Apatani plateau in the upper Subansiri area. A small area is planted with seventeen different rice landraces. In terms of culm, tillering, panicle, and grain characteristics, several of the landraces resemble Japonica plant types. In Lohit District, the "Khamati" tribe continues to cultivate their



own landraces using the transplanting method, which produces a higher yield than other available types.

Assam's terrain includes both hills and plains. Under the PL-480 initiative, 493 collections of rice germplasm were conducted from the Mikir and North Cachar hills, with 1118 accessions taken from Assam's five plain districts. Until 2008, the NBPGR Regional Station in Shillong gathered 1580 rice accessions, including wild relatives. Except for the Imphal valley area, the rest of Manipur has a hilly topography. Rice farming occurs in both upland and lowland environments. The state's first black kernelled rice, known locally as "Chahao," is grown at higher elevations in the Ukhrul district. The variety is aromatic, but gives less yield, making cultivation difficult. Because of the HYV invasion in valley areas, most indigenous rice types are rapidly becoming obsolete and vanishing from agriculture. However, 40 native rice landraces from this state were gathered and analysed by scientists (1) from the ICAR Research Complex for North Eastern Hill Region, Shillong.

Despite the considerable rainfall in Meghalaya, the extensive hill tracts are unsuited for rice production due to acidic soil, rocky plateau, forest cover, grassland, and coal and limestone mining operations. Soft varieties are served as breakfast in Khasi-Mikir Hills border communities, either flaked or raw. The notable indigenous rice varieties are *Mirikrak*, *Chanmouri*, *Kbathugmaw*, *Batlong*, *Rvlloded*, *Kbaswarit*, *Abor red*, *Khonorullu*, *Ngoba*, *dullo*, *Thermeru red*, *Lyngsi*, *Kuki*, *Tongla*, *Nonglwai* and *Maiku Tsuk* (1).

Mizoram is entirely hilly, with steep slopes, and wetland farming is limited to the Champhai district's valley and flatland areas. The bulk of Jhoom rice cultivars are long-lasting, whereas wetland varieties mature early. The state was maybe excluded from the PL-480 rice germplasm gathering scheme due to political concerns. The NBPGR Regional Station in Shillong, on the other hand, has collected 362 rice accessions from the state thus far.

Nagaland is prosperous because Nagas are hardworking people. The Zabo technique (12) is a traditional practise among Chakehsang farmers in the state's Phek area. At least 489 accessions of rice germplasm were collected under the PL480 initiative, while the NBPGR Regional Station in Shillong

collected 460 accessions.

Tripura's terrain is made up of hills, hillocks, and flat valleys. Deep-water rice cultivation is also practised in flood-prone submerged areas. This small state is home to ten tribal communities and 22 sub-tribal communities. Bangladesh has a sizable Bengali community in the state. It's also used in the production of parched and flaked rice. Assam rice collections (PL-480) indicated the collection of 246 Assam accessions.

Sikkim is a hilly state located within a contiguous portion of the Himalaya. Each year, only about 20,000 hectares of land in the state are grown for rice. Every year, the bulk of the landraces grown in the state. Directly sown varieties – *Buidhan*, *Lama* and *hapachini*. Transplanted varieties - *Attey*, *Mansara*, *Jhapaka*, *Dut-kalami*, *Basmati*, *Krishna-Bhog*, *Talasi*, *Poudal* and *Brimphul*. *Attey*, *Marshi* are early maturity type and suited up to 1500 m altitude, while *Phudange*, *Takmaru* and *Darmali* grows beyond 1500 m. (Source: Conspectus of rice diversities of Northeast region: Development approach through ecosystem based, NBPGR Shillong centre).

Diversity of Maize Landraces in NE India

1250 accessions from the NEH region, predominantly from Meghalaya (303), Mizoram (220), Sikkim (210), Arunachal Pradesh (187) and Nagaland (135). These accessions are available in National Gene Bank. (Source: Diversity of Maize Landraces in India by B.M. Prasanna).

Diversity of Pulses Landraces in NE India

The Department of Biotechnology, Guwahati University, Guwahati screened thirty land races of the legume *Vigna umbellata* collected from the hilly state of Nagaland, North-East India, for nutritional value and discovered that Crude protein concentration ranged from 14.66 percent to 26.88 percent. The principal pulse crops farmed in NE India are lentil, rice bean, and chickpea (*Cicer arietinum* L.).

Citrus Genetic Diversity in North Eastern Region

North Eastern India is said to be the natural home of certain citrus species. Favorable climatic conditions that facilitate simple hybridization between diverse species and genera have resulted in numerous types of citrus thriving in the wild and semi-wild. Around 18 different citrus species viz. *Citrus reticulata* Blanco,



Citrus sinensis Osbeck, *Citrus Jambhiri* Lush., *Citrus Medica* L., *Citrus Karna Ratin.*, *Citrus aurantifolia* Swingle, *Citrus limetta* (Risso.) Lush., *Citrus indica* Tanaka, *Citrus aurantium* L., *Citrus grandis* Osbeck, *Citrus megaloxycarpa* Lush., *Citrus assamensis*. (2) described 17 citrus species, their 52 cultivars and a few probablenatural hybrids from this region. In lemon alone, as many as 32 strains are available. The species *C. limon*, *C. medica*, *C. jambhiri*, *C. ichangensis*, *C. latipes*, *C. macroptera*, *C. assamensis*, *C. indica* and *C. aurantium* are considered indigenous to this region. The Indian wild orange *C. indiaca* is found in the Naga Hills and Meghalaya. (Source: Various publications of ICAR Research Complex for NEH Region, Umiam, Meghalaya). Though citrus output is strong in the Indian plains, it is greatly reduced in the North Eastern region due to a lack of quality planting materials and poor orchard management, necessitating the search for advanced procedures to meet the crop's increased demand (11). The North-Eastern region is regarded as a bio-diversity hotspot, with a wide range of citrus species (5). Arunachal Pradesh is one of the major citrus diversity centres in India's north-eastern region (12).

Banana and mango

Maximum genetic variability of *Musa acuminata* and *M. balbisiana* occurs in NE India. *M. flaviflora* is localized to Manipur and Meghalaya. There are other species found in Sikkim and Khasi Hills, which need systematic collection and conservation. Some native *Mangifera spp.* are found in Tripura, Manipur, Mizoram and South Assam. Wild form of *M. indica* and its allied species *M. sylvestica* occur in Arunachal Pradesh, *M. khasiana* and *M. pentandra* in Assam. (Source: Diversity of horticultural crops in north eastern region, B.S. Asati and D.S. Yadav, ICAR Research Complex for NEH Region)

Temperate fruits

Rich diversity occurs in *Pyrus*, *Rubus*, *Ribes* and *Prunus*. The Shillong plateau of Khasi hills in Meghalaya has many *Prunus* species such as *P. napalensis*, *P. undulata* and *P. cerasoides*. *Pyrus pyrifolia* var. cubha makai (*P. serotina* Red) are grown semi commercially in Meghalaya, Manipur and other places. Wild kiwi (*Actinidia callosa* and *A. stragosa*) is found growing in the natural forests of Arunachal Pradesh and Sikkim.

Tropical and sub tropical fruits

Other tropical and subtropical fruits found growing wild in the region include *Garcinia*, *Artocarpus*, *Phyllanthus*, *Annona*, *Averrhoa*, *Persia*, *Aegle*, *Passiflora*, and others. Jackfruit, which grows abundantly in Tripura, Assam, and Meghalaya and has a huge variety of varieties, is one of the indigenous fruits that require care.

Under utilized fruits

Of the 300 edible plant species found in the NE region, some of them are really worth consuming by various ethnic groups of tribals. Two species of *Elaeagnus*, viz *E. latifolia* and *E. pyriformis* are known to be grown in NE region (5). It is quite common in Sibsagar (Dikho valley), Naga Hills, Khasi and Jaintia Hills. *Docynia indica* and *D. hookeriana* are commonly found in the region. *Pyrus pashia* is a medium sized deciduous fruit tree also found in NE region.

Solanum group

There is wide range of *Solanum spp.* found in the various parts of the region. Local tribals cultivate a vegetable with red tomato-like fruits that are slightly bitter in flavour but are linked to brinjal and belong to the genus *Solanum*. Another type of brinjal is grown in Manipur, with roundish fruit that looks like a cross between a tomato and a brinjal.

Tomato and chili

Tomato is an introduced crop roughly in 18th century and most of the introductions are bred varieties, which have adapted to this region (9). Germplasm of wild species of tomato *L. pimpinellifolium*, has been found in NE region. Chilies are often grown in warm to hot and humid climates in Manipur, Mizoram, Meghalaya, Nagaland, Tripura, and Arunachal Pradesh, in that order. Because of the crop's long history of cultivation, outcrossing nature, and popularity, a vast genetic diversity has evolved, including local landraces. The North Eastern region has a wide range of variability in hot chilli for numerous qualities (fruit form, size, colour, bearing habit, and semi-perennial, perennial, and pungency).

Cucurbitaceous vegetables

Consisting of more than 15 kinds, these vegetables are grown and consumed within the region. In North East many species of cucurbits are found as vegetables and



fruits; these include *Cucurbita*, *Momordica*, *Luffa* and several lesser known cucurbitaceous crops.

Leguminous vegetables

The region contains a large range of French bean, cowpea, and Indian bean varieties. The climbing or pole kind of French bean is popular among tribals because it is used for mix cropping with maize, the stem of which serves as support for the bean. The tribals of Tripura cultivate one of the more fascinating *Vigna* species, *V. vexillata*. It is a legume cum tuber crop with a wide range of edible tubers (2). The papilionaceae family's sword bean (*Canavalia ensiformis* (L) DC) is also grown on a small scale in the North Eastern region (1). Winged bean is restricted to humid subtropical areas in the NE region.

Spices

Ginger and turmeric have a wide range of diversity.

Lakadong, an indigenous kind of turmeric, is grown in Meghalaya's Jowai district. Except for Tripura and Sikkim, Poona and Thinglaidon scored better in most states, showing viability for large-scale planting for green ginger production. The Nadia ginger cultivar is widely used in the North East. Mizoram residents produce Black ginger, a form of ginger with rhizomes that have a blue black tinge inside. Wild relatives of large cardamom (*Amomum subulatum*) and cinnamon are available in the forests of this region.

Ornamental Plants

Ornamental plants present in the NEH region include *Mannolia*, *Rhododendron*, *Cassia*, *Erythrina*, *Calustemom*, *Dacasenda*, *Myrica*, *Bauhinia*, and others. In this location, around 600 orchid species have been naturalised in large numbers. Sikkim, Arunachal Pradesh, Meghalaya, and Manipur have shown a wide range of variations.

Table 4: Example of market sectors dependent on genetic resources

Sector	Size of Market	Comment
Pharmaceutical	US\$ 640 bn. (2006)	25-50% derived from genetic resources
Biotechnology	US\$ 70 bn. (2006) from public companies alone	Many products derived from genetic resources (enzymes, microorganisms)
Agricultural seeds	US\$ 30 bn. (2006)	All derived from genetic resources
Personal care, Botanical and food & Beverage industries	US\$ 22 bn. (2006) for herbal supplements US\$ 12 bn. (2006) for personal care US\$ 31 bn. (2006) for food products	Some products derived from genetic resources represents 'natural' component of the market.

Source: The Economics of Ecosystems and Biodiversity (TEEB), UNEP, Switzerland.

Medicinal and Aromatic Plants

Medicinal plants of known use like *Rauvolfia serpentina*, *Solanum khasianum*, *Dioscorea proceri*, *Coptis teeta* are widely available in the region. Orchids as medicinal agent have been used by the tribals of NE states like Arunachal Pradesh, Nagaland, Meghalaya and Mizoram.

Germplasm Evaluation

It is critical to analyse plant genetic resources for productivity, including components, crop duration, resilience to biotic and abiotic stress, and output quality, in order to promote effective usage of plant genetic resources. Moresh, a dwarf and late maturing polyembryonic mango cultivar, provides sweet fruit with good pulp content within 2 years of planting and is stone weevil free. Locally available species such as

Malus baccata are extensively used as apple rootstock, whilst *Pyrus pashia* is a common pear rootstock. *Elaeagnus* mature fruits, namely *E. latifolia*, as well as *E. Pyriformis* is edible and can be used to make a pleasant drink. *Docynia indica* and *D. indica* fruits *Hookeriana*, which is sour and greenish with a crimson tinge, is consumed fresh, in pickles, and in jelly making. Some brinjal types have good qualities such as large size, tender flesh, and few seeds. *S.* is a medicinally important plant (it contains solasodine). *khasianum*. *S.* another species *Torvum* is widely utilised in the Ayurvedic medical system. The State Variety Release Committee of Manipur released three tomato varieties, *Manileima*, *Manikhamnu*, and *Manithoibi*, which were deemed to be suited for rice-based farming systems. *L. pimpinellifolium* provides resistance to late blight and tomato leaf curl virus (9).



A chilli collection from Tezpur (Assam) was discovered to have the highest capsaicin level ever recorded anywhere in the globe. Cho-Cho (*Sechium edule*) grows huge starchy edible roots as well as fruits. More than ten germplasms of Indian bean are kept at the National Bureau of Plant Genetic Resources' Regional Station in Shillong. Winged bean has outstanding nutritional characteristics, especially because it is high in protein (8). The native species of orchids having ornamental value and market potential usually belong to *Aerides*, *Anachnantha*, *Arundina*, *Cymbidium*, *Dendrobium*, *Paphiopedillum*, *Phaius*, *Renanthera*, *Phycostylus* and *Vanda* etc. (2). Khasis utilise the juice of *Cymbidium giganteum* cut leaves to aid in blood clotting, while *Vanda* flower juice is used as an eye drop to treat glaucoma. There is a vast array of medicinal and aromatic plants that could be used to improve vegetable crops for use in the agricultural business using indigenous germplasm. (Source: Diversity of horticultural crops in north eastern region, *B.S. Asati and D.S. Yadav, ICAR Research Complex for NEH Region*).

2 Conservation of Diversity in NEH Region

Role of Women and Tribal people in Biodiversity conservation for North East Region

Women's responsibilities in an agrarian setting include crop cultivation, vegetable production, animal husbandry, marketing, fishing, and slightly more skilled jobs such as dyeing and domestic industries. Tribal people, notably women, in general, and the North East hill region in particular, play a significant role in diverse agricultural operations while maintaining biodiversity. The North East region is unusual in that it provides a variety of habitats that support a diversified biota with a high level of endemism. The region is also home to around 225 of India's 450 tribes, the culture and practises of which play a crucial role in comprehending biodiversity conservation and management challenges. The North Eastern region has received attention because to its high biodiversity, and it has been a priority for the world's premier conservation organisations. The diversity of habitats associated with a wide altitudinal range is reflected in the richness of the region's avifauna. (Source: Anupam Mishra, Seeralan.S, and S.V.Ngachan, ICAR RC for NEH Region, Prospects and Retrospects of Women in Biodiversity for North East Region). The Adi tribe in the eastern Himalayas is

unique in that they have customary rights to the land, water, and forests under their authority. The Adi tribal community has authority over the natural resources in their area. There are no written land records of ownerships in the state of Arunachal Pradesh however, they are playing crucial role in maintaining biodiversity, natural resources, streams, hills and other land marks.

Major constraints

Land tenure issues

Land tenure regimes varies greatly between North-Eastern states, which are considerably different from the rest of India. The complexities of land ownership and tenurial rights make survey, demarcation, and consolidation of land challenging. As a result, cadastral survey and land demarcation are virtually lacking in the northeastern hill areas.

Gender and equity issues in natural resources and diversity management

Unequal distribution of land resources is to blame for increasing reliance on forests by certain segments of society, resulting in biodiversity destruction. Resolving gender and equity issues in natural resource management is as vital in the North-East as it is in the rest of the country.

Inter-departmental coordination

Inter-departmental cooperation is critical for the long-term management of the region's horticultural resources.

Smuggling of timber across the international border

The most significant source of horticultural area/forest degradation in border areas has been illegal tree felling and timber smuggling across international borders.

Shifting cultivation

Unregulated shifting cropping by local tribe people has posed a significant threat to sustainable variety management in the region's unclassified and community forests.



Inter-state border dispute

There are numerous inter-state border disputes amongst the northeastern states. The majority of these border territories are forest lands, and due to boundary disputes, such lands are frequently termed "no man's land," and so are not managed. This results in a loss of diversity in such places.

Insurgency

The long-running insurgency in some states, like as Assam and Tripura, has a significant influence on biodiversity conservation.

Prospects in NEH Region

Although there aren't many agencies/organizations in the north-east that work solely on diversity conservation, the activities of many organisations, including nongovernmental and traditional institutions, government departments, and scientific institutions, have direct or indirect implications for diversity conservation.

State Government Agencies

Many state agencies are now involved in such diversity conservation activities as establishment of germplasm banks for horticultural crops.

Research Organizations

Many state and federal government research agencies, including universities in the region, are involved in biodiversity research, inventory, and conservation. Such organizations are Botanical Survey of India, Shillong, G.B. Pant Institute of Himalayan Environment and Development, (North-East Unit, Itanagar and Sikkim Unit, Panthang), Indian Council of Agricultural Research for North-Eastern Hill Region, Barapani, Shillong with campuses through out the north-east, State Forest Research Institute, Itanagar, NBPGR, Shillong, North-Eastern Hill University, Shillong, Nagaland University, Kohima, Mizoram University, Aizawl, Arunachal University, Itanagar, Tripura University, Agartala, Assam University, Silchar, Tezpur University, Tezpur, Gauhati University, Guwahati, Assam Agricultural University, Jorhat, Regional Research Laboratory, Jorhat, Dibrugarh University.

Non-Governmental Organizations

Many non-governmental organisations (NGOs) are now working in the north-east to conserve biodiversity,

however the majority of them are at the local and grassroots level.

International Donor Agencies

Through their separate projects, international donor agencies in Meghalaya, Manipur and Assam, and Nagaland have played critical roles in conserving variety.

International and National Policies and Conventions

All the international treaties and national policies have significant impact on the conservation of diversity in the north-east.

Academic Institutions Including Schools and Colleges

The educational curriculum in the universities, colleges and schools has an important role to play in diversity conservation.

Shifting Cultivators

Shifting cultivators and other traditional agricultural groups in the northeast have played an important role in preserving the region's rich horticulture crop genetics. Despite the availability of several hybrid and high producing types, some farmers have grown traditional varieties for years.

Why Conservation of Biodiversity is Important?

Biodiversity is the bedrock upon which all of the Earth's fundamental commodities and services are built. The air we breathe, the water we drink, and the food we eat are all dependent on the vast biodiversity of the Earth. Plants and animals offer food and medication to humans. Natural chemicals found in various species account for 40% of all prescriptions dispensed today. There are an estimated 80,000 edible plants in the world, and one out of every three mouthfuls of food you eat is prepared from plants pollinated by wild insects and animals.

While plants and animals keep you fed and healthy, trees help to reduce greenhouse gas emissions. Forests also help to prevent soil erosion and filter water. The biodiversity of the Earth supports every element of our lives. Biological resources must be protected if life on Earth is to continue. USAID mostly promotes biodiversity conservation through habitat conservation, although it also supports limited species-specific conservation activities. www.usaid.gov.in is the source.



Although some people are opposed to attempting to put a monetary value on biodiversity, attempts have been made in order for people to comprehend the severity of the problem. The following industries are dependent on genetic resources, according to a recent paper, The Economics of Ecosystems and Biodiversity (TEEB) for National and Inter-national Policymakers 2009. TTEB is an organization backed by the United Nation and various European Governments attempted to compile, build and make a compelling economics case for the conservation of ecosystems and biodiversity.

What should be done?

1. Long-term planning based on sustainable development techniques, as well as the incorporation of biodiversity conservation issues into development planning, is critical. The improper conservation policies, which focused solely on commercially significant species, have proved detrimental to diversity. Such policies should be implemented with caution. They have not only reduced species variety in natural/rehabilitated forests, but they have also exacerbated soil erosion and moisture loss.

1. Regeneration and cultural practices for many species need to be researched and standardized for their cultivation. Threatened species need immediate action for ensuring their continued existence.
2. Identification and classification of threatened species need to be done.
3. Richness of diversity of agricultural and horticultural crop species should be fully inventoried and documented.
4. There is a conspicuous gap between research and field needs. The established formal institutions like university departments, departmental research stations and others rarely consult the farmers and local communities about their problems while pursuing research. Need-based research needs must be encouraged in public private partnership (PPP) mode.
5. Through the Public Distribution System only HYV are distributed. There is a need to include distribution of indigenous varieties too.
6. The planners have not considered the role and value of diversity in preparing developmental plans. Such ignorance has been responsible for depletion diversity.

The majority of the issues are related to population growth. The north-population east's growth rate is extremely rapid. This puts a significant demand on natural resources and leads to the implementation of policies that are unfriendly to the conservation of diversity. There has been no population strategy adopted for future planning, hence proper population policy is required.

Diversity conservation education is not included in education policy. The school curriculum should be able to shape young brains in favour of preserving variety.

3. Conclusion

To make this region self-sufficient in all aspects, a comprehensive plan is required, and conservation of biodiversity and entrepreneurship development will undoubtedly play a significant part in improving people's socioeconomic conditions. Crop output in India's North Eastern Region is primarily consumed to meet the demands of farmers. Low productivity and cropping intensity have resulted from the use of local varieties, low consumption of fertilisers and pesticides, low moisture retention capacity of upland soil, undulating terrain with varying altitudes and slopes, low temperature, poor drainage in valley land during monsoon and lack of irrigation facilities during winter months, low sunshine hours, and traditional management practises. Adoption of better agro-techniques has the potential to significantly increase agricultural productivity in the region. Adoption of a watershed approach, an integrated farming system approach, land configuration for increasing cropping intensity, organic farming, conservation tillage, and other resource conservation measures have been identified as potential resource conservation measures for the region's agricultural sustainability. Because the region has a high degree of rice genetic resources in relation to area and population, modernization of agriculture is one of the causes of genetic erosion and extinction of germplasms. A farmers-based approach, i.e. in-situ conservation, will be most appropriate for conserving rice germplasm. The tribal farmers of the northeastern region kept a greater variety of rice varieties than was available in the market. They must be encouraged to continue planting their native landraces, which they are familiar with. Different germplasm collection, variations, and technology development on a cooperation basis can assist this region in establishing various agro-based industries.



The sui generis system for plant variety protection was developed at the national level, incorporating the rights of breeders, farmers, and village communities, as well as concerns for equitable benefit sharing, so that biodiversity conservation can be a tool to make this region self-sufficient in all aspects.

References

1. Cairns, M. and D.P. Garrity 1999. Improving shifting cultivation in Southeast Asia by building on indigenous fallow management strategies. *Agro forestry System* 47: 37-48.
2. Chakraborty, S.K. 2005. "Protect jhumlands, jhumia right," Grassroots Options, Spring, 24-26.
3. CSIR. 1970. Wealth of India: Raw Materials Vol.
4. VI-Livestock (including Poultry). *Council of Scientific and Industrial Research, New Delhi*
5. De Jong, W. 1997. "Developing swidden agriculture and the treat of biodiversity loss", *Agriculture, Ecosystems and Environment*, 62: 187-197.
6. Hazarika, T.K., 2012. Citrus genetic diversity of north-east India, their distribution, ecogeography and ecobiology. *Genetic Resource and Crop Evolution* 59: 1267–1280.
7. Kinzing, A.P., S.W. Pacala, and D. Tilman. eds. 2001. The Functional Consequences of Biodiversity. *Princeton University Press, Princeton, NJ*.
8. Kothari, A. 1997. Agro-biodiversity: the future of india's agriculture, *Article for MCAER Book; 7 February, 1999*.
9. Kothari, A. 2005. The khonoma Magic. *The Hindu Survey of the Environment* 2005: 125-129.
10. Loreau, M., S. Naeem and P. Inchausti. eds. 2002. Biodiversity and Ecosystem Functioning
11. Mertz O. 2002. Rethinking the fallow-yield relationship in shifting cultivation? *Agroforestry System* 55(2): 149-159.
12. Rabha, A., Wangchu, L. and Singh, B. 2013. Studies on genetic diversity of citrus in east Siang district of Arunachal Pradesh. *International Journal of Agriculture, Environment & Biotechnology* 6(1): 131-137.
13. Singh, I.P., 2010. Exploration, collection and characterization of Citrus germplasm from Meghalaya, Assam and Arunachal Pradesh. *Progressive Horticulture* 42 : 39-43.