AGROBIODIVERSITY OF SIKKIM

H. Rahman and R.Karuppaiyan

ABSTRACT

This article describes a brief account on the agrobiodiversity of Sikkim. Agrobiodiversity is the variety and variability of animals, plants, and microbes that are used directly or indirectly for food and agriculture, including crops, livestock, forestry, and fisheries. Sikkim, a constituent states of Northeastern Region of India has a diversified ecosystem as evident by 5 different climatic zones, 6 different forest types, 3 soils orders, 26 soil subgroups, 21 glaciers, 28 mountains and peaks, 227 lakes and wetlands, more than 104 rivers and streams within a small geographical area of 7,096 sq.km. The State can be considered as one of a biodiversity rich region of India. Being a part of inner ranges of the Himalaya, Sikkim has no open valley and plains but has rugged terrain with elevations ranging from 300 to 6000m amsl. The topography is comprised of low hills, mid hills, high hills, alpine zones and snow bound land. About 69 crop species of food, vegetable, fruit, ornamental and commercial importance are cultivated between 300 and 2000 m elevation. A great diversity is found within most of the food crops and large part of the arable land is planted by local cultivars. According to a modest estimate, more than 178 cultivars or landraces are available among the 69 crop plants grown in Sikkim. Rice has greater genetic diversity in Sikkim. About 43 landraces could be distinguished in rice. About 26 landraces of maize were found in addition to 6 landraces of finger millet; 14 local cultivars of Rajmash, 7 rice bean, 9 each in chillies and chow-chow, 4 in rai sag; about 11 clones of large cardamom, 5 clones of ginger and 4 clones of banana. The rich agro-biodiversity in the hill has evolved over time and space due to extreme variations in altitude and environmental conditions. In addition to the physical and ecological conditions and the natural evolutionary process, the diversity that exist on-farm has also been greatly influenced by diverse social, cultural and economic conditions of the farming communities. Numerous ethnic groups with varying socio-cultural preferences and needs have contributed to the diversity and farmers have accumulated a wealth of knowledge on these diversities and the systems as a whole.

KEYWORDS: *Agrobiodiversity, ecosystem diversity, species diversity, genetic diversity, Sikkim, Northeastern Region*

Squash diversity

Maize diversity

1. Introduction

Certain degree of diversity is needed for biological system to function properly on the biosphere and this is what the nature has provided on the mother earth. Diversity occurs at all levels of biological organization from molecules to entire biotas. The UN Conference on Environment and Development held in Rio de Janeiro in 1992 defined biological diversity as "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part. Almost everything, large or small is included in the definition of biological diversity. However, a decision of the Second Conference of Parties excludes human genetic resources from purview of this definition to avoid endorsement of their commercialization. The biodiversity existing on the earth can be studied at three level namely, i) ecosystem diversity, ii) species diversity and iii) genetic diversity, corresponding to the three fundamental and hierarchically-related levels of biological organization. Ecosystem diversity refers to the variety of systems of living things in relation with their environment, within a region. Species diversity refers to the variety of species within a region. Genetic diversity refers to the variation of genes within species. Biodiversity can also be expressed at three spatial levels (Whittaker, 1960) namely, i) alpha diversity, ii) beta diversity and iii) gamma diversity. Alpha diversity is a measure of within habitat diversity. It is measured by the number of species within a given area. Beta diversity is a measure of between habitat diversity. It reflects how organisms respond to environmental heterogeneity. Gamma diversity is a measure of large scale biodiversity and is defined as the number of species within a region. It is analogous to alpha diversity, but at a regional scale. Agrobiodiversity or agricultural biological diversity is a component of biodiversity that contributes to food and agriculture production. The Food and Agricultural Organization defined agrobiodiversity as the variety and variability of animals, plants, and microbes that are used directly or indirectly for food and agriculture, including crops, livestock, forestry, and fisheries (FAO, 1999). It comprises the diversity of genetic resources (varieties and breeds), species used for food, fodder, fiber, fuel, and pharmaceuticals, the diversity of non-harvested species that support production such as soil microorganisms, predators, pollinators, and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest, and aquatic) as well as the diversity of the agro-ecosystems. Agricultural biodiversity provides food, income, materials for clothing, shelter and medicine. It also performs ecological services essential to human survival, such as nutrient cycling, pest and disease regulation and pollination.

The diversity of ecosystems, species, and genes are the most precious resources gifted by nature. Each species on the earth has a value in itself, and therefore we humans have no right to destroy the natural order, rather we must take care to preserve or save them. But what are happening in the civilized society from pre-agricultural times are *the human induced changes*-which are affecting the biodiversity. Agricultural and animal husbandry also affects biological diversity by destroying and modifying the native biota. In view of it, a concern arises on the safety, integrity and sustainability of biodiversity. Indian agriculture is one of the world's largest and oldest agricultural system which has remained predominantly rural and subsistence despite decades of modernization. The stability and sustainability of its agriculture is therefore, of paramount important. The country's economy and polity, and the day-to-day life of the majority of its 102 million population are governed by what happens in the agricultural sector. Therefore, the role of agricultural biodiversity *i.e.* the diversity of agro-ecosystems, crops and livestock and of related husbandry practices and knowledge is of great important. In this chapter a broad idea of agricultural biodiversity of Sikkim is presented in comparison with biodiversity of India and North Eastern Region of India.

2. Agrarian scenario of Sikkim

Sikkim is a small multi-ethnic State, located on the Eastern Himalaya covering a geographical area (GA) of 7096 sq.km, representing a meager portion of (0.22%) India's GA. The topography is characterised by rugged mountainous

terrains with wide variations in slopes and altitude. Of the 7096 sq.km GA, 2,091 sq.km or roughly 30% is covered by perpetual snow. Human settlement occurs within an area of 2500 sq. km. The major ethnic groups are '*Bhutias'*, '*Lepchas'*, 'Nepalese', '*Limbus'*. Administratively, the State is divided into four districts, North, West, East and South. Tourism, agriculture and allied activities continue to be important occupations and form main base of the economy. The arable land is 1.09 lakh hectares which is about 16% of the geographical area. The net cultivable area is 79,000 ha with a total cultivator of 1.31 lakhs and 16,939 agricultural labourers. The irrigated area is only 11% hence agriculture is, by and large, rainfed. But the State receives plenty of rainfall (3250 mm/annum), well distributed over 6 months from May to October. Though, the average size of operational holding is 3.9 ha/person against national average of 0.69 ha the entire holding cannot be used for agriculture due to rugged topography or high slopes. Population growth and consequent fragmentation of farm land has caused reduction in per capita holdings. Further, about 81.28% of the geographical area is under various types of forest hence, the arable land to agrarian (cultivators and agricultural labourers) ratio is only 0.74 ha/person. Agricultural is still traditional. Cultivation is done in hill slopes with and without terracing. Use of inorganic pesticides and fertilizers are low hence, farming is organic by default. In 2003, Sikkim was declared as organic State. Agriculture is maize based but large cardamom, ginger and mandarin are the main cash crops. Animal husbandry is a subsidiary occupation. Barring maize, mandarin and ginger, the production and productivity of other crops are low and below the national average. In many places, traditional system of farming still prevails and agricultural operations are carried out by men and women.

Annual crops are grown in three seasons- pre-kharif, kharif or monsoon season and rabi or winter season. Pre-kharif starts with onset of first shower during spring. The period coincides with Feb-mid March. Maize is the only pre-kharif cereal. Kharif season begins during May-June. Rice, urd, soybean, finger millet, rice bean, beans, ginger and few solanaceous vegetables are grown during the kharif season. Wheat, mustard, sarson, rai sag, potato, pea, cabbage, cauliflower, radish and carrot are the rabi season crops. The rabi sowing season starts during Sept-Oct. Out of the GA of 7,09,600 ha, agriculture dominated mixed farming system practiced in about 81,320 ha in the mid and low hills. In another 24,730 ha large cardamom based agroforestry system prevails. Specialised commercial horticultural crops like potato, vegetable, turmeric and ginger are grow in about 23,270 ha. Fruit crop based (mandarin and apple) farming system prevails in about 7,620 ha. Plantation crop mainly tea is grown in about 200 ha. Reserve, Khasmal and Goucharan forests covers 2,65,000 ha and alpine, sub-alpine scrub and pasture grasses spreads 1,02,400 ha.

Agro-biodiversity of Sikkim

3. Ecosystem diversity

The ecological complexes can be a component of landscape such as a natural forest, a mountain, grassland, an agricultural field, a desert, a human habitation or it can be a component of waterscape such as a river and a wetland, a delta, a marshy area, ocean, etc. The natural ecosystems provide civilization with a variety of essential services *gratis* and on a large scale. The World Resources Institute classified the ecosystem into five types namely, i) agro-ecosystem, ii) forest ecosystem, iii) grassland ecosystem, iv) fresh water ecosystem and v) coastal ecosystem. Like many large tropical countries, India is characterised by a complex mosaic of distinct agro-ecosystems differentiated by their climatic, soil, geological, vegetations, crop growing, and other features. The NBSS&LUP, Nagpur has delineated the country into 21 agro-ecological zones, based on physiography, soil bioclimatic type and crop growing period (Sahgal *et al*., 1992). The North Eastern Hills (Purvachal) including Sikkim with warm perhumid climate, red and lateritic soils and growing period < 210 days form one among the 21 agro-ecological zones.

3.1 Ecoregion of Sikkim: The geographical area of Sikkim stretched over 112 km in North-South and 64 km in East-West can be considered as "*God's Own Garden*" because this is perhaps one of the few regions in India to exhibit such a vast diversity of ecosystem, flora and fauna within a small area. There are about 21 glaciers, 28 mountains and peaks, 227 lakes and wetlands, more than 104 rivers and streams, sloppy lands, terraced agricultural fields spreading over 16% of the GA of Sikkim. The Teesta and Rangit, originates respectively, from Khangchenjau Lake and Rathong Glacier, are the major rivers of the State. Many smaller streams are also flowing. They are Rani *Khola*, Rangpo *Khola*, Sethi *Khola*, Jolly *Khola* in the East District; Lachen *chu* and Lachung *chu* in the North District. Lentic water bodies such as lake Aritar, lake Chhangu, lake Mamen *chu* and lake Khecheopalri harbours cold water fauna. The State is blessed with heavy rainfall. The annual rainfall varies 2000 to 5360 mm (average 3159 mm) with intensity of precipitation ranging from drizzling to torrential rains. The greater part of rainfall occurs between July and September. The temperature varies with altitude and slope. The maximum temperature usually records during Jun-Aug (27 to 29 ^{o}C) minimum during Dec-Jan (5-8 ^{o}C) and the average temperature in the region is 20 ^{o}C. The relative humidity also varies from 63.8 to 88.7% defining the region as humid zone. At higher altitudes humidity is more often causing fog and inhibiting the intensity of light. Snowfall during January to March is also very common in North Sikkim. Bright sunshine hours vary from 1.97 to 6.3 hrs/day. This is the major climatic parameter limiting photosynthesis thereby production of crops. The mountainous State of Sikkim has an altitudinal variation ranging from 300 to 8598 m above the mean sea level (amsl). Mount *Khangchendzonga* (8598 m), India's highest and world's third highest peak is located on the north-east border of the State. Such a vast altitude gradation might have given a wide variety of plants, from tropical to temperate and even alpine. However, greater floristic diversity can be seen between the altitudes of 2,500 and 5,000 m. Elevation plays a prime role in delineating vegetation and eco-regions of the state but in some areas, altitude alone may not define a zone but other physical properties of the terrain are also be the factors. It is within these diverse habitats the variety of flora and fauna endemic to Sikkim has evolved over the millennia. The Forests, Environment and Wildlife Management Department of Sikkim have described 5 ecoregions or altitudinal zones of vegetation in Sikkim. They are:

1. Tropical ecoregion: It extends from the foothills of the outer Himalayas to an altitude of 1200 m. The topography is characterized by steep sided valleys and gorges with well-drained flanking slopes. Beneath canopies of tall evergreen and semi-deciduous trees, the dense undergrowth growth includes various species of orchids, *Rhapidophora*, wild banana, *Pandanus*, Nettles and giant bamboo. The Rangit Valley, which has an abundance of sal forests (*Shorea robusta*) is come under the zone. *Lantana camera* is a major weed species. Lowland forests are the home of animals like Assamese macaque, Barking deer, Porcupine, Python, Geckos, butterflies and other invertebrates, river fish, frogs and toads, birds like the Rufous-necked hornbill (*Aceros nepalensis)*, Great Indian hornbill (*Buceros bicornis)*, *H*omrai or Hongraio, Chestnut-breasted partridge, Black-breasted parrotbill, Grey-crowned *Prinia*, Ward's Trogon and Peafowl.

2. Sub-tropical ecoregion: The sub-tropical eco-region extends from about 1800 to 3000 m. Features of mid and high hills are associated in the region. The precipitation is high and climate remains humid throughout the year. The crop in the upper storey consists of mainly *Castanopsis hystrix* (Katus), *Machilus* (Kawla), *Rhododendron* (Chimal), *Symplocos spicata* (Kholme), *Symplocos theifolia* (Kharane), *Michelia excelsa* (Rani Champ), *Quercus lineata* (Phalant),

Leucoseptrum canum (Ghurpis), *Quercus pachyphylla* (Sungure Katus), etc. The other associates in the upper storey are: *Betula alnoides* (Saur), *Nyssa javanica* (Lekh Chilaune), *Bucklandia populnea* (Pipli), etc. In the underwood, *Engelhardtia spicata* (Mahuwa), *Eurya japonica* (Jhingni), *Rhododendron arboreum* (Guransh), *Viburnum* (Asare), etc. are the predominant species. In the upper reaches, dense tall evergreen forests with oak and *Rhododendron* predominate. Trees like *Quercus lamellosa* (Himalayan Oak), *Q. lineata* (Phalant), *Machilus* species (Kaula) and undergrowth like *Arundinaria maling* (dwarf bamboo), dwarf *Rhododendron*, ferns, epiphytic moss and orchids can also be seen. The fauna in the climate includes birds like Rusty-bellied and Lesser Shortwings, Kalij and Tragopan pheasants, Red jungle fowl; Himalayan Bull frog, reptiles like pangolin, cobra, Krait and Himalayan pit viper, as well as many butterflies. Most of the human settlement of Sikkim is found in the sub-tropical and tropical zones. Terrace cultivation of rice, ginger, orange, are common while guava, banana, squash and marigold are grown along with vegetables and herbs in home gardens. Plantations of large cardamom under the shades Himalayan alder or Utis (*Alnus nepalensis*) and tea estate at Temi-Tarku are some of the features. Wild edibles like bamboo shoot, ferns and nettles are collected during season. Stall fed livestock rearing is also common.

3. Temperate ecoregion: The temperate eco-region extends from 3000 to 4000 m with mixed coniferous forests of Hemlock, spruce, pine, fir and junipers with shrubby undergrowth of *Rhododendron* and *Arundinaria*. Wild edible cum dye plant Seabuckthorn (*Hippophae* spp) are also found. Subsistence farming of wheat, barley and high altitude maize is carried out while beans, peas, apple, peach and pear are grown on homesteads. Potato and cabbage are grown as cash crops. Predominant fauna of the climate includes Musk deer, Himalayan tahr, Blue sheep, Red panda, Common langur and Himalayan black bear, Goral, Serow and Lesser cats, avian species like Blood pheasant, Ibisbill, Monal pheasant, Fire-tailed sunbird, Blue magpie, reptiles, amphibians and cold water fishes like Brown trout. Yak rearing and cattle rearing is practiced with grazing in forest pasture lands.

4. Sub-alpine and Alpine: This region has a very small resident human population, herding livestock such as yaks and dairy cattle on alpine pasture. The Alpine forests and scrub extend from 4000 to 4,500 m. Many species of *Rhododendron*, small crooked trees and large shrubs interspersed with fir and pine.

5. Trans-Himalayan: This region lies between 4,500 and 5,500 m and is characterized by cold desert vegetation. This eco-region is restricted to the North of Sikkim. Some of the endangered fauna like Kiang, Nayan, Tibetan gazelle, Snow leopard, Tibetan wolf, Tibetan snowcock, Lammergeier, Raven, Golden eagle and Ruddy shelduck are seen. The region has a short four-month growing season during which grass, flowering plants and herbs grow abundantly supporting a

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host of insects as well as wild and domestic herbivores, larks and finches. There are no permanent settlements. Human population consists of a small number of nomadic herders of Tibetan origin called 'Drokpas' who herd yak, sheep and alpine goat (*Capra hircus)*, and army personnel as the area lies close to the international border with Tibet in China.

3.2 Agro-ecosystems of Sikkim: The agro-ecosystem of Sikkim is described in Table 1.

Table 1. Agro-ecosystems of Sikkim and crop and livestock components across altitude

Area	Climate	Altitude (m amsl)	Ecological adaption	Crops	Remarks
Lower hills	Tropical	300-500	Wet and dry agriculture, sedentary farming, horticulture, livestock rearing - goats, pigs, poultry, ducks, cattle and sheep.	Rice, maize, finger millet, wheat, sarson, urd, rice bean, soybean, vegetables, potato guava, lime, lemon, ginger, mandarin, etc.	Altitude between 300 and 900 m is treated as low hills by some authors. The climate is essentially sub-tropical hence, suitable for sub-tropical crops.
	Sub-tropical	500-1500			
Mid hills	Tempera te	1500-2000	Wet and dry agriculture, rearing of goats, pigs, poultry, ducks, cattle and sheep, growing of horticultural crops, collection of minor forest produce.	Maize, rice, finger millet, wheat, pulses like ricebean, rajmash, beans, sarson, soybean, vegetables, potato, mandarin, plum, peach, pear, large cardamom, ginger.	Altitude from 900-1800 is treated as mid-hills by some authors. This is essentially the field and horticultural crops belt. Heavy rainfall during summer and dry and cold weather during winter is the feature.
High hills	Tempera te	2000-2700	Dry agriculture, livestock-cattle, yaks, sheep, horses, mules are reared. Lachung, Lachen, Damthang, Ravangla, Zabuk, Phadumchu, Hilley, Okhrey, Ribdi and Bhareng are important cultivable areas of this climatic type	Maize, barley, vegetables, potato, apple, plum, peach, peas, off-season vegetables and large cardamom	Snowfall is common during winter (Dec-Feb) and heavy rainfall during June-July.Temperature ranges from 0 to 15 ^{o}C.
	Sub-alpine	2700-4000	Yak herding, horticulture, pastoral economy (wool, cheese, butter, hides, and potato are commercial commodities), livestock-yaks, sheep, horses, mules	Seed potato and vegetables are grown in few places.	Snowfall is common during winter months *i.e.* during December-January and heavy rainfall during June-July.
	Alpine	4000-5000	Pastoral economy, yak herding	Apple, potato and other horticultural crops.	Mainly used for pasturage.
Very high hills	Alpine	Above 5000	Snow bound land without vegetation. Cultivable land is not available in this climatic type	Vegetation is mainly herbs and medicinal plants.	In the region cultivable land is not available, precipitation is mainly through snowfall.

3.3 Soil diversity of Sikkim: The soils of Sikkim belong to 3 orders namely, Inceptisol (42.84 %), Entisol (42.52 %) and Mollisol (14.64 %), 7 suborders, 12 great groups and 26 subgroups (Das *et al*., 1996). The distribution of soil sub-groups across the physiographic units is shown in Table 2. The soils are mostly of light texture, well drained, therefore its water holding capacity is poor. Texture of soil various from loamy sand to silty clay loam. The depth of soil varies from few inches and in some places practically nil to several meters. With respect to soil fertility, soils in Sikkim are high in organic carbon content, potassium, zinc, copper, iron and manganese contents, medium in available phosphorus and nitrogen and deficient in boron and molybdenum. The soils are having high phosphorus fixation capacity due to high amount of active iron and aluminium oxides. In many soils, the total amount of native phosphorus is high but present in unavailable forms to plants. The soil of Sikkim developed under the influence of heavy rainfall has the acidic reaction throughout the State. The soil reaction varies form moderately acidic to strongly acidic (pH range from 4.3 to 6.4; mean is 5.37) and low exchangeable bases. Of the four Districts of Sikkim, the frequency of soil having pH < 5.0 are 50 per cent in North Sikkim while in the others it is about 12 per cent (Bhutia *et al*. 1985). Such soils pose aluminium and manganese toxicities to the crops. Soil remains wet from March to October. Thereafter due to paucity of rainfall post monsoon / winter moisture stress occurs. During winter (Oct to Feb) natural springs serves as the main source of water for feeding cattle and as life saving irrigation to winter crops.

Table 2. Soil diversity in Sikkim across physiographic units

SNo	Physiographic Units	Dominant Soils Subgroup
1	Summit and ridge (<30% slope)	Typic Haplumbrepts, Typic Hapludolls, Pachic Haplumbrepts, Typic Udorthents
2	Side slope of hills	
2.1	Very steeply sloping (>50%)	Typic Hapludoll, Entic Hapludolls, Dystric Eutrochrepts, Lithic Cryorthents
2.2	Escarpments (>50%)	Typic Udorthents, Entic Hapludolls, Umbric Dystrochrepts
2.3	Steeply sloping (30-50%)	Umbric Dystrochrepts, Typic Hapludolls, Typic Argiudolls, Cumulic Haplumbrepts, Entic Cryumbrepts
2.4	Moderately steep sloping (15-30%)	Fluventic Eutrochrepts, Mollic Udarents, Typic Argiudolls, Cumulic apludolls
3.	Valleys (15-30%)	Typic Haplumbrepts, Aquic Udorthents, Cumulic Hapludolls
4	Rocky cliffs and Precipitous slope	Lithic Udorthents, Lithic Haplumbrepts.

4. Species diversity in Sikkim

Species diversity refers to the variety of species and subspecies which can be measured by determining the species richness (the number of species in a defined area) and species abundance (the relative numbers among the species). Species diversity on the earth has been estimated between 5 and 14 million or more, though only about 1.75 million have actually been described (Table 3)

Table 3. Estimated and described species diversity in the World

Kingdom	World		India	
	Described species	Estimated species	Described species	Estimated species
Bacteria	4,000	10,00,000	850	
Protoctista	80,000	60,000	2,577	
Animalia	12,25,000	95,55,000	81,261	
Fungi	72,000	15,00,000	14,500	
Plantae	2,70,000	3,20,000	17,000	
Total	**17,50,000**	**1,40,00,000**	**1,16,118**	**3-4 lakh**

Sources: World Conservation Monitoring Centre; Global Environment Outlook 2000 (UNEP, Earthscan).

India supports approximately 8% of the world's biodiversity on 2% of the Earth's surface, making it one of the 12 mega-diversity countries in the world. This is based on the species richness and levels of endemism recorded in a wide range of taxa of both plants and animals. A total of 167 cultivated crop species and 326 wild relatives of crops (116 genera and 48 families) have originated in Hindustan Centre of origin (Paroda and Arora, 1991; NAAS, 1998). They include rice, pigeon pea, green gram, black gram, turmeric, ginger, pepper, banana, bitter gourd, brinjal, okra, coconut,

Species diversity of butterflies in Sikkim

cardamom, jack fruit, sugarcane, bamboo, taro, indigo, sunhemp, amaranthus, mango, and gooseberries. Species which are believed to have originated exclusively in India are mango, taro, cucumber, pigeon pea, pepper, brinjal, and cardamom. India also has amongst the world's largest diversity of domesticated animals, including some 26 breeds of cattle, 40 of sheep, 20 of goats, 8 of camels, 6 of horses, and 18 of poultry (Mohapatra and Panda, 1981; Sahai, 1993). This diversity can be attributed to the vast variety of landforms and climate resulting in habitats ranging from tropical to temperate, and from alpine to desert. Adding to this is a very high diversity of human-influenced ecosystems, including agricultural and pasturelands, and an impressive range of domesticated plants and animals. Being a predominantly agriculture based country, India also has a mix of wild and cultivated habitats, giving rise to very specialised biodiversity which is specific to the confluence of two or more habitats (Kothari, 1999).

The North Eastern Region (NER) comprising seven sister States- Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and a brother State-Sikkim is one of the World's 18 hot spot region of the World. Hot spot are characterized by high concentrations of endemic species and are experiencing unusually rapid rates of habitat modification or loss (Mittermeier *et al*., 2000). The region has at least 7,500 flowering plants (1800 of them are found no where in the world), 700 orchids, 58 bamboos, 64 citrus, 28 conifers, 500 mosses, 700 ferns and 728 lichen species (Table

4). The region is equally rich in faunal diversity. An estimated 3,624 species of insects, 50 molluscs, 236 fishes, 64 amphibians, 137 reptiles, 541 birds and 160 mammalian species have been so far described (Ali, 1962; Ghosh and Tiwari, 1984; Meena, 1992; Ramakantha *et al*. 2003). Out of 315 families of flowering plants documented in India, more than 200 families are found in this region. Rhododendrons are well represented in eastern Himalaya. Out of a total of 82 species recorded from Himalaya, about 70 species are confined to the Eastern Himalaya and North Eastern Region. Of about 125 species of Indian bamboos, 58 species are found in NER (Borthakur, 2003). About 50% of ferns, out of 1000 species found in India, are represented from NER. The region is also rich in terms of genetic and ecosystem diversity. Some of the important gene pools of *Citrus* species (lime, lemon, orange and grapefruit), *Musa* species (banana) and *Oryza sativa* (rice) are believed to have been originated in this region. Crop plants such as rice, maize, finger millet (*Eleusine*), foxtail millet (*Setaria*), job's tears (*Coix*), french bean (*Phaseolus*), soybean (*Glycine*), pigeon pea (*Cajanus*), black gram (*Vigna*), rice bean (*Vigna*), beans (*Dolichus*), winged bean (*Psophocarpus*), sword bean (*Canavalia*), pumpkin (*Cucurbita*), cucumber (*Cucumber*), okra (*Abelmoschus*), egg plant (*Solanum*), chillies (*Solanum*), pointed gourd, ash gourd (*Lagenaria*), taro (*Colocasia*), yam (*Dioscorea, Amorphophalus* and *Xanthosoma*), citrus species such as lime, lemon, banana, tea (*Thea*), jute (*Corchorus*), kenaf, mesta (*Hibiscus*), large cardamom (*Ammomum*), ginger *(Zingiber*), bitter gourd (*Momordica*), chow-chow (*Sechium*), long pepper (*Piper*), mango (*Mangifera*), turmeric (*Curcuma*), sugarcane (*Sachharum barberi*) are being cultivated in the traditional farming system with greater diversity within each species.

Table 4. Biodiversity of Sikkim in comparison with Northeastern Region

Flora / Fauna	North Eastern Region	Sikkim
Flowering Plants	7500	4500
Orchids	700 (825)	527
Rhododendrons	70	38
Conifers	28	16
Bamboos	58 (63)	23
Citrus	64	3
Ferns and Ferns allies	700	480
Primulas		58
Oaks		11
Medicinal Plants		424
Mammals	160	144
Birds	541	574
Butterflies	183	689
Fishes	236	48
Reptiles	137	88
Frog	64	50

Sources: Ghosh and Tiwari (1984), Sikkim Statistical Profiles 2003; Anon (2008).

Field and horticultural crops: The Sikkim Himalaya harbours as many as 190 wild plants suitable for human consumption (Sundriyal and Sundriyal, 2003). About 69 crop species of food, vegetable, fruit, ornamental and commercial importance are cultivated in Sikkim (Table 5), in addition to the semi-domesticated wild edibles like tree tomato or rampeda (*Cypomandra batacea*), bee (*Solanum incanum*), sweat gourd or Suchey Karela (*Cyclandra pedata*), Ferns and Bamboo shoots. The species diversity in cultivated plants includes 5 cereals (rice, wheat, maize, ragi, barley), 2 Psuedo-cereal (buckwheat), 4 pulses (urd, rajma, mung, rice bean), 5 species of oilseeds (yellow sarson, brown sarson, toria, rai, soybean), 8 fruit crops (mandarin, peach, plum, apple, straw berry, passion fruit, guava, banana), as manay as 34 vegetables (potato, chillies, bhendi, peas, beans, cowpea, tomato, cucumber, chow-chow, radish, pumpkin, bottle gourd, bitter gourd, cabbage, cauliflower, broccoli, tapioca, sweet potato, fenugreek, coriander, palak, onion, garlic, rai saag, taro, xanthosoma), 3 spices (large cardamom, ginger, turmeric) and more than 8 species of ornamental flowers namely, orchids, gladiolus, gerbera, rose, anthurium, marigold, carnation, glaxonia, begonia, tuberose lilly, and chrysanthemum.

Table 5. Field and Horticultural crops cultivated in Sikkim

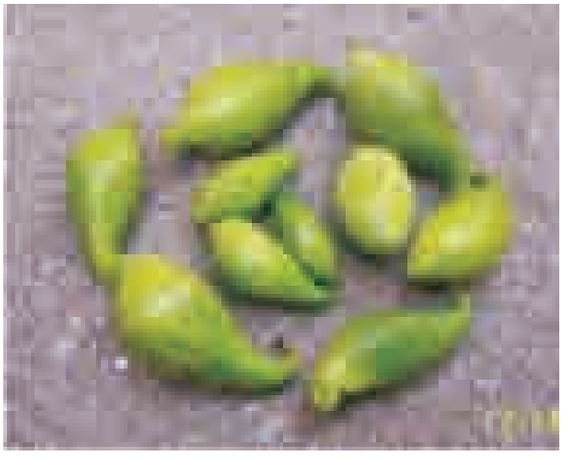
S.No	Cultivated species	Status	No. of local cultivars	Crop duration
I	**Cereal**			
1	Rice (*Oryza sativa*)	Major crop	43	June to Sept
2	Wheat (*Triticum aestivum*)	Minor crop	Not known	Oct to Feb
3	Maize (*Zea mays*)	Major crop	26	Feb-Jun
4	Ragi (*Eleusine coracana*)	Major crop	6	June-Sept
5	Barley (*Hordeum vulgare*)	Minor crop	Not known	Oct to Feb
6	Buckwheat (*Fagopyron esculentus* and *F. tataricum*)	Minor crop	1+1	June-Sept
II	**Pulses**			
1	Urd (*Vigna mungo*)	Major crop	3	Aug-Oct
2	Rice bean (*Vigna umbellata*)	Minor crop	7	July-Oct
3	Rajma (*Phaseolus vulgaris*)	Minor crop	14	Jul-Oct
4	Mung (*Vigna radiata*)	Minor crop	1	Aug-Oct
III	**Oilseeds**			
1	Rapeseed (*Brassica campestris* var. *yellow sarso, brown sarson, toria*) & Mustard (*B. juncea*)	Major crop	Not known	Oct-Feb
2	Soybean (*Glycine max*)	Major crop	2	Jul-Oct
IV	**Fruits**			
1	Mandarin (*Citrus reticulate*)	Major crop	1	Fruiting in Nov-Jan
2	Peach (*Prunus persica*)	Major crop	Not known	Fruiting in Feb-Apr
3	Plum (*Prunus domestica)*	Minor crop	Not known	Fruiting in Feb-Apr
4	Apple (*Malus*)	Minor crop	Not known	Fruiting in Feb-Apr
5	Straw berry (*Fragaria ananassa*)	Minor crop	Not known	Fruiting in June-Aug
6	Passion fruit (*Passiflora edulis*)	Minor crop	2	Fruiting in June-Aug
7	Guava (*Psidium guajava*))	Minor crop	Not known	Fruiting in Sept-Nov
8	Banana (*Musa* spp)	Minor crop	4	
V	**Vegetables**			
1	Potato (*Solanum tuberosum*)	Major crop	Not known	Jan-Apr
2	Chillies (*Capsicum annuum, C. frutescence, C. chinensis*)	Major crop	9	May-Nov
3	Bhindi (*Abelmoschus esculentus* and *A. caillei*)	Minor crop	4	May-Aug
4	Peas (*Pisum sativum*)	Major crop	2	Oct-Feb
5	Beans (*Dolichs lablab*)	Major crop	Not known	Jul-Oct
6	Butter bean (*P. lunatus*)	Minor crop	3	Jul-Oct
7	Broad bean (*Vicia faba*)	Minor crop	Not known	Oct-Jan
8	Cowpea (*Vigna unguiculata*)	Minor crop	2	Jul-Oct
9	Tomato (*Lycopersicon esculentum & L. pimpinellifolium*)	Minor crop	2 in *pimpinellifolium*	May-Aug
10	Cucumber (*Cucumis* spp)	Major crop	2	May-Aug
11	Chow-chow (*Sechium edule*)	Major crop	9	Fruitng in Sep-Jan
12	Radish (*Raphanus sativus*)	Major crop	3	Oct-Dec

13	Pumpkin (*Cucurbita moschata*)	Major crop	3	May-Oct
14	Bottle gourd (*Lagenaria siceraria*)	Minor crop	2	May-Oct
15	Bitter gourd (*Momordica charantia* & *M. subangulata var. renigera*)	Minor crop	2	May-Oct
16	Cabbage (*Brassica oleracea* var. *capitata*)	Major crop	Not known	Oct-Jan
17	Cauliflower (*Brassica oleracea* var. *botrytis*)	Major crop	Not known	Oct-Jan
18	Broccoli (*Brassica oleracea* var. *italica*)	Minor crop	Not known	Oct-Jan
19	Tapioca (*Manihot esculenta*)	Minor crop	Not known	Feb-Dec
20	Sweet potato (*Ipomoea batatas*)	Minor crop	2	May-Oct
21	Fenugreek (*Trigonella foenum-graecum*)	Minor crop	Not known	Oct-Jan
22	Rai saag (*Brassica juncea* var. *rugosa*)	Major crop	4	
23	Taro (*Colocasia esculenta*)	Minor crop	Not known	Feb-Oct
24	Xanthosoma (*Xanthosoma sagittifolium*)	Minor crop	Not known	Feb-Oct
25	Coriander (*Coriandrum sarivum*)	Minor crop	Not known	Feb-Oct
26	Onion (*Allium cepa*)	Minor crop	Not known	Feb-Oct
27	Garlic (*Allium sativum*)	Minor crop		Feb-Oct
28	Palak (*Beta vulgaris* var. *bengalensis*)	Minor crop	Not known	Sep-Feb
VI	**Spices**			
1	Large cardamom (*Amomum subulatum*)	Major crop	11	Fruitng in June-Aug
2	Ginger (*Zingeber officinale*)	Major crop	5	Mar-Dec
3	Turmeric (*Curcuma longa*)	Major crop	2	Apr-Dec
VI	**Ornamental flowers**			
1-3	Orchids, Gladiolus, Gerbera	Major crop	Not known	
4-8	Rose, Anthurium, Marigold, Carnation, Glaxonia, Begonia, Tuberose lilly, Chrysanthemum	Minor cops	Not known	

Buckwheat: Two species of '*Fabar*' *viz*., *Fagopyron esculentum* (*Meeta fabar*) and *F. tataricum* (*Deetha fabar*) are found in Sikkim, the former is more preferred. The conversion ratio from whole grain to fabar powder is very low (300 g per kilo of kernel). This can be improved to 400- 500 g / kg of kernel by selecting bold kernel.

Inland and cold water fishes: Fishes are the most ancient and numerous of vertebrates. Over 24,000 species of fishes are known in the world, and-a majority of these are from warm tropical waters. Northeast India is exceptionally rich in freshwater fishes, and it is heartening to note that the region has been extensively surveyed, and accounts for 236 species. About 48 species of inland and cold water fishes were reported from Sikkim. They are: *Acanthophthalmus pangia* (Chhadibam), *Acrossocheilus hexagonolepis* (Katley), *Anguilla bengalensis* (Rajabam), *Bagarius bagarius* (Gonch), *Barilius barila* (Chaley), *B. bendelisis* (Chedra), *B. vagra (Fakate), Belitora bruccei, Channa orientalis, Clarius batrachus* (Mungri), *Clupisoma bhandaril* (Jalkapur), *Crossocheilus latius latius* (Dhurla), *Ctenophryngodon idlus, Cyprinus carpio, Danio acquipinnatus* (Bhitti), *Danio neganensis, Euchiloglanis hodgarti, Garra annandalei* (Lohari),

Tree tomato-*Cyphomandra betacea*



Chuchey Karela-*Cyclandra Pedata*

Underutilized crops grown in Homestead

Bee-*Solanum incanum*

Bhat Karela
M. subangulata ssp. renigera

Pumpkin-*Cucurbita maxima*

G. gotyla (Buduna), *G. gotyla-stenarhynchus* (Buduna), *G. lamta* (Lohori), *G. mcclellandi, G. mullya, Glyptothorax basnetti, G. bhutiai, G. conirostrae , G. deyi, G. gracilis, G. sinense manipurensis, G. sinense sikkimemsis, G. trilineatus* (Kavre), *Hilsa ilisha, Labeo dero* (Gundi), *Labeo pangusis* (Termassa), *Laguvia ribeiroi jorethangensis, L. ribeiroi ribeiroi, Noemacheilus beavani* (Gadela), *N. carietoni, N. corica* (Gadelo), *N. devdevi* (Gadela or Garolla), *N. kangjupkhulensis, N. multifasciatus, N. sikkimensis, N. spilopterus, Pangasius pangasius, Pseudechenesis salcatus* (Kabri), *Salmo gairdneri, S. trutta, Schizhiphyge progastus, S. richardsonii* (Asala), *Semiplotus semiplotus* (Chepti), *and Tor putitora* (Mahaseer). However, the most common local fishes are Monday Asala *(Schizothoraichthys plagiostomus*), Thumray Asala (*Schizothoraichthys esocinus*), Pangri (*Danio rerio*), Kanday *(Puntius sarana),* Balm (*Amphipnous cuchia*), Sahar (*Tor tor*), Thend (*Labeo angra*), and Gardhi (*Labeo gorrius*).

5. Genetic diversity in Sikkim

Genetic diversity refers to the variations in genetic information contained in the living organism-plants, animals and microorganisms that inhabit the earth. Genetic diversity is essential by any species, population or community in order to maintain reproductive vitality, resistance to diseases and the ability to adapt to a changing environment. While the species diversity of India's crop plants is significant, what is amazing is the genetic diversity within each of these species. To quote an example, one species of rice (*Oryza sativa*) has been diversified into at least 50,000 distinct rice varieties or more; one species of mango (*Mangifera indica*) has diversified into over 1000 mango varieties. In Sikkim, crop production takes place between 300 and 2000 m elevation where a wide range of micro-ecological niches are found, and varied crop production systems are being practiced by the farmers. A great diversity is found within most of the food crops and large part of the arable land is planted by local cultivars. According to a modest estimate by the authors, more than 178 cultivars or landraces are available among the 69 crop plants grown in Sikkim (Table 5). Rice has greater genetic

diversity in Sikkim. About 43 landraces could be distinguished in rice. Existence of such huge number of cultivars in self pollinated crop justifies the diversity in ecology and selection and conservation efforts by the farmers of Sikkim. About 26 landraces of maize were documented at ICAR Sikkim Centre including the Sikkim primitive maize; there are 6 local cultivars in finger millet; more than 14 local cultivars of Rajmash, 7 in rice bean, 9 each in chillies and chow-chow, 4 in rai sag; about 11 clones of large cardamom, 5 clones of ginger and 4 clones of banana are being cultivated in this State. The rich agro-biodiversity in the hill has evolved over time and space due to extreme variations in altitude and environmental conditions. In addition to the physical and ecological conditions and the natural evolutionary process, the diversity that exist on-farm has also been greatly influenced by diverse social, cultural and economic conditions of the farming communities. Numerous ethnic groups with varying socio-cultural preferences and needs have contributed to the diversity and farmers have accumulated a wealth of knowledge on these diversities and the systems as a whole. A brief account on the genetic diversity of cultivated crop species of Sikkim is given below.

Maize: The agrarian economy of NER is rice based bur in Sikkim the agriculture economy is maize based. This underline the importance attached to the crop, of course now the situation is changing towards other remunerative crop. Although maize was originated in Mexico, India too has considerable genetic diversity. The available landraces of maize in Sikkim can be grouped into four groups namely: i) primitive, ii) advanced or derived, iii) recent introductions and iv) hybrid races. The primitive group comprised several races of popcorn such as *Poorvi Botapa, Tirap Nag-Sahypung, Arun Tepi* and *Alok Sapa*. These races are distributed in the Eastern Himalaya including Sikkim in the altitude range from 600 to 2000 m. *Poorvi Botapa*, the most primitive race, is found in pure form in North Sikkim. It is locally known as ¡¶*Murli makkai*¡±.Two forms of *Murli makkai* differing in kernel colour (purple and yellow kernel maize) are found; they were designated as Sikkim Primitive-1 (purple kernel type) and Sikkim Primitive-2 (yellow kernel type). Important varietal characters of *Murli makkai* are: i) ear prolificacy (bearing 3-5 cobs/plant which is a rare trait in commercial maize), ii) presence of style remnants on the mature kernel, iii) very small size cob (8 cm long and 6 cm girth; each cob bears around 100 small kernels) as well as kernel (100 kernel weight is 9.5 g) and iv) high popping efficiency. Murli makkai thrives well (but slow vegetative growth) in high altitude (1000-1800 m amsl) and under moisture stress condition. It is a potential donor for incorporating adaptability and multiple cob bearing traits in an otherwise desirable variety of mid and high hills. It is disheartening to mention that this rare genotype is gradually disappearing from cultivation (endangered cultivar). Germplasm exploration and collection programme in Sikkim has revealed the existence of large number of indigenous maize cultivars befitting to different altitude and purpose. About 58 local germplasm were collected during 2003-04 from 4 districts of Sikkim and at different altitude. They include white kernel maize locally known as ¡°*Sethi makkai*¡±yellow kernel maize known as ¡¶*Pahenlo makkai*¡±,orange to red kernel maize locally called as ¡¶*Rato makkai*¡±, purple kernel maize known as ¡¶*Baiguney makkai*¡±;high altitude maize such as ¡¶*Lachung makkai*¡±¡¶*Sehrung*¡±¡¶*Tempo Ringing*¡±*Sano makkai* (pop corn type), *Garbarey* and *Khukurey*. There were variations within *Sethi makkai* which were grouped as *Sethi Makkai*-1 to 4; likewise there were 6 sub-types in *Pahenli makkai* (grouped as *Pahenli makkai* 1-6), 4

Diversity of Sikkim local maize

Multiple cob bearing Murli Makkai (Sakkim primitive maize)

Maize diversity

sub-types in *Rato makkai* named as (*Rato Makkai*1-4), 3 sub-types in *Sano makkai* designated as *Sikkim Popcorn* 1 to 3 and 2 sub-types in *Baiguney makkai* named as *Sano baiguney* and *Tulo baiguney*. In addition, there were many non-descript cultivars without specific name. The local germplasm exhibited high variability for cob orientation, cob size, kernel colour, leaf orientation, silk colour, height at which ear arise, cob length, number of kernels per row and kernel yield per plant .'*Lachung maize*' exhibits para-mutation (multi coloured cob) and showed tolerance to cold weather. Some of the *Sethi makkai* and *Pahenlo makkai* had thick husk coverage and oblong cob orientation which impart resistance against ear rot in rainy season. The high altitude maize *Tempo Ringing* attains maturity in 85-90 days in mid-hills when other maize did not complete silking. Such extra-earliness is a rare trait in mid and high altitude maize. Local germplasm such as *Murli makkai, Tempo Ringing* and *Sethi makkai* are being utilized in the on-going breeding programme at the ICAR Sikkim Centre, Tadong. In nutshell, maize genetic resources in Sikkim are rich due to which the Sikkim Himalaya is considered as *secondary centres of diversity* of maize.

Rice: There are more than 650 landraces / local cultivars of rice in NER. Some of them have been collected and maintained at the ICAR Research Complex for NEH Region. It includes black rice cultivars such as *Chakhao Kumbi, Kemeste, Ching chakhao, Atu kumupu, Chakhao, Simtharla Mah, Keme Yaisha, Marina, Chakhao Local, Chakha Tsia, Themyouh khange, Chakhao Amubi, Maise Jang, Runya, Chakhao Amubi, Koite, Yamu, Otsok Khipa, Seical Ha, Machang kazik; dark brown or horse colour cultivars such as Chingtui Mah, Tsluma sojang, Rochat Makra, Ching chakhao, Thagmo, Mutsaky, Moroephyo, Noin, Koite, Ngono Chasla, Kahangam, Thumpak Tssok, Charai Lunap; light red or red colour rice such as Ching CHakhao, Khatu tha, Ching Chakhao, Makhapui Kahare, Seical Ha, Chingtui makru, Khatighi, Zunkebop,Keda, Runya, Kerebe phek, Ccpur cool, Kere be phek, Manui Kharamui, Chalha Tsia, Keme, Yaisha, Thagmo, Tsluma, Sojang, Mayo jang; short bold rice like Tsushruri, Eeyo Tssok, Kumunubthi, Minre, Yanjoepya, Thumpak Tssok, Younnyo kangbu, Tabusen, Kimin, Mephong Tssok, Rukhotung; long slender or fine grain rice namely, Sumi special, Simtharka mah, Manipur thi, Jalesa, Mesa tsuk, Zunri Bota, Lungnila phou, Kenton, Deissek Khangba; medium bold rice like Teyangret Jang, Makharo, Mashuta, Dumkung Mei, Daramphow, Upokpi, Manui Nira, Ronga, Koyajang, Wangshim, Phumcham mah, Ayono mah, Phourene Kachar, Khangra Mah, Rohole, Mashi mah, Kezu, Them Youn, Purunui Makrei, Ahutenei, Deisek, Youhshou, Kisheghi, Tsunghi, Mutnk (SB), Sang Buman, Phougak, Hundung, Mainong Kangbk, Ching phou, Mata mah, Salsonya isia, Phumpha maha, Megalay wonder rice Rulo Tasia, Phouoibi, Mutsaku, Yanjoepya, Talui, Taloi Mah, Langphou Angouba, Taothabi, Retu maso jang, Ereimaphou, Makharo, Wokha, Younyo Kangbu, Rosoka Isia, Kiphere mukhi, Daramphou, Kemenya (Kepeu), Ebeme Tshi, Toshrro phek, Manipur Thi, Aya mao maho, Chingphou, Langphou, Upokpi Yagakion derri, Leimaphtu, Meikedo-u Lhatsi, Lesem jang, Mipun, Jingu, Kumin, Chang phai, Khongnembi, Ngoazu, Metiak, Azhoghi, Tengu bed phek, Mana balwa, Bali* (similar to Attey of Sikkim), *Moirang phou, Allechisho, Paokei machong, Tang sekkanbi, Kezijhum, Chakhao Antuba, Kiphere muki, Dara nphou, Teutoranssok, Balo red, LM sajang, Tengu bed phek, Morang phou, Paokei machang, Tang sekkanbi, Kenzijhum, Tabusen, Yungra makrei, Changphai awangbi, Sangbuman, Ngamie China, Chandel, Sana phou, Wesheloru, Athar mah, Tampha phou, Phoutum mah, Maya jang temesong, Nagono lhasia, Moi lohong, Nembi, Tsuduuri, Phouren utlou, Chongfoi lehong nimbi, Thekrulha, Ramyang, Plai kho mah, Ong pang masojong, Kh Abhangphou, Khe Moru, Zunhi Boto, Jenil leazi, Machim maha, Kenyo, Yegnto, Kemenga sopa, Phatsen,* and *Kahaora mah*.

Rice has great antiquity in Sikkim as is evident from the etymological significance of Tibetan word "*Denzong*" (erstwhile name of Sikkim) meaning "*the valley of rice*". It is a major crop after maize and has been in cultivation for thousands of years in different ecological conditions. In Sikkim, rice is grown at varying altitudes (foot hills to 1700 m amsl) and from sub-tropical to temperate climate. Selection by various ethnic groups over generations has led to the evolution of wide array of indigenous landraces, numbering as many as 43 and still dominated the traditional rice production systems with 55-60 % share in acreage. The local rice cultivars/ landraces under cultivation were *Anandi* red, *Attey* or *Tulo attey, Bachhi, Basmati attey* or *Nunia, Bhagey tulasi, Birinpool* or *Bhuinphul, Champasare, Champey,* two forms of *Chirakey, Dhanase, Dharmali, Dut-Kati, Dhorokey* or *Dahrey, Godule* or *Kalo tulasi, Gujri bhog, Japanese, Jeerasari, Jholungey, Kalami or Ramkalan,,* two forms of *Kalo nunia, Kalo dhan, Kalchhati, Kataka, Khemtey, Krishna bhog, Khaiya dhan, Lamo dhan* or *Barmi dhan, Mansare, Pouryal, Phudungey, Ramzira, Sano attey* or *Kanchi attey* or *Masino attey, Sirkey-Marsee, Taichung,, Thakmaru, Thapacheeni,* two forms of *Thaprey, Tulasi, Zapaka* and *Zornali*.

Cultivars known as *Taichung, Japanese* and *Zornali* are tall *indica* types, probably introduced into Sikkim long back. These cultivars are being cultivated only in few places and therefore, could be treated as obsolete cultivars. In addition to these local cultivars, few improved varieties like HPR 1028, PD 10, RCPL 1-87-8, VL 61, VL 62, VL 88-1011, VL 89-1167 and Pusa Sugandh 2 were also found growing in Sikkim. These varieties occupies roughly about 40-45% of total rice area.

Among the landraces, *Attey* is popular and occupied larger areas. It was found in all the four districts, at an elevation ranging from foot-hills to about 1500m above mean sea level (amsl). *Attey* is a tall *indica* cultivar attaining a height of 130-160 cm with 5-6 productive tillers/ hill. The culm is long and weak hence, lodge easily. It attain maturity in 145-150 days and yield around 3-4 t/ ha. It has medium bold white kernel of non-glutinous nature but shows good expansion after cooking. The keeping quality of cooked rice (*bath*) is better than improved varieties. Its taste and palatability are considered superior. *Phudungey, Champey, Champasare* and *Thakmaru* were specific to high altitudes. Like other high altitude cultivars *Attey* perform well but upto 1500 m amsl. *Phudungey and Thakmaru were found in Upper Rumtek (1500 m amsl). Phudungey, Champey and Champasare were also grown in Dzongu and Mangan (1400-1700 masl).* All other landraces were found mostly in the mid-hills (1000-1500 masl). Cultivars such as *Bacchi, Barmi Dhan, Bhuinphul, Champey, Dahrey, Dharmali, Dhanase, Dut-Kate, Japanese, Kalami, Kalo Dhan, Kalo Nunia, Lama Dhan, Nunia, Ramkalan, Sirkey-Marsee, Taichung, Thakmaru, Thaprey* and *Zornali were found rarely* and the populations are facing acute genetic drift.

The indigenous landraces from Sikkim mainly belonged to tall *indica* group and showed considerable variability in duration, adaptability to various agroclimate, cultural practice, seasons, plant height, tillering, lodging, grain morphology and disease resistance. Among 43 landraces, plant height varied from 77.89 cm in *Lamo dhan* to 132.44 cm in *Sirkey-Marsee*. The average height of tillers was 110.09 cm. Cultivars like *Anandi Red, Phudungey, Khaiya Dhan, Basmati Attey, Dharmali, Champasare, Dut-kate, Sano attey Attey,* and *Sirkey-Marsee* grew tall (120-133 cm) and lodge before attain harvest maturity. This could be attributed to its long and weak culm. Cultivars such as *Lamo dhan, Kalo dhan, Mansare, Chirakey* were non-lodging. The average days to 50% flowering were 107.09 days; cultivar *Thakmaru* has flowered within 79.67 days while *Gujri bhog, Mansare* and *Thaprey-II* flowered after 120 days. The variation in days to flowering had reflected in its maturity. Cultivars like *Thakmaru* and *Ramzira* attained maturity in 126, 137 days whereas, *Kalo Nunia-I & II, Thaprey-II, Jeerasari* and *Gujri bhog,* due to photosensitive nature, have attained maturity between 167 and 176 days. Variability was recorded for tillering ability. The number of tillers/culm was as low as 5 in Chirakey whereas, it has surpassed above 10 in *Gujri bhog, Godule* and *Kalo Nunia*. Shortest grain (3.58mm) was recorded in *Godule* and the longest (9.94mm) in *Kalchhati. Nunia, Bhagey Tulasi, Sano attey, Tulasi, Jeerasari, Ramzira, Chirakey-I, Dhorokey* and *Bachhi* were short grain types (5.20-6.56 mm) while *Anandi red, Champasare, Kalami, Lamo dhan, Dut-kati* and *Kalchhati* were longer grain types (9.00-9.82 mm). The intermediate types were *Taichung, Attey, Dhanase, Thapacheeni* and *Phudungey*. Grain breadth was low (1.63-1.67 mm) in *Krishna Bhog, Birinpool, Kalo Nunia-I & II, Pouryal, Jeerasari*, and high in *Phudungey (2.43 mm) and Anandi Red (3.03 mm). Birinpool, Japanese* and *Godule* landraces bear very thin caryopsis (grain thickness 2.30-2.40 mm) whereas, *Phudungey* and *Taichung* bear bold caryopsis (2.45 mm). The variability for seed weight was high with 100-seed weight ranging from 1.70 to 2.82 g. *Gujri bhog, Ramzira, Nunia, Godule, Sano attey, Bhagey Tulasi, Bachhi* and *Chirakey II* possessed short bold seeds with 100-seed weight less than 2.0 g as compared to *Kalchhati and Anandi red (2.82 g).* Under organic condition, the grain yield averaged over three years was 2.62 t/ha. The minimum being 1.5 or 1.6 t/ha, recorded in *Jeerasari* and *Kalo nunia* and the maximum was 3.67 t/ha recorded in *Dharmali*. The high yielding cultivars are *Phudungey* (3.03 t/ha), *Champasare* (3.03 t/ha), *Birinpool* (3.10 t/ha), *Ramzira* (3.13 t/ha), *Sano attey* (3.13 t/ha), *Basmati attey* (3.15 t/ha), *Mansare* (3.20 t/ha), *Khemtey* (3.31 t/ha), *Dhanase* (3.45 t/ha), *Pouryal* (3.48 t/ha), *Lamo Dhan* (3.48 t/ha), *Thakmaru* (3.5 t/ha), *Attey* (3.53 t/ha) and *Dharmali* (3.67 t/ha).

High degree of variability was observed among landraces for qualitative traits such as pigmentation on plant parts, seed coat colour, grain shape, kernel colour, awnness and aroma. The colour of culm varied from green to purple. Although green culm was common, yellowish culm was observed in *Attey* and *Sano attey*; purple streaked culm in *Krishna bhog, Birinpool* and purple culm in *Thapacheeni* and *Kalo nunia*. Auricle colour was either pale

green (most of the landraces) or light purple (*Birinpool* and *Kalo nunia*). Purple leaf margin was observed in *Bhagey tulasi, Jeerasari, Ramzira, Jholungey, Kalo nunia-I & II, Birinpool* and *Thapacheeni* whereas, green leaf margin was recorded in all other cultivars. Krishna bhog has purple pigmentation on lamina margin and apex. Cultivars like *Godule, Tulasi, Chirakey- II, Bhagey Tulasi, Krishna bhog, Kalo nunia-II* and *Thapacheeni* posses red or purple stigma while all other cultivars has white stigma. The local rice collections have comprised of both awned and awnless cultivars. In *Chirakey-I, Phudungey, Krishna bhog, Taichung* and *Thakmaru* awns were relatively shorter whereas, highly conspicuous awns were recorded in *Birinphul, Thaprey-B* and *Champey*. Seed coat colour varied from golden brown in *Kalchhati* or *Dhanase* to black in *Kalo dhan* or *Kalo nunia* through purple tinge on brown lemma in *Kalo tulasi, Godule, Tulasi* and *Chirakey*. Light brown seed coat was noticed in *Khemtey,* brown in *Attey, Sano attey*, golden in *Dhanase, Zornali, Champasare,* etc. The kernel colour varied from milky white in *Dut-kate* to brown in *Thakmaru* through light brown in *Bachhi* or *Kalo dhan* and white in all other landraces. Translucent kernels were found in *Champasare, Kalami, Dut-kate, Kalchhati, Japanese, Pouryal, Thaprey* and *Zornali* and opaque kernels in *Bachhi* and *Thakmaru*. White spot or white belly was prominent in the kernels of *Taichung* and *Attey*; feeble in *Godule, Kalo tulasi, Bhagey tulasi, Chirakey* and *Champey* and absent in others.

Many of these landraces have several desired traits of potential use in crop improvement. *Dut-Kalam, Tulasi* and *Dharmali* can be utilized for increasing harvest index and grain quality. In mixed farming system where straw yield and adaptability to mid and high hills is preferred, landraces such as *Champasare, Champey, Thakmaru* and *Chirakey* can be used for cold tolerance. *Bhagey tulasi, Attey, Sano attey* and *Phudungey* for developing dual purpose types with increased straw yield; *Phudungey* for both grain yield and cold tolerance and *Attey* for wider adaptability and palatability can be used. *Krishna bhog, Bhuinphul, Gujri bhog, Thaprey, Kalo nunia* and *Nunia* can be used as donor for aroma and blast tolerance. *Kalchhati* is tall *indic*a rice with longest (10 mm) slender (1.78 mm) gain. Therefore it is an ideal parent in breeding programmes for quality. *Champey* and *Champasare* emit characteristic taste and aroma, hence used for preparing powdered rice (*Atta*) and enriched soft food called *Sathua* in combination with barley and pulses. Cereal and pulse combined in *Sathua* balance calorie and protein requirements of human diet. These landraces may contain better nutrients in kernel that needs to be investigated further. *Nunia* (*Basmati attey*) is the only aromatic rice among short bold grain types. It has wider acceptability among farmers and consumers for making *biriani, polau* and *sale roti*. Sikkim people prefer long slender grain like *Kalami, Dut-Kati, Kalchhati, Japanese* and *Pouryal* for preparing *sale roti*. Local aromatic rice landraces, *Krishna bhog, Birinpool* and *Kalo Nunia* fetch premium price in the market. *Thaprey* and *Bhuinphul* are suitable landraces for popped rice (*morai*) and *Dhanase* and *Mansare* for pressed rice (*chewda*).

Ginger: *Zingiber officinale* is one among the regionally advantageous crops of NER. The region as a whole supported 49.5 per cent ginger area (33,240 ha) in the country with 81.7 per cent of production *i.e.* 1, 91,040 tonnes. In 2001-02, all India ginger productivity was 3.50 t/ha while, it was 5.80 t/ha in NER *i.e.* 1.66 times higher than the all India average. Among NER States, Sikkim ranks 3rd in area and 5th in production as well as productivity. Within a species *Z. officinale,* about 73 local cultivars have diversified and are being grown in NER (Table 6). Sikkim has 5 local ginger cultivar namely, *Bhaise or bada aduwa, Gorubathane, Jorethange, Nangrey or sano aduwa and Majhauley*. The cultivar *Bhaise* possess plumpy rhizomes, long internode, pale brown non-persistent scales, primary and secondary fingers are bulky/plumpy, lemon yellow concentric ring with creamy yellow core and light brown outer layer, medium fibre and less pungent. It is known for its high yield (a plant can give 1.8 kg rhizome from 50 g seed rhizome) hence not only popular in Sikkim but in other NER States. The improved variety *Nadia* is also popular in this region due to its low fibre content. The local cultivars are susceptible to soft rot and rhizome rot. Improved varieties like Rio-de-Janeiro, Nadia, Maran, Dharja, PGS 35 and SG 666 were introduced in Sikkim and tested at the ICAR Farm, Tadong located at an elevation of 1350 m amsl. Bhaise was the highest yielder (9.41 t/ha) followed by Nadia (7.61 t/ha) and Gorubathaney (7.00 t / ha). Cultivar Gorubathane bears bold rhizomes, light brown external skin, scaly, elongated secondary fingers, cream yellow inner core with typical green concentric ring, low fibre and medium pungent. Nangery is a medicinal ginger characterised by turmeric like long slender rhizomes, brown skin, non-persistent scales, fingers are long, thin with long internode, the bluish inner ring visible at internode as well as nodal region, size of inner concentric ring is bigger than other cultivars, highly fibrous and highly pungent. These cultivars are given for flatulence and colic.

Table 6. Indigenous ginger cultivars found in North Eastern Region

S.No.	State	Name of the cultivars
1	Arunachal Pradesh	*Adi Dhakeng, Aying Dhakeng, China ginger, Dhake Kechan, Dhake Kedang, Dhake Keba, Khamti dham, Kaemey Dhakey, Keach Khem and KekirKeth (Dhakey/dhakeng=ginger)*
2	Assam	*Bahari Ada, Bhola Ada, Dhupdhara Ada, Essel Ada, Garo Ada, Gauley Ada, Hanso -Kethe, Hanso-So, Harmati Ada, Hym Ada, Jatia Ada, Kazli Ada, Kabew Ada, Migri Ada, Morana Ada, Nikashi Ada and Sadia Ada (ada= ginger)*
3	Manipur	*Aihing Makhu, Ehiing, Fi, Kahi, Kava, Naga Shing, Ravo, Tamenglong Shing, Thingpui zalchi, Thingte, Thingte zalchi, Thingpui -a-baemlien, Thingpui Densen, Thingpui Lienchi, Thoubal Shing, Thuypui, Vo (shing=ginger)*
4	Meghalaya	*Chona-jath Eching, Dalgipa -jath Eching, Shing Bhukir, Shing Poh, Khasi local and Tura local*
5	Mizoram	*Thinglaidum, Thingpui, Thingria, Thinglai and Jugijan. (thing=ginger)*
6	Nagaland	*Kebii, Kala Ada, Naga bada Ada, Naga Shing, Thinglai, Vuchu, Vubu, Vuthu.*
7	Sikkim	*Bhaise, Gorubathane, Jorethange, Nangrey or sano aduwa and Majhauley.*
8	Tripura	*Bhaisa, Khothar Haching, Chickon Haching, Kresho Haching and Thingpui.*

***Large Cardamom**:* Large cardamom is a perennial cash crop grown beneath the forest cover on marginal land hence it is well-fitted in the agroforestry system. Sikkim is the largest producer of large cardamom in India, having plantation area of 24,000 ha. The cardamom plantation has a considerable contribution towards preservation and protection of forest cover. The extent of genetic diversity within *A. subulatum* is recognizable and it is greater in Sikkim than Arunachal Pradesh. Perhaps mutation followed by conscious and unconscious selection for big capsule size, capsule colour, suitability to different altitude, disease resistance, etc might have given rise to large number of clones and sub-clones within *Amomum subulatum*. The present day clonal cultivars such as *Ramsey, Sawney, Golsey, Varlangey, Seremna* (found in Sikkim and Darjeeling), *Bebo, elak, Boklok* (found in Arunachal Pradesh) are the outcome / manifestation of the natural and artificial selection process. These clones, according to their adaptability can be grouped into low, mid and high altitude cultivars. Ramsey (derived from Bhutia language-*Ram* means mother and *sey* means gold) is well suited to high altitude (1200-1550m amsl) and in steep slopes but susceptible to viral diseases *Chirke* and *Foorkey*. *Sawney* (*meaning harvested in Sawan i.e. August*) gives best quality cardamom with bigger and bolder capsules containing 35-50 seeds. Though this clone is widely adapted its performance would be slightly better in mid and high altitudes (700-1200 m amsl). Golsey (*meaning round capsule*) is suitable for low altitude. Many sub-types (minor variants) of this clone such as *Seto Golsey, Pink Golsey, Green Golsey, Dzongu Golsey, Ramnag and Madhusey* are found in Sikkim and Darjeeling. Dzongu Golsey is very specific in Dzongu area of North Sikkim (1500 m amsl). Its capsules are bolder with more seeds (50-70). Unlike Ramsey and Sawney, its tillers are green and the leaves are narrow and erect. Dzongu Golsey is relatively tolerant to *Chirkey* but susceptible to *Foorkey* and leaf streak diseases. Seremna (*meaning drooping leaves*) is grown at lower altitude whose capsule quality is also good. This clone is known for high yield potential. It bears 2-3 spikes in each productive tiller with about 10 capsules in each spike and 65-70 seeds per capsules. *Varlangey* (*meaning robust*) is grown in the mid and high hills. It performs well in high altitudes. The spike to productive tiller ratio is relatively high, capsule size is bold with 50-70 seeds. Flowering starts in May at mid altitude and in June-July at high altitude. Consequently harvesting is delayed up to the end of November in high altitude. *Bebo* and *Belok* are found in mid altitude. *Bebo* prefer moist area adjacent to stream / *Jhora*. The presence of wild species and variability within cultivated species support the view of its origin in Sikkim.

Finger Millet: Six types of ragi differing in panicle type and maturity are found in Sikkim. They were: *Karthikey, Mangsirey, Murkey, Nangkatua, Pangdur* and *Phangrey*. They were collected and evaluated at the ICAR Sikkim Centre, Tadong. *Karthikey* is the earliest maturing millet (50% flowering in 85 days) variety. Its maturity coincides with

Large Cardamom Species Sikkim

Karthikey month. Its panicle type is fisty and fingers are small. *Mangsirey* bears broad culm, purple streaked leaf sheath, long and horizontal leaves, flat and open finger, white +purple spikelet and bold grain. *Murkey* (meaning folded finger or panicle) is a popular local cultivar characterised by tall, light pink culm, 3 to 5 tillers but thin, almost opposite leaf arrangement, more leafiness (14 leafs per plant), narrow leaves, green leaf , small fingers, panicle type fisty, bluish purple glumes, small seed, mature one week later than *Phangrey*. *Nangkatua* means "open finger /panicle". This local cultivar bears only one or two thin culm (tillers) only, however produce more but narrow leaves, panicle shape is open and out-curved. *Pangdur* is a late maturing / photosensitive cultivars bear small and narrow leaves. *Pangrey* is also a late maturing cultivar with luxuriant vegetative growth and showing purple pigmentation at the outer juncture of leaf sheath and lamina, panicle type is top curved or open and bears bold seeds.

Black gram: Three forms of urdbean differing in seed colour *viz*., green seed, brown seed and black seed are being cultivated in Sikkim. The green seeded urd belongs to *Vigna mungo* ssp. *viridis* and locally known as '*Pahenlo dal'*. It has price advantage compared to black seeded urd. In Sikkim, *Pahenlo dal* is boiled with little spices and salt and consumed along with rice. The other two types belong to *Vigna mungo* ssp. *niger*, locally known as '*Kalo dal'*. The local Pahenlo dal and Kalo dal are semi-spreading urd, takes comparatively longer times to mature. However, they were adapted to mid-hill climate and high yielders.

Soybean: Two forms of soybean namely '*Kalo bhatmas'* (black seeded soybean) and *Pahelo bhatmas* (brown seeded soybean) are found in cultivation. The '*Kalo bhatmas*' is a high yielder. Both the forms of soybean are consumed in three forms namely, boiled fermented food (*kinema*), fried nut (*buteko bhatmas*) and processed foods (soya milk, oil, etc).

Beans: About 70 local cultivars of beans are described from Northeast Region. Rice bean (*Vigna umbellate*), Butter bean (*Phaseolus lunatus*), Rajma and French bean (*Phaseolus vulgaris*) are cultivated in small scale and in the homesteads of Sikkim. The infra-specific variability within each group is fairy high. Among the beans greater variability has been noticed in rice bean. Rice bean, locally known as "*Masyum dal*". is an important ingredient of pig feed and therefore, forms an ideal component in integrated farming system in the low and mid hills. The local cultivars of rice bean are the red seeded *Rato masyam dal,* black mottled *Kalo masyam dal*, brown coloured *Seto masyam dal.* Another rare type of rice bean with bluish seed was also found in Sikkim. In Seto and kalo dal, there were small seeded type called *Sano masyum dal* and bold seeded type called *Tulo masyum dal*. The local cultivars of rice bean are pole type. Butter bean is locally known as *Ghew sibi*. There are not many variations in it except seed type (bold and small seeded type). Another variant of Ghew sibi was found in Lachung. It is called *Lachung Tibi*. In Rajmash two plant types exists-one type is the pure rajma type, only its seeds are used. Cultivars such as *Harey sibi, Potherey sib, Jotharey, Jureli, Kali sibi, Mantulal, Singtamey sibi, Harey Doode, Doode Haddey, Lam Rangey, Bharlangey, Kalo Mantulal,* and *Thakmanacy* belongs to this category. Seed colour in this group varies from milk

Pulses, ginger, chow chow, squash, chilies diversity

white to black through brown, red, brown mottled. The other plant type has dual purposes-young pods are used as vegetable and matured seeds is used as rajma. It is called *Alpatre sibi*. Rice bean, butter bean, rajma and french bean are suitable for the mid and high-hills of Sikkim either as intercrop with maize or sole crop in homesteads whereas black gram is suitable for low and mid -altitudes as sole crop or intercrop or relay crop with maize.

Chillies: Three species of chillies namely, *Capsicum frutescence, C. chinensis and C. annuum* are found in Sikkim. In each species, the extent of intra-specific variability with respect to fruit colour, fruit position, fruit shape and pungency are rich. There are 200 landraces of chillies were described from Northeast Region. In Sikkim *Dalle khorsani* (round chillies), *Thadey khorsani* (erect fruit), *Thalo khorsani* (vegetable type), *Jeerey khorsani* (thin fruit), *Lamchey khorsani* (medium size-less pungent) are seen. *Dalle khorsani* belongs to *C. frutescence*. It has the twin combination of high

pungency and characteristic aroma for which is it liked in Sikkim and fetch premium price. Four sub-types of *Dalle Khorsai* were noticed.

Rai sag (*Brassica juncea* var. *rugosa*): It is an important rabi leafy vegetable in Sikkim locally known as *Layo patha*. There were 4 distinct morphological forms in rai sag namely-green leaf, purple leaf, purple striped on green leaf and frego or dissected leaf type.

Rai sag diversity

Chow-Chow (*Sechium edule): It* is called '*Isqoash*' in Nepali. Early and late maturing genotypes, vivipary and non vivipary, spiny and non spiny fruits, green and yellow fruits, glossy and non-glabrous fruits were found. They were collected and are being evaluated at ICAR Sikkim Centre.

Sweet potato: Red skinned and yellow skinned cultivars were collected from Sikkim and were evaluated at ICAR Sikkim Centre. The yellow skinned sweet potato is a rich source of β-carotene.

Banana: The NER including Sikkim are supposed to be the original home of bananas since this region harbours a number of clones including *Musa acuminata, M. balbisiana,* several species from the section *Rhodochlamys* as well as *Ensete glaucum.* Few species such as *Musa sikkimensis* (*Syn. M. hookeri*) is still growing as wild in the jungles of Sikkim. This perennial plant often survives where natural disasters have adversely affected the production of many annual crops. At present four clones *viz., Cheeni Champa, Ghew Kera, Japadi* and *Kadali* are grown but Cheeni chamba (AAB) is the preferred for dessert purpose.

Animal genetic resources: Dairy farming, piggery, goat rearing, backyard poultry are the subsidiary occupations. Yak rearing is practiced in the alpine zone. The population of cattle in Sikkim is ~1,60,000, buffaloes 2,000, sheep 6,000, goats 1,25,000, pigs 38,000, yaks, 6,500 and poultry 3,25,000. The genetic diversity within each species are described below.

Cattle (*Bovine*): Local breed is called *Siri*. But pure breed of this is rearely found as it has been cross-breds with bloods of Jersey, HF & Brown Swiss.

Goat (*Caprine*): *Singhari* and *Changra* are the two local breeds of goat. It is being cross bred with with Jamnapari, Black Bengal, Beetal and Barbari. Another breed of goat is found in alpine zone (alpine goat). But it belongs to a separate species *Capra hircus.*

Sheep (*Ovine*): Two breeds of local sheep are found in low, mid and high hills. They are *Banpala* and *Gharpala*. Blue sheep is another species breed found in high hills / alpine zone.

Animal Diversity

Yak: Two types of Sikkimese Yak (breed *Gargu*) were reported from Sikkim. The large body yak is called *Bho* and small body yak is called *Aho*.

Poultry: Desi fowl and Naked neck are the two common breeds of poultry in addition to the introduced fowl like Rhode Island Red and Vanaraja. Other Avian breeds are Dumshi, Basti, and Nangay.

6. An analysis of present situation

Throughout history, human beings have used thousands of plant species for food, many of which have also been domesticated. Today at global level, only 150 plant species are cultivated, 12 of which and 5 animal species provide approximately 75 percent of our food and four of which produce over half of the food we eat. Even more disheartening is that only 3 plant species namely, rice, maize, and wheat contribute nearly 6 percent of calories and proteins consumed by humans from plants. It is alarming to realize that the food security of the world rests on the continued perseverance of only this many species of crop. Many local crops that have traditionally been important for feeding the poorest sectors of society are now under utilised or neglected. About 35 percent of livestock breeds are in danger, and 6 are lost each month.

Genetic erosion *i.e.* the reduction of diversity within species is a global threat to agriculture. The erosion in agro-biodiversity in the hills is due to a number of factors such as degradation of natural forests, which sustained traditional agriculture, introduction of modern and uniform plant varieties in place of mixed farming system with traditional varieties, destruction of habitat and developmental activities, changing food habit and attitudes of the consumers from coarse grains and fine grains, the latter being considered more ease to produce and consume, large-scale migration for employment, causing some hills or fields to be abandoned or neglected, the inevitable supply of high yielding varieties seeds and other inputs at subsidized cost by the government, attraction to maximize profits through cash crop monocultures such as maize, paddy, and above all the lack of incentives for marketing of traditional crops, etc .The same is hold good for animal genetic resources. The introduction of modern breeds of cow, goat, and poultry that are best suited for the high input-output of industrial agriculture is displacing the diversity of indigenous livestock breeds. As for as Sikkim is concerned, the Green revolution technology has not spread to this tiny and marginal Sate, for several reasons. This means that a lot of traditional agriculture still survives, retaining with it considerable diversity of crops and livestock, and the knowledge and practices associated with them.

Wherever the traditional inter-cropping and mixed cropping system is replaced by mono-cropping, a wide diversity of species is replaced by a few crop species. Further, in areas where intensive agriculture is practiced, the genetic diversity within a crop species is replaced by a few varieties with narrow genetic base. The net effect of these and other practices has been the displacement and finally disappearance of indigenous crop varieties. Such situation has not happened in Sikkim, but with increasing population pressure, developmental activities in farm and non-farm sectors the situation may likely to foresee in near future. Appropriate measures, approaches and strategies are, therefore, required for the conservation and utilisation of these crop genetic resources.

Mountains have been described as islands of biodiversity but are vulnerable. Isolation and relative inaccessibility have helped protect and preserve species in mountains. Rapid changes in elevation, slope and orientation to the sun have a tremendous influence on temperature, wind, moisture availability and soil composition over very short distances. These subtle changes create pockets of life found nowhere else but at a particular elevation and on a specific mountain or range. A typical household in Sikkim consists of some upland (*sukha bari*) around the house, few terraced plots (*dhan khet*) at lower reach, few fruit plants like Sikkim mandarin and pear, few fodder or fuel trees like *Alnus*, vegetable like wild brinjal, local chillies, tree tomato, beans, cucurbits and flower crops like orchids, *Zinnia, Primula*, one or two cows, pigs, goat and few fowls. Cultivation of many varieties and species in close proximity often encourage cross-fertilization between cultivars and rarely between wild and cultivated varieties. In a field of paddy or ragi or maize or ricebean more than 2 varieties of seeds are seen. This is not an encouraged practice from seed certification point of view, but it encourages new characteristics to emerge while strengthening a species genetic diversity and resilience. Knowingly or unknowingly many farmers do this practice in Sikkim.

Traditionally, over 70 crop species and 200 cultivars of varieties of cereals, millets, pseudo cereals, pulses, oil seeds, tubers, bulbs, and spices have been said to be cultivated in Sikkim. Traditional homestead gardens in Sikkim have been a major source of household requirements ut also acting as repository of biodiversity of agri-horticultural and forest species. Apart from maize and paddy, these gardens provided non-staple food such as fruits, vegetables, timbers and other house construction materials, biomass energy, fodder, organic manure for the fields, medicinal plants, spices, ornamental flowers. A survey report of Karuppaiyan and Bisht during 2008 have indicated that with increasing homogenisation coming into the agricultural practices, the area under traditional crops like buckwheat, naked barley (*Hordeum himalayens*), adzuki bean, horse gram, are declining and many of the landraces like *murli makkai* of maize, *Ramzira, Thaprey, Ramkalan, Birinpool, Dharmali, Dhorokey Jholungey, Ramkalan, Kalchhati, Kataka, Khaiya dhan, Mansare, and Sirkey-Marsee of rice, Harey sibi, Potherey sib, Jotharey, Jureli, Kali sibi, Harey Doode, Doode Haddey, Lam Rangey, Bharlangey, Kalo Mantulal,* and *Thakmanacy* of rajmash, and *Ghew Kera, Japadi* and *Kadali* of banana are obsolete (out of cultivation). According to the Statistics of Govt. of Sikkim, it can be inferred that 45-55% area under traditional rice varieties have been replaced by improved varieties. Livestock genetic resources are also at threat, mainly due to deliberate cross-breeding with exotics to increase the yields of milk or other animal products. It is difficult to get pure breeds of Sikkim local goat and cattle. Semen banks are generally storing the semen of exotic breeds.

To sum up, the natural ecosystem of Sikkim spread over an area of 7096 sq.km. A portion of the natural ecosystem (16% of GA) has been brought under human management, called agro-ecosystem. It is within the small area of agro ecosystem, as many as 69 crop species are being cultivated and over 178 cultivars were diversified. However, over a period of time considerable amount of the genetic material which has been grown or bred by farmers has been lost or no longer be available in the field, but some of them have been collected and stored in the gene banks of the National Bureau of Plant Genetic Resources and the breeding station of ICAR Research Complex for NEH Region, Sikkim Centre. Such *ex situ* collections are important for the present and future generation breeders for upgrading their genetic materials.

AUTHOR:

H. Rahman
Joint Director
ICAR Research complex NEH Region
Sikkim Centre, Tadong, Gangtok-737 102
Email: hricar@gmail.com

R. Karuppaiyan
Sr. Scientist (Plant Breeding)
Sugarcane Breeding Institute, Regional Centre, Karnal-132 001
Phone: 09467581011
Email: sikkimkarups@gmail.com

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