

---

# Chapter 17

---

## Crop Genepools in the North East Indian Himalayas and Threats

R. C. Upadhaya and R. C. Sundriyal

The Indian Himalayas constitute a core area and the centre of origin and diversity for more than 20 major agricultural and horticultural crops (Vavilov 1950). About 160 domesticated species of economic importance and over 325 species of their wild forms and relatives are native to this region and constitute an invaluable reservoir of genes. This diversity is attributed to the wide variation in topography, geographical position, and climatic conditions within the region (Arora & Nayar 1983 Borthakur 1992). The NE Indian Himalayan (NEH) region is also rich in primitive and endemic flora and economically important species. Thus it is a 'hot spot' of variability for many economic crops and their wild relatives. This region as a whole may be an active speciation zone as a result of natural mutation, hybridisation, and floral evolution (Kanjiyal et al. 1936, Robinson 1841, Hooker 1854 and 1906). The recent exploration by the Botanical Survey of India (BSI) revealed about 70 new species, belonging to 50 genera, previously unrecognised in the region. It is believed that about 40 per cent of the forest area has yet to be surveyed and the flora classified. The NE Indian Himalayas also have a contiguous border with other countries (China, Burma, Bhutan, and Nepal) and this has helped in mobility as well as micro-speciation. Crop selection is performed by a large number of different ethnic groups, and their traditional farming systems have also helped create the Genetic Diversity of crops (Chatterjee 1939).

This paper highlights the Genetic Diversity of some important crops in the northeastern region. It is based on work done by various research institutes including the Indian Council of Agricultural Research (ICAR) Centres for the NEH region, the National Bureau of Plant Genetic Resources (NBPGR) Centres, the BSI, and other organizations.

## Geography and Physical Characteristics

The Indian Himalayas comprise the northwestern region (Jammu and Kashmir, Himachal Pradesh), central region (hills of Uttar Pradesh), and northeastern region. The North East Indian Himalayas include the Darjeeling district of West Bengal, Sikkim, Arunachal Pradesh, and other North Eastern States (Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura). Wide climatic variations are recorded from tropical to sub-tropical, temperate, and alpine zones, but, as a whole, the region is considered to be wet tropical because of its high rainfall and humidity.

Over 90 per cent of the population is rural and engaged in agriculture. Land uses vary from state to state. Wide variations in elevation from area to area contribute to great variations in climate, vegetation types, and agricultural practices. Generally, the valleys are warm and cold temperatures prevail at higher elevations. Annual rainfall varies from 1,300mm in parts of Assam, Sikkim, and Nagaland to over 10,000 mm at Cherrapunji, Meghalaya.

## Genetic Variability of Some Important Crops

The crops and their wild relatives mainly confined to the NE Indian Himalayas are *Abelmoschus*, *Alocasia*, *Alpinia*, *Amomum*, *Brassica*, *Camellia*, *Canavalia*, *Citrus*, *Colocasia*, *Corchorus*, *Cucumis*, *Curcuma*, *Digitaria*, *Dioscorea*, *Docynia*, *Erianthus*, *Eurya*, *Hedychium*, *Hibiscus*, *Mangifera*, *Momordica*, *Morus*, *Mucuna*, *Musa*, *Oryza*, *Prunus*, *Rubus*, *Setaria*, *Sorbus*, *Trichosanthes* and *Vitis*.

## Food Crops

Rice, barley, Coix, finger millet, and foxtail millet are native to the region. Rice is the main crop in the region and there are diverse cultivars with useful genes. Of 8,000 land races, about 5,000 come from the NE Indian Himalayas (Shastry et al. 1971). There is wide variability in the rice germplasm collected from different parts of the northeastern region (Table 17.1), but glutinous and japonica forms dominate the endemic types. Some of the cultivars are resistant to diseases and pests and are tolerant to drought and cold. Genetic divergence among the land races of the NE region is classified into nine clusters. Some clusters occupy an intermediate position between japonica and indica. Noticeable sterility in some crosses of upland/lowland ecotypes led to the conclusion that they might differ by a number of genes. There are a number of wild rice species, including *Oryza granulata*, *O. rufipogon*, *O. jeyporensis*, *O. malampuzhaensis*, and *O. sativa var spontanea* (Table 17.2).

**Table 17.1: Distribution of Wild Relatives of Cultivated Crops in India as a Whole and in the NE Indian Himalayan Region**

Crop	Number of Species	
	NE Himalayas	India
Cereals	16	60
Legumes	6	33
Fruits	51	109
Vegetables	27	64
Oil seeds	1	12
Fibre Crops	5	24
Species and condiments	13	27
Miscellaneous	13	26

Source: Authors compilation from ICAR publications

**Table 17.2: Some Characteristics of Assam Rice Collections (ARC) and Variability in Rice Germplasm Collected from the NE Region (as a percentage of total land races in India, showing the traits)**

States	Japonica	Semi dwarf	Glamorous husk	Waxy endosperm	Fine grains	Scented kernel
Arunachal	24	1	11	8	16	2
Assam hills	2	5	1	11	12	4
Manipur	1	0	5	12	16	2
Meghalaya	0	1	2	11	17	5
Nagaland	3	16	22	18	10	6
Tripura	5	0	0	4	11	3

Primitive types of maize have been recorded in the region. Wild relatives of *Digitaria*, *Coix*, *Panicum*, *Setaria*, and *Elusine* are also found. Different finger millet and foxtail millet land races are being cultivated by tribal farming communities in the region. Some wild forms of barley (*Hordeum agricrithon*) are cultivated in parts of Sikkim.

Gene pools of legumes such as perennial types of pigeon pea, rice beans, green gram, winged beans, broad beans, *Dolichos*, and sword beans (Borthakur 1992) are also found in the eastern Himalayas. The genus *Vigna* has more variability and looks like black gram or green gram. There is also a wide diversity in the *Atylosia* species, which are related to the cultivated *Cajanus cajan* (pigeon pea). Wild forms of sword bean are found in the hills of Manipur and Mizoram. Arunachal Pradesh is home to a Genetic Diversity which includes *S. spontaneum*, *S. longisetosus*, *S. procerum*, and *S. sikkimensis*. A range of land races of *S. officinarum* are maintained by farmers in the eastern Himalayas.

Indigenous cotton, such as perennial, short staple, and khaki cotton, grows in Mizoram and other hills of the NE Indian region.

## Horticultural Crops

The North East Indian Himalayas are home to many horticultural crops including fruits, vegetables, spices and condiments, medicinal plants, and ornamentals. Among the tropical fruits, *Citrus*, *Musa sp*, *Mangifera*, and *Artocarpus* exhibit wide variation. Sub-tropical fruits include *Garcinia*, *Artocarpus*, *Phyllanthus*, *Anona*, *Averrhoa*, *Persia*, *Aegale*, *Flacourtica*, *Passiflora*, *Avocado*, *Actinidia*, *Dillenia laeocarpus*, *Eugenia*, *Ficus*, *Juglans*, *Vitis*, *Spondias*, and *Sygyimum*. Variability is also very high in the region among temperate fruits. A number of species belonging to the genera *Malus*, *Prunus*, *Pyrus*, *Sorbus*, *Docynia*, *Rubus*, *Cotoneaster*, *Ribes*, *Fragaria*, and *Actinidia* grow in the wild.

The citrus fruits include oranges, limes, lemons, and pommelo. About 37 citrus species are cultivated in India. Bhattacharya and Dutta (1951) described 17 species, 52 varieties, and seven natural hybrids of citrus fruits that come from Assam. *Citrus indica*, a primitive and endangered species of citrus and the probable progenitor of cultivated species, grows in the Garo hills. About 100 land races have been collected by ICAR. *Citrus* (*C. medica*) is planted widely in kitchen gardens all through the region and has a wide range of variation in fruit.

Mango, a major fruit in India, grows wild in the northeastern Himalayas. Several land races are available in the region.

The banana is common to the eastern Himalayas. *M. balbisiana* and *M. acuminata* are seedy and grow in the wild. There is a great variability in species, and wild forms are common in the region. Chakravorty (1951) considered that the NE Himalayas were the centre of origin of the banana. The Genetic Diversity is enormous, with tolerance to disease and cold conditions.

## Vegetables, Tuber Crops and Spices

The region is rich in cucurbit, *Benicasa hispida*, *Momordica cochinchinensis*, *M. charantia*, *M. dioica*, *Lagenaria siceraria*, *Trichosanthes*, *Luffa acutangula*, *Cucumis sativus*, and *C. melo*. There are two edible species and many non-edible types of *Trichosanthes*. There are a large number of cultivars of brinjal, and it has much more variability in the region. The other crops are *Cucurbit moschata* and *Sechium edule*. *Alocasia*, *Colocasia*, and *Dioscorea* of different shapes and sizes are commonly used in the region as edible roots.

Ginger, turmeric, chillies, cinnamon and large cardamom (*Amomum subulatum*) have wild relatives in the region. The variability is very high in turmeric, chillies, and ginger. Black pepper grows in abundance in the wild in the lower forests of Assam and other parts of the eastern Himalayas.

## Bamboo

Bamboos are indispensable for tribal groups in the region because of their many uses in day to day life. They are used for shelter, food, furniture, handicrafts, medicine, and other ethno-religious purposes. Bamboos are also used as a raw material in paper and pulp industries. Of the 136 species available in India, nearly half (63 species) are native to the NE Indian Himalayan region (Kochhar et al. 1992). The commonly available species are *Dendrocalamux hamiltonii*, *D. hookerii*, *Bambusa balcoa*, *B. tulda*, *B. pallida*, *B. nulans*, *Cephalostachyum capitatum*, and *Melocanna baccifera*. The rare and endangered species are *D. hamnei*, *Teinostachyum helferei*, and *Bambusa mastersei*.

## Orchids

Orchids are a unique group of plants with a wide range of variability. The main economic importance of orchids lies in their ornamental value, but some species also have a medicinal and/or aromatic value. Of 1,300 species belonging to 163 genera reported in India, more than 600 are from the eastern Himalayas. Sikkim alone has more than 450 species belonging to 100 genera. Eighteen endemic species are found in Arunachal Pradesh (Hegde 1984). The orchids are found from tropical to alpine zones. As many as 225 orchid species are rare, 12 endangered, 16 vulnerable, and one species, *Paphiopedium wardii*, is nearly extinct.

## Mushrooms

There are more than 250 fleshy mushrooms indigenous to the eastern Himalayas, belonging to about 100 species. Many of them are edible.

## Scientific concerns

Wild relatives of crop plants and other related species are of considerable importance for meeting the growing demands for food of the increasing population. Wild species can be used for crop improvement and are of great help in studies related to basic information about species' relationships. However, knowledge about the taxonomic, morphological and biosystematic position of various wild relatives of crop plants is poor, therefore these species are not properly used. Furthermore, there have been few detailed investigations of the interrelationships between wild and cultivated taxa of most genera and species. The wild relatives can benefit production by providing genes for adaptability to adverse environmental conditions, disease resistance, cold hardiness, and drought tolerance. They are adapted to a variety of soil types. Such characteristics could make a significant contribution to improving crop genetic resources through breeding programmes. Despite the wide diversity in crops and potential for crops, the average standard

of living of the people in the NE region is by and large poor. This is the result of the various constraints in the area. Most of the area is still inaccessible and lacks adequate infrastructure. The low temperatures at higher elevations markedly reduce the growing season. Farmers are not aware of modern technologies, fertilizers, and improved crop varieties. Farmers still collect large quantities of various wild edible plants from natural habitats. There is increasing evidence of indigenous forests and other natural areas being affected by grazing, firing, shifting cultivation, and land conversion for agriculture and other purposes. Thus this region of great Genetic Diversity is under serious threat of rapid extinction or depletion of the germplasm. The governments in the region are thoroughly aware of the problem of depleting natural resources, their solution lies in creating national parks and wildlife sanctuaries (Table 17.3). Research institutions (NBPGR, ICAR, BSI, and universities) are also preserving economically important genetic materials. There is a need to bring a greater area into such a conservation network.

**Table 17.3: National Parks, Sanctuaries and Biosphere Reserves in the North East Himalayan Region of India, as a Part of Biodiversity Conservation Efforts**

State	No of national parks	No of wildlife sanctuaries	Total area (km <sup>2</sup> )
Arunachal Pradesh	2	4	3699
Assam	1	11	4316
Manipur	2	0	6 ??
Meghalaya	2	3	305
Mizoram	1	0	600
Nagaland	1	2	522
Sikkim	1	4	988
Tripura	0	2	186

Further, gene pools have to be preserved for future use before they become extinct. Systematic collection and proper evaluation of genetic materials are necessary and are of immediate concern. *In situ* and *ex situ* conservation are important in the region.

## References

Arora, R.K., and Nayar, E.R. 1983. 'Wild Relatives and Related Species of Crop Plants in India - Their Diversity and Distribution'. In *Bull. Bot. Surv. India* 25(1-4): 35-45.

Bhattacharya, S.C. and Dutta, S., 1951. 'Citrus Varieties of Assam'. In *Ind. Jour. Genet. & Pl. Br.* 11 (1): 57-62.

Borthakur, D.N., 1992. *Agriculture of the North Eastern Region with Special Reference to Hill Agriculture*. Guwahati: Beecee Prakashan.

Chakravarty, A.K., 1951. 'Origin of Cultivated Banana of South-east Asia'. In *Ind. Jour. Genet.* 11: 34-45.

Chatterjee, D., 1939. 'Studies on the Endemic Flora of India and Burma'. In *J. Royal Asiat. Soc. Beng Sci.* 5: 19-67.

Hegde, S.N., 1984. *Orchids of Arunachal Pradesh*. Itanagar: Department of Forest, Govt. of Arunachal Pradesh.

Hooker, J.D., 1854. 'Himalayan Journals: Notes of a Naturalist in Bengal, the Sikkim and Nepal Himalayas'. In *The Khaia Mountains*, 2 vol. Minerva. 574 p.

Hooker, J.D., 1906. *A sketch of flora of British India*. London.

Kanjilal, U.N., Das, A., Kanjilal, P.C. and De, R.N. 1936. *Flora of Assam*, Vol. I to VII. Calcutta: Prabashi Press.

Kochhar, Arora, R. K., and Nayar, E. R., 1992. 'Bamboo in NE Region'. In *ICAR Bulletin*. Barapani, Meghalaya: ICAR Research Complex for NEH region.

Robinson, W. 1841. *A Descriptive Account of Assam*. Delhi: Sanskaran Prakashan.

Vavilov, N.I., 1950. 'The Origin, Variation, Immunity and Breeding of Cultivated Plant'. In *Chron. Bot.* 13: 364.