

## Biodiversity in North East India and their Conservation

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### ABSTRACT

Northeast States of India is blessed with a wide range of physiographic and ecoclimatic conditions and the geographical 'gateway' for much of India's endemic flora as well as fauna. It is a home of 17 crop species that represent 47% of the crop species diversity available in the country. The region receives an annual average rainfall of 2000 mm accounting for about 10 % (42.5 mhm) of the country's total precipitation of 420 mhm. Forest cover in the region is 14.2 million ha which is about 54.16 % of total geographical area which is higher than the national average (19.39 %). By and large, the region is characterized by fragility, marginality, inaccessibility, cultural heterogeneity, ethnicity and rich in biodiversity. Floristically, the region covers 43% of the total plants species that are occurring in India. The rate of endemic species percentage is also high (39%). Two primitive variety of maize, Sikkim Primitive 1 and 2 have also been reported from Sikkim. The region is rich in medicinal plants and many other rare and endangered taxa.

**Key words:** biodiversity, flora, fauna, species, medicinal plant

Biodiversity is the variety and differences among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part. This includes genetic diversity within and between species and of ecosystems. Thus, in essence, biodiversity represents all life. India is one of the mega biodiversity centres in the world and has two of the world's 18 'biodiversity hotspots' located in the Western Ghats and in the Eastern Himalayas. The North East India comprising of eight states namely Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim and Tripura has a total geographical area of 262180 km<sup>2</sup> which is about 8 % of the country's total area with a population of about 40 million. Because of its vast diversity in soil, slope, altitudes and ecological conditions, it hosts diverse life forms, the plant biodiversity primarily forms the basis of existence of human life on earth, which concern agriculture production systems existing among farming communities. WWF has identified the entire Eastern Himalayas as a priority global 200 ecoregion while Conservation International has upscaled the Eastern Himalaya Hotspot which initially covered the states of Arunachal Pradesh, Sikkim, Darjeeling Hills, Bhutan, and Southern China to the Indo Burma Hotspot which now includes all the eight states of

**Strength of the Region**

North-East India, along with the neighboring countries of Bhutan, southern China and Myanmar. Northeast India is geographically nestled in one of the most biodiversity-rich regions of the world. 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 endowed with diversities of economic plants. Interspecific diversities among the among the various crops are also too high due to the occurring of such variability, perhaps the region has been identified as one of the 'HOT SPOT' of India. Recent discoveries of new species and range extensions of many others demonstrate that efforts taken to date need further strengthening, particularly now that the region is under tremendous pressure to unleash its resources to pave the way for development. However, the region also provides an immense opportunity to its stakeholders to exhibit a strong willingness to balance conservation and development so as to reflect the sustainable use of its resources and ensure livelihood security.

**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

### Diverse Agro-climatic conditions

The region has the climatic situation between tropical to alpine environment ranges, the soil is rich in organic matter 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

Rice is the staple food of this region. There are so many cultivars belonging to *indica* and *japonica* race exists in this region and some cultivars have some special feature. Based on the exploration and collection of rice germplasm diversity, some examples are cited below.

In Arunachal Pradesh rice is the principal crop, which grows up to 2000 m, beyond which millets, buckwheat and other temperate fruits and Cole crops are grown. Indigenous methods of water harvesting and use for irrigation were seen in *Apatani* plateau of upper Subansiri district. Seventeen diverse rice landraces are used to grown a limited area. Some of the landraces resemble *Japonica* plant type in respect of their culm, tillering, panicle and grain characters. In Lohit District where "Khamati" tribe is still cultivating their own landraces, following transplanting method, which gives higher yield than other available varieties.

The topography of Assam constitutes both hills and plains. Under PL-480 scheme, 493 collections of rice germplasm have been made from Mikir hills and North Cachar hills, which 1118 accessions were collected from five plain districts of Assam. The NBPGR Regional Station, Shillong has collected 1580 accessions of rice including their wild relatives, till 2008.

In Manipur except the Imphal valley area, the rest of the state is hilly in topography. Both upland and lowland rice cultivation exists at different eco-environment. At higher elevation of Ukhrul district, the black kernelled rice locally called "Chahao" is a novelty of the state. The variety is aromatic but contributes less yield and thus limited in cultivation. Due to the invasion of HYV in the valley areas, most of the indigenous rice varieties are gradually becoming obsolete and are disappearing from cultivation. However, 40 local rice landraces were collected and evaluated by the scientists (Asthana and Majumdar, 1981) of ICAR Research Complex for North Eastern Hill Region, Shillong from this state.

Though the Meghalaya state receives high rainfall, the large hill tracts are unsuitable for rice cultivation due to acidic soil, rocky plateau, forest cover, grassland and mining operations of coal and limestone. Soft varieties are both used as flaked or in raw form and served as breakfast in Khasi-Mikir Hills border areas. The notable indigenous rice varieties are *Mirikrak*, *Chanmouri*, *Kbathugmaw*, *Batlong*, *Rvlobed*, *Kbaswarit*, *Abor red*, *Khonorullu*, *Ngoba*, *dullo*, *Thermeru red*, *Lyngsi*, *Kuki*, *Tongla*, *Nonglwai* and *Maiku Tsuk* (Asthana and Majumdar, 1981).

Mizoram state is completely hilly with steep slopes where wetland cultivation is limited only in valley and flatland areas of Champhai district. Most of the *Jhoom* rice cultivars are long

duration type, while wetland varieties mature early. Perhaps due to the political problem the state was not included under PL-480 scheme for rice germplasm collection. However, NBPGR Regional Station, Shillong has collected 362 rice accessions so far from the state.

Nagaland state is very prosperous as the Nagas are hardworking people. Zabo system (Sonowal *et al.*, 1989) is a traditional practice among the farmers of Chakehsang community in Phek district of the state. At least 489 accessions of rice germplasm were collected under PL480 scheme, while NBPGR Regional Station, Shillong has collected 460 accessions.

Topography of Tripura comprises hills, hillocks and flat valley. Deep-water rice cultivation is also done in flood prone submerged areas. About 10 tribal and 22 sub-tribal communities inhabit this small state. Migrated Bengali community from Bangladesh from a major population in the state. Besides that it is used in preparation of parched and flaked rice. Assam rice collections (PL-480) have indicated that 246 accessions were collected from this state.

Sikkim hilly and falls within the contiguous stretch of Himalaya. Rice crop is grown in hardly 20,000 h of land area in the state annually. Most of the landraces grown in the state annually. 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

Thirty land races of the legume *Vigna umbellata*, collected from the hilly state of Nagaland, North-East India were screened for nutritive value by Department of Biotechnology, Guwahati University, Guwahati and found that Crude protein content varied from 14.66% to 26.88%. Lentil, rice bean, chickpea (*Cicer arietinum* L.) are the major pulse crops grown in NE India.

### Citrus Genetic Diversity in North Eastern Region

North Eastern India is considered to be the natural home of different citrus species. Favourable climatic conditions aiding in easy hybridization amongst different species and genera has brought in about numerous forms of citrus growing wild and semi-wild condition. 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*. Bhattacharya and Dutta (1956) 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. indica* is found in the Naga Hills and Meghalaya. (Source: Various publications of ICAR Research Complex for NEH Region, Umiam, Meghalaya). Though production of citrus in Indian plains is high, it is reduced to a great extent in North Eastern region due to lack of quality planting materials and poor orchard management, which necessitates to explore for advance techniques that can manage higher demand of this crop (Rabha *et al.*, 2013). North-Eastern region is considered as one of the bio-diversity hot spot, has a good diversity of citrus species (Hazarika, 2012). The state of Arunachal Pradesh is one of the major centres of diversity of citrus in the North eastern region of India (Singh, 2010).

#### **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**

A large number of other tropical and subtropical fruits belonging to the genera *Garcinia*, *Artocarpus*, *Phyllanthus*, *Annona*, *Averrhoa*, *Persia*, *Aegle*, *Passiflora*, etc., are found growing wild in the region. One of the indigenous fruits that require attention is jackfruit, which grows abundantly in Tripura, Assam and Meghalaya with a large number of cultivars.

#### **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. pyrifolia* are known to be grown in NE region (Pandey, 2002). 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. The local tribals grow a vegetable having red tomato like fruits slightly bitter in taste but related to brinjal and belonging to the genus *Solanum*. In Manipur another kind of brinjal having roundish fruit and intermediate in appearance between tomato and brinjal is grown.

#### **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 (Seshadri and Srivastava, 2002). Germplasm of wild species of tomato *L. pimpinellifolium*, has been found in NE region. Chilies are usually grown in warm to hot and humid climate in Manipur, Mizoram, Meghalaya, Nagaland, Tripura, and Arunachal Pradesh in that order with respect to area under the crop. Due to the long history of cultivation, outcrossing nature and popularity of the crop, large genetic diversity including local landraces have evolved. In hot chili great range of variability for several attributes (fruit shape, size, colour and bearing habit and semi-perennial, perennial and pungency) occur throughout the North Eastern region.

#### **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**

A wide variability of French bean, cowpea and Indian bean is found in the various parts of the region. In French bean, climbing or pole type is popular among the tribals since it is used for mix cropping with maize, the stem of which act as the support for the bean. One of the interesting species of *Vigna* namely *V. vexillata* is grown by the tribals of Tripura. It is a legume cum tuber crop with much variation in edible tubers (Arora and Pandey, 1996). Sword bean (*Canavalia ensiformis* (L) DC) of papilionaceae family is also cultivated on limited scale in the North Eastern region (CSIR, 1950). Winged bean is confined in humid sub tropical parts of NE region.

#### **Spices**

A wide range of variability has been found in ginger and turmeric. Lakadong the local variety of turmeric is grown in Jowai area of Meghalaya. Poona and Thinglaidon performed better in most of the states except Tripura and Sikkim indicating suitability for large scale cultivation for green ginger production. Nadia variety of ginger is well adopted in North East region. A type of ginger having rhizomes with bluish black tinge inside called Black ginger is grown by the inhabitants of Mizoram. Wild relatives of large cardamom (*Amomum subulatum*) and cinnamon are available in the forests of this region.

#### **Ornamental Plants**

The ornamental plants, which are found in NEH region, include species of *Mannolia*, *Rhododendron*, *Cassia*, *Erythrina*, *Calustemom*, *Dacasenda*, *Myrica*, *Bauhinia*, etc. About 600 species of orchids are naturalized in great proportion in this region. Wide range of variability has been found in Sikkim, Arunachal Pradesh, Meghalaya and Manipur.

#### **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**

In order to facilitate effective utilization of plant genetic resources, it is important that the plant genetic resources are evaluated for productivity including components, crop duration, resistance to biotic and abiotic stress and quality of produce. A dwarf and late maturing polyembryonic mango cultivar Moresh

bears sweet fruit with high pulp content within 2 years from planting and is free from stone weevil. The locally available species like *Malus baccata* is widely used as rootstock of apple while *Pyrus pashia* is a common rootstock of pear. The ripe fruits of *Elaeagnus*, viz *E. latifolia* and *E. pyriformis* are edible and used for making refreshing drink (Pandey, 2002). The fruits of *Docynia indica* and *D. hookeriana* acidic, greenish with red tinged are eaten fresh and in pickles as well as in jelly preparation. Some of the brinjal varieties have excellent quality in having large size, soft flesh and less seeds. An important species of medicinal importance (solasodine content) is *S. khasianum*. Another species *S. torvum* is extensively used in Ayurvedic medicine system. Three tomato varieties namely Manileima, Manikhamnu and Manithoibi were released by State Variety Release Committee, Manipur and found suitable for rice-based cropping system. *L. pimpinellifolium* is also good source of resistance to late blight and tomato leaf curl virus (Seshadri and Srivastava, 2002). In chilli, a collections from Tezpur (Assam) has been found to have the highest capsaicin content recorded so far anywhere in the world. Cho-Cho (*Sechium edule*) produce large starchy edible roots in addition to fruits. The National Bureau of Plant Genetic Resources, Regional Station, Shillong is maintaining more than 10 germplasm of Indian bean. Winged bean has excellent nutritional qualities particularly being very rich in protein (Rao and Dora, 2002). 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. (Borthakur, 1992). The juice from cut leaves of *Cymbidium giganteum* is used by Khasis for clotting of blood while the juice of *Vanda* flower is used as eye drop for cure of glaucoma. There is immense scope of medicinal and aromatic plants for possible use of local germplasm in the improvement of vegetable crops for the use in Agricultural industry. (Source: Diversity of horticultural crops in north eastern region, B.S. Asati and D.S. Yadav, ICAR Research Complex for NEH Region)

### **Conservation of Diversity in NEH Region**

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

In agrarian set up, duties of women are crop cultivation, vegetable production, animal husbandry, marketing, fishery and little more skilled job such as dyeing and household industries. Tribal people particularly women in general and North East hill region in particular play predominant role in various agricultural activities by keeping biodiversity in concern. North East region is unique in providing a provision of habitats, which features diverse biota with high level of endemism. The region is also the abode of approximately 225 tribes in India out of 450 in the country as a whole, the culture and customs of which have an important role in understanding biodiversity conservation and management issues. The North Eastern region has been in focus for its high biodiversity and this region has been a priority for leading conservation agencies of the world. The richness of the region's avifauna largely reflects the diversity of the habitats associated with wide altitudinal range. (Source: Prospects and Retrospects of Women in Biodiversity for North East Region, Anupam Mishra, Seeralan.S and S.V.Ngachan, ICAR RC for NEH Region). The *Adi* tribe of eastern Himalaya is unique in

having traditional rights over land, water and forests within their jurisdiction. The *Adi* tribal community exercises control over the natural resources within their surroundings. 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 systems vary widely among different North-Eastern states, which are quite different from the rest of India. The complexity in land ownership and tenurial rights makes it difficult for survey, demarcation and consolidation of land. Therefore, cadastral survey and land demarcation are completely absent in the hill areas of northeast.

##### **Gender and equity issues in natural resources and diversity management**

Unequal distribution of land resources is responsible for increasing dependence on forests by certain sections of the society leading to diversity degradation. Resolving the gender and equity issues concerning natural resource management is equally important in North-East as in the other parts of the country.

##### **Inter-departmental coordination**

Inter-departmental coordination is essential to the sustainable management of horticultural resources in the region.

##### **Smuggling of timber across the international border**

The illicit felling of trees and timber smuggling across the international borders has been the most important cause of horticulture areas/forest degradation in border.

##### **Shifting cultivation**

Unregulated shifting cultivation by the local tribal populations has been a major threat to sustainable diversity management particularly in unclassified and community forests of the region.

##### **Inter-state border dispute**

There exist a lot of inter-state border disputes among the northeastern states. Most of these border areas are forest lands and because of boundary disputes, such lands are often declared as 'no man's land' and hence, do not come under any form of management. This leads to the degradation of diversity in such areas.

##### **Insurgency**

The long insurgency problem in some states such as Assam and Tripura has considerable impact on diversity conservation.

##### **Prospects in NEH Region**

Although there are not many agencies/organizations working exclusively for diversity conservation in north-east *per se*, the activities taken up by many organizations 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 central government research organizations including universities of the region are engaged in research,

inventory and conservation of diversity in the region. 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 organizations are now working for the conservation of diversity in north-east, although most of them are local and grassroots level.

#### International Donor Agencies

International donor agencies in Meghalaya, Manipur and Assam, and Nagaland have been playing crucial role in conserving the diversity through their respective projects.

#### 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

The shifting cultivators and other traditional farming communities of northeast have played a key role in conserving the rich horticultural crops germplasm of the region. In spite of

the availability of many hybrid and high yielding varieties these farmers have been cultivating the traditional varieties for generations.

#### Why Conservation of Biodiversity is Important?

Biodiversity is the very foundation for all the Earth's essential goods and services. The air we breathe, water we drink, and the food we eat all depend on the Earth's rich biodiversity. Plants and animals provide people with food and medicine. Forty percent of all prescriptions written today are composed from the natural compounds found in different species. An estimated 80,000 edible plants are found in the world, and one in every three mouthfuls of the food you swallow is prepared from plants pollinated by wild insects and animals. While plants and animals keep you well fed and healthy, trees play an important role in absorbing greenhouse gases. Forests also control soil erosion and purify water. Every aspect of our life is sustained by the Earth's biodiversity. Biological resources must be conserved if they are to continue supporting life on Earth. USAID supports biodiversity conservation principally through habitat conservation and supports limited species specific conservation efforts as well. (source: [www.usaid.gov.in](http://www.usaid.gov.in)). Although some people dislike the thought of trying to put an economic value on biodiversity there have been attempts to do so in order for people to understand the magnitude of the issue. In a recent report, The Economics of Ecosystems and Biodiversity (TEEB) for National and International policy makers 2009, provided the following example of sectors dependent on genetic resources. 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.

**Table 2: 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.

#### What should be done?

Long-term planning based on sustainable development strategies and integration of diversity conservation issues with development planning is the need of the hour. The wrong conservation policies with focus on economically important species only, have been harmful to diversity. Such policies should be introduced cautiously. They have not only decreased the species diversity in natural/ rehabilitated forests but have also resulted in accelerated soil erosion and loss of soil moisture.

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.
7. Most of the problems are related to increase in population. The rate of population growth in the north-east is unusually high. This causes tremendous strain on the natural resources and adoption of certain policies that are not very friendly to conserve diversity. No population policy has been adopted for future planning so there is a need for proper population policy.
8. Education policy does not include teaching on diversity conservation. The school curriculum should be able to mould the young minds in favour of diversity conservation.

### CONCLUSION

Making this region self sufficient in all the aspect a holistic plan is needed and definitely conservation of biodiversity and entrepreneurship development will play a major role in changing the socio economic condition of the people. Crops production in the North Eastern Region of India is mostly consumption oriented to meet the needs of the farmers. Use of local varieties, low consumption of fertilizers 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 along with

traditional management practices have resulted have resulted into low productivity and low cropping intensity. Adoption of improved agro-techniques can improve the crop productivity substantially in the region. Adoption of watershed approach, Integrated farming system approach, land configuration for increasing cropping intensity, organic farming, conservation tillage etc. are identified as potential resource conservation measures for the region for sustainability in agriculture. Modernization of agriculture is one of the cause of genetic erosion and extinction of germplasm, since the region possesses a high degree of rice genetic resources in relation to area and population. In order to conserve rice germplasm, a farmers based approach i.e. *in-situ* conservation will be most suitable. The tribal farmers of northeastern region maintained higher varietal diversity of rice than the availability in the market. They must be encouraged to continue the planting of their native landraces, as they are conversant with that. Based on different germplasm collection, varieties and technologies development on partnership mode can help this region to establish different agro based industry. The sui generis system for protection of plant varieties was developed at national level integrating the rights of breeders, farmers and village communities, and taking care of the concerns for equitable sharing of benefits so biodiversity conservation can be a tool to make this region self sufficient in all the aspect.

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