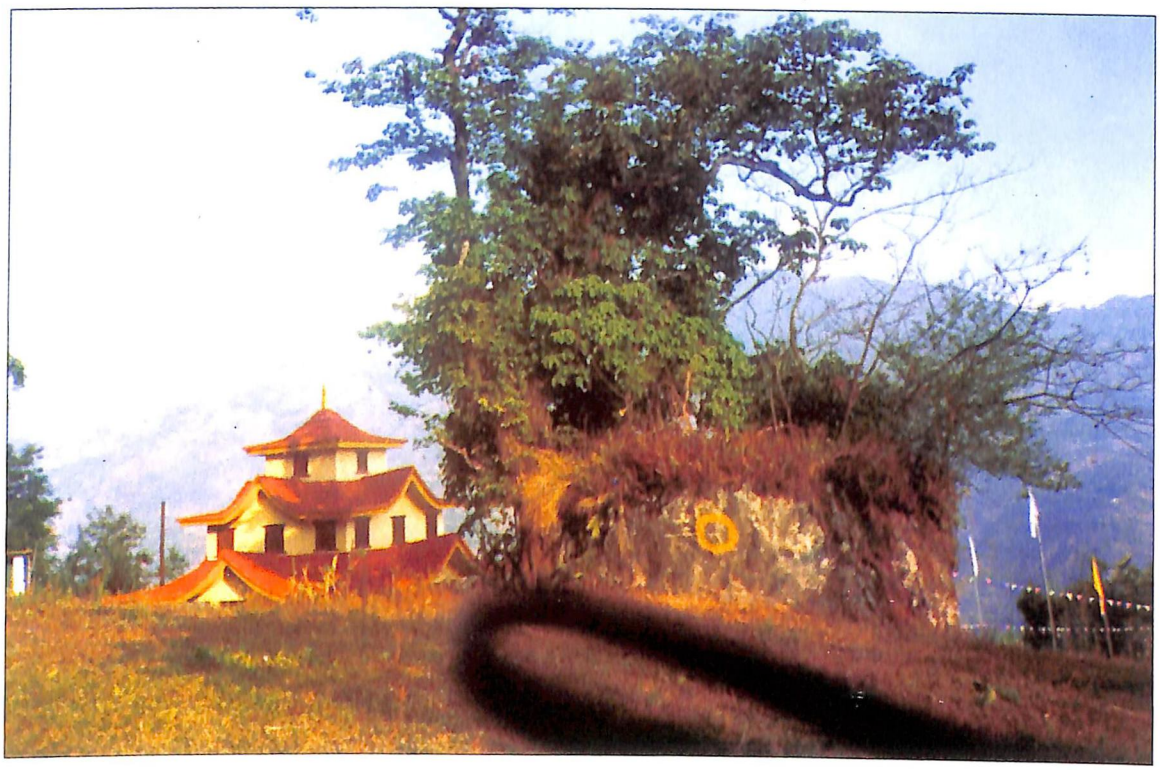
BIODIVERSITY OF THE SIKKIM HIMALAYAS



J.R. SUBBA

BIODIVERSITY OF THE SIKKIM HIMALAYAS

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FOREWORD

Just after the Dashera this year, one afternoon, Mr. J.R. Subba met me with a manuscript of his book "The Biodiversity of the Sikkim Himalayas" and briefed me about its contents. As he was taking leave, he requested me to write the foreword for the book. I do not know what prompted me to say 'yes.' Only much later, I came to realize that my limited and superficial knowledge about the different varieties of crops, weeds, grasses, shrubs, flowers, trees, birds, animals, insects, etc. rendered me incompetent for the job. However, retracting would amount to a let down. So I decided to take up the work with the best of my ability. In the end I confess that I drew immense pleasure from the job.

The Biodiversity of the Sikkim Himalayas is a unique book. It speaks of the Flora and Fauna including, the various crops of the Sikkim Himalayan region. It also mentions the diversity that is undergoing in them. As early as in 1843 A.D. W. Griffith, a renowned botanist had made a research work on many varieties of orchids. Another biologist J.D. Hooker had also conducted an intensive research work in this field in Sikkim from 1948 to 53, and had identified various types of plants and more than three hundred species of butterflies of Sikkim. His complete works were published as early as in 1885. Now the publication of this book after a gap of more than a century adds a new dimension to the previous research works by dealing with the process of diversity that is at work in animals and as well as in plants.

Environmentalists claim that every day numerous species of flora and fauna become extinct. Now, there arises a question –

" What makes all of them extinct ?"

- We may come to a rough conclusion –
- "The process of diversity is at work." Again, another question arises –
- " What is the cause of the diversity ?"

Mr. Subba replies, - "Man" – his continuous march towards civilization, his great achievements in various fields of sciences and technologies, his dominance over other animals, his ever multiplying population – all combined together work enough to destroy the ecological balance of nature by polluting water on the surface of the earth and atmosphere as well.

The book itself is very small in size. It consists of only eight brief chapters which are in fact only introductory notes. The bulk of the book is formed by its thirteen

annexures. Every chapter is brief but it provides many interesting information about the family, genus or species of the flora and fauna that it is dealing with. For instance, Chapter-I dealing with Agro-biodiversity provides important information and facts about the various types of crop-plants, weeds and grasses associated with them, their diseases and pests and so on. It also talks about the process of diversity that is at work in them and says some crops like paddy, maize, etc. that were extensively cultivated some forty years back have been completely displaced by new varieties. Similarly, other chapters, excepting the Chapter VIII, provide information and preliminary knowledge about flowers, trees, shrubs, birds, animals, reptiles, amphibians, fish, etc. along with their family, genus or species.

The book, in its Chapter VI, even deals with microbial organisms with the help of which, the people of Sikkim prepare some of their traditional food such as gundruk (fermented rayosag, mula-sag, cauliflower and cabbage sag etc.), Sinki (fermented radish), Kinema (fermented soybean), Beverages eg: Jand (fermented local beer made of maize, finger-millet, barley or wheat), Liquor (locally distilled alcohol), etc.

Realizing the fast diminishing tendency in the population of some species like birds and animals, the Union Parliament enacted an Act enabling the Union Government of India to take necessary steps for the safeguard and protection of these rare birds and animals from becoming extinct before it becomes too late. The Act has been enforced in the State also and certain actions are being taken in this direction. Chapter VII contains the schedules of the Act in question.

The second part of the book consists of thirteen annexure. It is the contents in these annexure that make the book unique and distinct. In these annexure, more than two thousand scientific names of various crop-plants, trees, flowers, birds, animals, etc. covered in the introductory notes in the preceding chapters are enlisted. As far as possible, their families, genus or species are also given. Along with the scientific ones their names in English, Nepali and Limboo languages have also been written. Nepali and Limboo words are written in Devnagari and Srijonga scripts respectively. Further, for the correct pronunciation of the Limboo naming words, they are again written in International Phonetic Alphabets (IPA) for convenience of the general reader.

In respect of the words enlisted in four different languages in the annexure, this is to be pointed out that, the number of words do not tally with one another. They vary. For instance, the number of words in common English is less than that of the scientific ones. So is the case with the number of Nepali words.

The number of Limboo words is still enormously higher for which Mr. J.R. Subba has furnished two reasons in the preface. In addition to that, I would also like to mention that wherever there was a want of Limboo words they have been filled in by borrowing words either from English or Nepali. In this way too, the number of Limboo words has increased to some extent.

Secondly, history records that the ten Limboo Kings (popularly known as Thibong Yakthung Hangs) of the ten Limboo families ruled over the Limboowana country independently for a pretty long time. Even when the country was under the kings of Vijayapur, Makwanpur and Sikkim, the ten Limboo Kings (Chieftains) took active part in the administration of their respective estates. This long period of time, therefore, accounts much to the increase in the synonymous words in Limboo Language. To this date, the languages of two Limboo families – Chhathorey (Limboo dialect spoken in some areas of Nepal and in some parts of Sikkim) and Phedapey (Limboo dialect spoken at Tehrathum area of Nepal and in some parts of Sikkim) have considerable differences from the modern Limboo language.

Diversity is a continuous process in plants and other living things but it is not limited to them. It also extends to the field of languages. The linguists have already made out that many languages have already become extinct during the last few decades. They have also predicted that many more may go out of use within some fifty years or so. This prediction does not make an exception to the languages, and dialects of the South Eastern Himalayas. The Limboo language at present has an underdeveloped literature. The Limboo speaking population is also declining and may ultimately become extinct.

In the light of the above background one can appreciate the timeliness of the release of the book as an effort towards the preservation of Limboo words. It is also hoped that this book may serve as a beckoning light for other authors to come forth with similar works.

Mr. J.R. Subba, being himself an authority collected all the agricultural and horticultural scientific names and other data for the book. As for the data and materials in respect of other sciences – flora, fauna, insects, microbial organisms, etc., other scholars of respective studies have extended their co-operation to make the collection a success. But above all, it was Mr. Subba's determined will to do something good for the people, his untiring perseverance and hard-work, his undetering patience all together made him successful in compiling and bringing out this marvelous piece of work.

Mr. Subba has carved a niche for himself in the field of writing. His published works so far are :-

1. Agriculture in the Hills of Sikkim (1984).
2. Sikkim Ka Sag-Subji (1991).
3. Vegetable crops of the Himalayan Region (1995).
4. My Journey to the New World (1997).
5. Cries unheard (1993)
   (A joint endeavor with Mrs. Budha Maya Subba).

6. Philosophy and Teachings of Yuma Samyo (1998), (About Yumaism – a cult of Shamanism). This book is published in English, Nepali and Limboo.
7. The Limboos of the Eastern Himalayas with special reference to Sikkim (1999). It is the most voluminous of his works to date. The book deals with the history, religion, culture, customs, language, literature, etc. of the Limboo, with their different races, sub-races (Thar) etc.
8. Indigenous Farming Systems of Sikkim Hills and Perspective Planning (2000).

Besides, he has enriched Limboo literature by publishing three Limboo books written purely in Sirijonga script. The books are :-

1. Yakthunghare Tendham Mekhim Mundhum (1998) (The appropriate ritualistic moment of marriage or Mundhum).
2. Yakthunghare Phung Sok Timma Mundhum (Expression of gratitude by every Limboo priest or priestess to the supreme one for bestowing him/her the power, reciting the sacred verses of the Limboo Mundhums once every three years).
3. Sum Senba Yagrangsing Tongsing Tookma Mundhum, (Three nights' continuous recitation of sacred verses and observation of rituals). This is one of the main Limboo es or Mundhums.

Considering all the works so far accomplished by Mr. J.R. Subba, the people of Sikkim particularly the Limboos should be proud to have him amongst them.

Date 05.12.2002

(P.S. SUBBA)
Dev. Area, GANGTOK

PREFACE

Sikkim, the 22nd State of Indian Union with its geographical area of 7096 sq km lies in the Eastern Himalaya between 27° and 28° N latitude and 88° and 89° E longitude. The mountainous terrain of the state consists of a tangled series of interlacing ridges, rising range after ranges, from the south to the foot of the wall of high peaks which mark the abode of snow in the North having general relief range of 350-8579 m. To its North lies the vast stretches of Tibetan Plateau, to the West - the Kingdom of Nepal, to the East – the Kingdom of Bhutan and Chumbi Valley of Tibet, and to the South Darjeeling Gorkha Hill Council of West Bengal. Sikkim is the watershed area of Teesta and Rangeet rivers.

Biological diversity or biodiversity, refers to all forms of life, including all species and genetic varieties within species and all ecosystems that contain and sustain those diverse forms of life. For millennia, when threatened with drought, insect outbreak, famine, and plague, humans have drawn upon this biodiversity for their short-term survival on the one hand and to develop new crops, new varieties within these crops, new farm animal resources, new medicines for their long-term benefit. The world has atleast 5 to 7 million different species of plants, animals, and micro-organisms, many of which only about 1.7 million is known to humans.

Sikkim is recognized as a hotspot of biodiversity. With only 0.22% of the geographical area of the country, Sikkim harbours around one-third of the flowering plants of India. It has been estimated that the state has 4,500 species of flowering plants and 350 species of ferns and fern allies, 450 species of orchids, 400 species of medicinal plants, 150 species of mammals, 550 species of birds, 650 species of butterflies and moths, 33 species of reptiles, 16 species of

amphibians and 48 species of fish. There is no estimate for other invertebrates and micro-organism diversity of the Sikkim Himalayas so far.

About 15 years back with the help of "Sukhim Yakthung Sapsok Songjumbho" (Sikkim Limboo Literary Society), Gangtok, Sikkim, an apex organization of the Limboo Community of Sikkim, I started the work of collection and compilation of Limboo Vernacular Names of the Biodiversity of the Sikkim Himalayas with the main objective of collection, compilation and preservation of the wealth of Nepali and Limboo Vernacular Names of the State's Biodiversity, which otherwise may get extinct like biodiversity in the influence of the powerful popular languages of this region.

The methods adopted to achieve this objective were:

1. Organizing a number of Limboo Vernacular Name collection competition and awarding nominal prizes for meritorious collectors. A tremendous response was received from the enthusiastic Limboo Language Teachers of the Education Department, Government of Sikkim, other Limboo officers of the Government of Sikkim and limboo language students of all age-groups.
2. Organizing a number of brain storming sessions in the villages
3. with the senior citizens of Sikkim.
4. Consultation of a number of Limboo Dictionaries (13 Nos.).
5. Consultation of a number of Limboo Mundhum Books; Most of the classical vernacular names were collected from Mundhum books.
6. Study of a number of Limboo Mundhum Cassettes and records. These materials are valuable resources of classical vernacular names of biodiversity. They are the resource materials of ethno-botanical and ethno-zoological descriptions and its use for various purposes.
7. Consultation of the entire Scientific Community of Sikkim, Kalimpong and Darjeeling, West Bengal, for co-relating these vernacular names with the Scientific names. I must record special mention of Dr. R.B. Bhujel, Klimpong Government College, West Bengal for Flora and Mrs Usha Lachungpa, for fauna, Bejoy Gurung for medicinal plants and S.Z.

Lucksom of Forest Department, Government of Sikkim, for orchids; Shri L.K.Rai, GP Pant institute, Sikkim, for Trees, Dr. P.Singh, BSI for flowering plants, Dr. J.P.Tamang, Government College, Tadong for micro-biodiversity and Dr. Mukhia of Government Degree College, Tadong, Sikkim, for invertibrate, Dr. Puspa Tamang, SIRD Karfectar, for fish fauna, Dr. U.C.Upadhyaya, Director, NRC Orchid, Pakyong, Sikkim for orchids.

In the process of collection and compilation of Limboo Vernacular Names, a considerable effort was made by Shri P.S.Subba, Ex-Secretary, Government of Sikkim, Shri B.B.Subba, Joint Director Education, Government of Sikkim, and Shri S.R.Subba, Additional Chief Engineer, Government of Sikkim, who were also the respected President or Executive Members of the Literary Society mentioned above during this period. Nepali vernacular names were also found essential for proper identification and were collected along with the limboo vernacular names and recorded in Devanagri Script.

The vernacular names vary from place to place, region to region and country to country and also with time as classical and colloquial vernacular names. For proper identification of any species, it is essential to tag up with the correct scientific name of the species. For this, with my Zoological or Entomological and Botanical background, and my effort to consult and take assistance of the entire scientific community of this region has yielded fruitfully. However, the scientific names also keeps changing and many of it may not be correct in the list mentioned.

Correct pronunciation of the vernacular name is possible only in the specific Script being used for that language. Hence, Nepali and Limboo vernacular names have been recorded in Devanagri and Sirijonga Scripts. The Nepali vernacular names mentioned here are by no means complete as these names were collected casually in the process of limboo vernacular name collection. This work is mainly confined to the limboo vernacular name collection and compilation.

For the international readers who know International Phonetic Alphabets (IPA), the limboo vernacular names have also been mentioned in IPA. IPA used in the text are as follows:

Vowels:

Sirijonga 𑤀 𑤁 𑤂 𑤃 𑤄 𑤅 𑤆 𑤇 𑤈

Devnagri	अ	आ	इ	उ	ए	ऐ	ओ	औ	ए
IPA	ɔ	a	i	u	e	ɔi	o	ɔu	ɛ

Consonents:

Sirijonga	𑄌	𑄍	𑄎	𑄏	𑄐	𑄑	𑄒	𑄓	,
Devnagri	क	ख	ग	घ	ङ	च	छ	ज	ऺ
IPA	k	kh	g	g^h	ŋ	c	ç	j	ʔ

Sirijonga	-	𑄕	𑄖	𑄗	𑄘	𑄙	𑄚	𑄛	𑄜
Devnagri	झ	त	थ	द	ध	न	प	फ	ब
IPA	j^h	t	t^h	d	d^h	n	p	p^h	b

Sirijonga	𑄝	𑄞	𑄟	𑄠	𑄡	𑄢	𑄣	𑄤
Devnagri	भ	म	य	र	ल	व	स	ह	:
IPA	b^h	m	y	r	l	w	s	h	:

Out of the biodiversity of the state, the text includes only those species for which the Limboo Vernacular Names have been collected and identified with scientific names so far. It is hoped that a number of species will be added in future. This work needs to be continued.

The Annexure includes the classified categories of flora and fauna of the Sikkim Himalayas as follows:

- The list comprises of about 573 species of agro-biodiversity including 17 species of cereals, 14 species of pulses, 13 species of oilseeds, 80 species of fruits, 115 species of vegetable crops, 26 species of spices and condiments, 138 species of medicinal and aromatic plants, 110 species of fodder grasses, shrubs and trees, 44 species of crop weeds and 16 species miscellaneous crops.
- 376 species of cultivated and semi-cultivated flowering and ornamental plants;

- 356 species of trees;
- 141 species of grasses, climbers and shrubs;
- 178 species of mammals;
- 410 species of birds;
- 22 species of reptiles;
- 17 species of amphibians;
- 52 species of fishes;
- 14 species of common invertebrates;
- 38 species of common insects;
- 51 species of common crop-pests and diseases; and
- 54 species of common parasites and predators of economic importance.

Besides, there are many limboo vernacular names collected but could not be identified scientifically or with other vernacular names. Many of these vernacular names may be duplication of the species as the vernacular names vary from place to place. Limboo language is very rich in classical language. A number of both classical and colloquial vernacular names have been listed for the same species. Vernacular names of many species mentioned above may have also been duplicated due to its multiple uses. Altogether about 2282 species of floral and faunal diversity of the Sikkim Himalayas has been listed with their number of Nepali and Limboo vernacular names.

From the Annexure it can be concluded that among all the biodiversity, the Limboos are most fascinated by the birds. Basically, the Limboos are hunters as such the game birds and mammals have high rate of vernacular names per species (5.97 per species in birds) in Limboo. The Limboo names of some of the birds are as many as 17 numbers which is a record in a language.

With a view to make it a little interesting for the general readers, the main work has been camouflaged with biodiversity of the Sikkim Himalayas. As a result the main work could be seen only in annexure.

ACKNOWLEDGEMENT

I am grateful to the Executive Members of "Sikhim Yakthung Sapsok Songjumbho" (Sikkim Limboo Literary Society), Gangtok Sikkim, for allowing me to use it as a platform for organizing Limboo Vernacular Name Collection Competition and for assisting me in its various ways to complete this work.

I am extremely thankful to the entire Limboo Community, Senior citizens, Government Officers, Limboo language teachers and students all age groups who took part in this collection competition and others works for assisting me in my endeavor.

I am specially thankful to the scientific community of Sikkim, Darjeeling and Kalimpong for their unconditional scientific support. Without the help of these Scientific Community this work would have not been complete. I record special thanks to Mrs Usha Lachungpa, Forest Department, Government of Sikkim and Dr. R.B.Bhujel, Kalimpong Degree College for their Scientific support.

I acknowledge my thanks to the executive members of "Kitant Yakthung Chumlung",Kathmandu Nepal and "Phadangma Songjumbho", Kathmandu Nepal for allowing me to record their live performances of Toongsing Mundhums, and providing me volumes of Mundhum cassettes. I am thankful to Shri Til Bikram Nembang (Bairagi Kainla) for providing me IPA font.

I record my sincere thanks to Shri P.S.Subba for writing befitting forward, Mr. Rabi for Typesetting and my wife Budha for forgoing family life for this work.

It is hoped that this book will be useful to the Limboo teachers, students, scholars and the entire limboo community as a whole in addition to the lovers of nature and environmentalists.

Air

- Air pollution has now become a major killer with three million people dying of it every year.
- Carbon emissions doubled in three decades. Global warming is now a serious threat. Car exhaust is a major source of the heat-trapping gases that produce global warming.
- Us carbon emissions are 16 per cent above 1990 levels making it a major polluter.

Water

- Forty per cent of world population now faces chronic shortage of fresh water for daily needs. Only 2.5 per cent of water is fresh, and only a fraction of that is accessible. In 25 years two-thirds of humanity may live in nations running short of life's elixir.
- Half the world's wetlands have been lost and one-fifth of the 10,000 freshwater species is extinct.
- Contaminated water kills around 2.2 million people every year.

Land

- Since 1990, 2.4 per cent of the world's forests have been destroyed. The rate of loss is now 90,000 sq km every year.
- Now two-thirds of the world's farmlands suffer from soil degradation.
- Half the world's grass-lands are over-grazed. India is 25 per cent short of its fodder needs.

Wildlife

- 800 species have become extinct and 11,000 more are threatened.
- Almost 75 per cent of world's marine captures is over-fished or fully utilized. In North America, 10 fish species went extinct in the 1990s.
- Of the 9,946 known bird species, 70 per cent has declined in numbers.
- Unless we guard wilderness, as many as half of all species could vanish in this century.

People

- The world added 800 million people since 1990. In 2000, global population was 6 billion, up from 2.5 billion in 1950.
- In 10 years, the world will have to feed and house another billion.
- Though it's not easy to see it from the well-fed West, a third of the world goes hungry.

Earth Summit 2002, Johannesburg

CONTENTS

Chapter - 1

Agro-Biodiversity of the Sikkim Himalayas

The world has at least 5 to 7 million different species of plants, animals, and micro-organisms, many of which have contributed to one of the most dramatic changes that has occurred on earth–the emergence of humans as the dominant species. Agriculture is the major reason for this success. During the past 10,000 years, and especially during the past century, advances in agriculture have supported ever-larger human populations enjoying higher standards of living. Agriculture have been so productive that an ever-decreasing proportion of society has been able to feed the rest, allowing more people to pursue careers in industry, medicine, science, arts, and humanities. The resulting cultural development and accumulation of knowledge has increased our ability to live at greater population densities and with higher standards of living. Thus, all of human society and most of human recorded history are intimately intertwined with and highly dependent on successes of agriculture. With the world's population at more than 5.9 billion, and with this number likely to double within the next 50 years, the future of humanity will depend even more on the way in which we manage both the agricultural/horticultural/animal husbandry enterprise and the remaining natural and semi-natural ecosystems of the world.

The essence of agriculture is the harnessing of numerous species of plants and animals for human benefit. Many of the advances in agriculture have come from the selection and development of new crops and from genetic refinements in these crops. Some major crops grown in this century were rare a century or two ago. Development of more-productive crops and the replacement of old ones have occurred for millennia. Today, 80 plant crops provide about 90% of the world's food from plants. Fifty animal species account for most domestic animal production of food and fiber. Thousands of other plant species are actively farmed, and tens of thousands of plant species are known to have edible parts. Hundreds of animal species are regularly harvested for food, and additional species are being domesticated. Hundreds of thousands of animal species, mainly insects, are essential for pollinating crops and protecting them from pests. Tens of thousands of microbial species, most of them living in soil and on plants, provide for nutrient cycling, crop residue decomposition, and enhanced crop growth. Humans always have been, presently are, and always will be dependent on the diversity of organisms to provide food for the growing human population. Humankind's agricultural successes have stemmed from its ability to use biological diversity to its advantage. However, expanding human activities are

threatening this diversity, which threatens the stability and sustainability of society.

Biodiversity

Biological diversity, or biodiversity, refers to all forms of life, including all species and genetic variants within species and all ecosystems that contain and sustain those diverse forms of life. For millennia, when threatened with drought, insect outbreak, famine, and plague, humans have drawn upon this biodiversity to develop new crops, new varieties within these crops, new farm animal resources, and new medicines. The new crops may be ones that are more droughts tolerant or disease resistant. They may be more productive on certain soil types, or especially suited to a new agricultural practice. New livestock breeds are created to fit new production environments and markets and resist disease. These genetic resources are not invented. Rather, they are discovered by trial-and-error processes and by careful searches of earth's biodiversity. The productivity and sustainability of agriculture also depend on the productivity and sustainability of soils, and on a variety of services, such as pollination of crops and provision of biological control agents, that are furnished to agriculture from nearby natural or semi-natural ecosystems.

Agro-biodiversity

Agro-biodiversity occupies a unique place within the overall ambit of biodiversity. All biotic factors related to agriculture, such as, plants, animals, fish, reptiles, insects, birds and microbes constitute directly or indirectly components of agro-biodiversity. Plant genetic diversity is the key component of agricultural production system. Without it, no natural evolutionary adjustment of the system to changing environmental and biotic conditions would be possible. The diversity of crops, cropping systems, and livestock in use worldwide is one measure of the importance of biodiversity to agriculture. These crops, livestock, and agricultural practices are the outcome of centuries of trial and error by farmers, of research on cultivation and husbandry practices, and of development of crop varieties and livestock breeds through breeding programs. This biodiversity includes different crops for different market needs. It also includes different cultivars and different mixtures of genes for pest and stress resistance, which, in turn, enable greater productivity and diversity. Although the genomes of maize, sorghum, rice, wheat, barley, oats and sugar cane, all of which are grasses, are similar, the differences among these genomes are of great value to agriculture. These differences can be preserved and used to the advantage of agriculture only if enough individuals of enough species are preserved, either as

growing crops, in specially designed seed banks. or as wild crop relatives in native grasslands or other habitats.

Diversity within each crop is essential to agriculture, as is the diversity between crops and the genetic diversity among all species on earth. Diversity within crops refers to the multitude of ancestral and domesticated forms. This diversity has two components. First are the close relatives of cultivated crops, such as the many species of wheat – einkorn, emmer, durum, spelt, goat-grass, and common wheat. Second are the different cultivated varieties of each crop, including the breeding lines that are the source of new varieties. Many of the varieties are landraces, which are locally used varieties of the crop developed by farmers for their own use. These landraces harbour most of the crop's genetic diversity. The world wheat collection, stored in dozens of national and international seed banks, includes 125,000 accessions (strains) that are held as an international service by the United States Department of Agriculture (USDA). Most of these strains are landraces. It is genetic diversity that has allowed wheat to be grown successfully around the world, allowing breeders to find varieties with genes that can overcome local problems such as novel diseases, insects, and climate. Genetic diversity has also been essential for maximizing and stabilizing the productivity of a crop in a given region. About half of the year-to-year increases in crop productivity result directly from genetic improvements – superior new crop varieties. The genes that make these varieties unique come from the existing genetic variability of crops, but genetic biotechnology now potentially allows genes to be transferred to crops from any other living species

Domestic animals of importance in the production of food, wool and leather are cow, sheep, pig, goat, chicken, duck, goose, salmon, trout, buffalo, yak, camel, reindeer, llama, alpaca, turkey, ostrich, game birds, and perhaps 30 more species. Each livestock species is represented by an array of genetic types known as breeds. Breed identify arose through regional isolation, adaptation to local stresses, genetic drift, and farmer preferences for physical or production characteristics. The FAO maintains a global listing of breeds. The FAO estimates that the total number of mammalian and avian livestock breeds is between 4,000 and 5,000, approximately equal to the known number of mammalian species As with plant crops, it is these breeds, and their wild relatives, that harbour the genetic diversity on which current and future agricultural livestock production depends. Both breeds and their wild relatives merit significantly greater conservation efforts.

Modern biotechnology has increased the value of biotechnology both within crop species and among their wild relatives because it has greatly enlarged the pool of potential sources of useful genes for crop breeding. Genes can now be moved from completely unrelated species into crop plant varieties. For example,

a gene that confers protection from insects was moved from bacteria to maize, cotton. and potatoes. Biotechnology thus has increased immensely the genetic biodiversity available to plant breeders, giving them the potential of using hereditary variation from the earth's vast biodiversity, not just from breeding stock or close relatives of crops. Because of biotechnology, biodiversity can contribute more than ever to agriculture. The ability to transfer to crops genes from unrelated species will clearly expand the productivity and long-term sustainability of agriculture and may well prove to be essential for the survival of modern agriculture. This means maintaining diversity of all forms of life should be a high social priority.

Factors controlling Agro-biodiversity

Three processes have limited or decreased the genetic diversity of crops and livestock that existed at the dawn of agriculture:

(1) Destruction of the natural, native habitats of crops, livestock, and their relatives;

(2) Domestication and ensuing development of genetically uniform crop varieties and livestock breeds;

(3) Farmer or consumer preferences for certain varieties and breeds of crops and animals.

Habitat destruction has caused extremely large losses of genetic diversity of direct value to crop and livestock production. Humans directly modify and use more than 40% of earth's terrestrial ecosystems, harnessing their productivity for human benefit and modifying their composition and, often, their very existence. Such land use practices, which are rapidly expanding, already have caused many extinctions and threaten a majority of the world's species with extinction during the coming centuries. Consumer demand also has led to loss of diversity.

Ecosystem services of agro-biodiversity

People derive a wide array of important economic and life-support benefits from biodiversity. Many of these benefits are described by the term ecosystem services, which refer to the wide range of ways that natural ecosystem, and the species they contain, produce services that sustain and fulfill human life. Ecosystem services include many critical life-support functions on which the productivity of agricultural activities depends:

(1) Purification of air and water;

(2) Mitigation of droughts and floods;

(3) Generation and preservation of soils and renewal of their fertility;

(4) Detoxification and decomposition of wastes;

(5) Pollination of crops and natural vegetation;

(6) Cycling and movement of nutrients;

(7) Control of most potential agricultural pests;

(8) Protection from harmful ultraviolet rays;

(9) Partial stabilization of the climate;

(10) Moderation of weather extremes and their impacts; and

(11) Maintenance of biodiversity.

Preservation of agro-biodiversity in germplasm collections

The genetic diversity of a species is called its germplasm. Farmers have always conserved germplasm by the act of saving seed to replant their local crop varieties, or landraces, and by maintaining breeding stock for livestock species. This is called *in situ*, or on the farm, conservation. During the 1900s, a system of specially designed seed storage facilities(seed banks) has been developed to better ensure long-term conservation of crop plant germplasm from many parts of the world. Seed bank conservation is often called *ex situ* conservation. The seed banks hold large collections of landraces and wild relatives of crop species, as well as modern crop varieties and special breeding stocks. These landraces and wild relatives preserved are utilized as sources of genetic diversity for future breeding operations.

In the 1920s, N.I.Vavilov in the Soviet Union established one of the first formally organized seed banks. The USDA began the National Plant Germplasm System (NPGS) in the 1940s with the establishment of Regional Plant Introduction Stations (Seed banks). The National Seed Storage Laboratory NSSL) in Fort Collins, Colorado opened in 1958. Soon thereafter, many other nations organized seed banks. Major national or international collections occur in the United States, China, Russia, Japan, India, Maxico, the Philippines, Peru, and other nations. Large collections now exist for wheat, rice, maize, soybean, potato, tomato, sorghum, legumes and many more of the world's grain, fruit, vegetable, fiber, forest, and industrial crops.

Much less attention has been paid to conserving the genetic diversity of livestock species, despite the importance of this genetic diversity for livestock production and its sustainability and stability. The current dependence on *in situ* conservation by hobbyists is inadequate. Formal government-sponsored

international programs for *in situ* and *ex situ* preservation of livestock genetic diversity must be established. In addition, the native habitats of the wild relatives of livestock species must be preserved.

Likewise, too little attention has been paid to conserving microbial germplasm, yet microorganisms represent an enormous genetic resource for use in agriculture.

Agro-biodiversity in India

India is endowed with rich plant wealth, having 356 domesticated species of economic importance and 326 species of their wild forms/relatives native to this subcontinent. This vast resource has formed the mainstay of agricultural and been associated economic growth of the country since centuries. These plant resources have been used either directly for cultivation or as source of useful traits for breeding improved varieties. The national plant genetic resources (PGR) activities began in 1946, first under a small unit of the Indian Agricultural Research Institute (IARI) and later expanded manifold with the establishment of an independent institute (NBPGR) of the ICAR in 1976. The Bureau has systematically organized survey and collection from all over the country, exchange of germplasm from over 80 countries and evaluation, documentation and conservation of germplasm through its Headquarters and network of 11 regional stations/base centres/quarantine stations in partnership with 30 other institutions of the ICAR and SAUs (National Active Germplasm Sites – NAGS) involved in the Indian National Plant Genetic Resources System (IN-PGRS). A sizeable germplasm collection of 1,13,360 accessions of agri-horticultural crop species and their wild relatives, medicinal and aromatic plants and other economic plants has been made through 634 explorations carried out since inception of the Bureau till March 1999. Over 1,20,000 accessions have been characterized, evaluated and are maintained at different regional stations of the Bureau. The characterization and evaluation data have been documented in 73 published crop catalogues. Since the installation of the first long-term conservation module in 1983, a total of 1,83,460 samples of different agri-horticultural crops have been conserved in the National Gene Bank at the NBPGR upto 31stMarch, 1999. The National Gene Bank facility got considerable boost in 1997 with the commissioning and operationalizing of 13 new modules, having a conservation capacity of over one million samples. Simultaneously, a cryo-bank facility with a holding capacity of a quarter million samples and in vitro repository for conservation of vegetatively propagated plants have also been established.

The agricultural biological diversity commonly referred to as the "agro-biodiversity" has been fast emerging as a strong, evolutionary, divergent line

from "biodiversity" which deals with the life forms at large. It has been specifically recognized to differentiate between concern for ecosystems versus agro-ecosystems, wild forest flora and fauna versus agriculture related plants, insects, microbes and aves; *in situ* conservation of wild forms versus on-farm conservation of landraces and traditional/primitive cultivars or *ex situ* conservation of plant genetic resources. The agro-biodiversity, although a small fraction of the total biological diversity, has an eminent role in sustaining and strengthening the food and nutritional security and health. Out of over 2,50,000 species of higher plants described and many more awaiting discovery and description, only about 3,000 are grown all over the world for human use. In fact, only 30 plant species account for most of the food calories, the major staple food crops being few, namely, rice, wheat, maize and potato etc.

Documentation of Biological Diversity

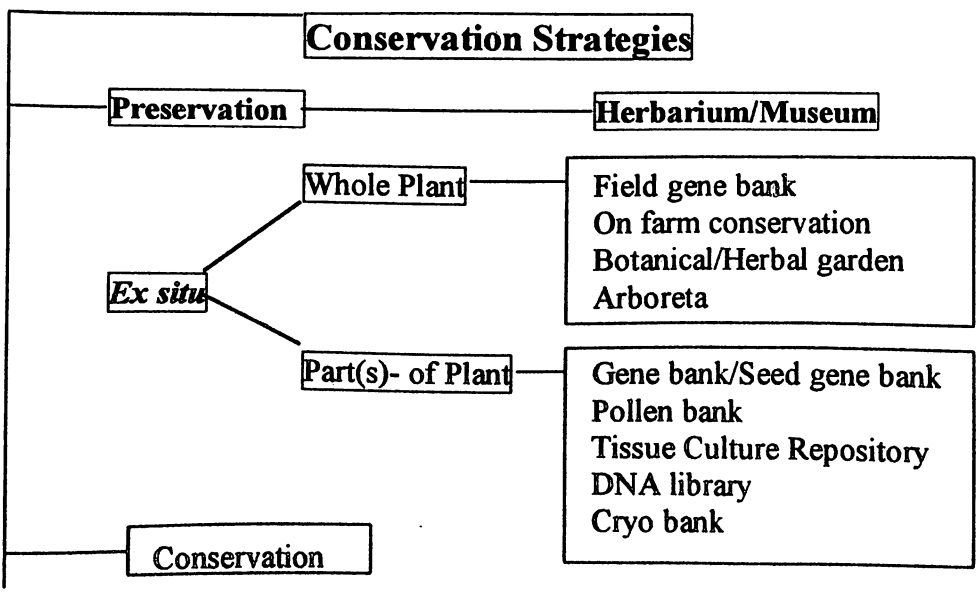
Taxa	Number of Species			Percentage	
	Sikkim	India	World	(India to the World)	(Sikkim to India)
Bacteria	Unknown	850	4,000	21.25	...
Viruses	Unknown	Unknown	4,000	....	...
Algae	Unknown	6,500	40,000	16.25	...
Fungi	Unknown	14,500	72,000	20.14	...
Lichens	Unknown	2,000	17,000	11.80	...
Bryophyta	Unknown	2,850	16,000	17.80	...
Pteridophyta	Unknown	1,100	13,000	8.46	...
Gymnosperms (ferns and Allies)	350	64	750	8.53	546.88
Angiosperms(flowering plants)	4,500	17,500	250,000	7.00	25.71
Orchids	515	1,500	25,000	6.00	34.33
Medicinal & Aromatic Plants	500	1,000	5,000	20.00	50.00
Protista	Unknown	2,577	31,290	8.24	...
Mollusca	Unknown	5,050	70,000	7.21	...
Arthropoda (Insecta, Crustacea, etc)	Unknown	60,383	1,065,000	5.67	...
Butterflies	650	1,400	17,820	7.85	46.43
Other Invertibrates (including hemichordata)	Unknown	8.329	87,121	9.56	...
Protochordata	Unknown	116	2,173	5.34	...
Pisces (Fishes)	48	2.546	21,723	11.72	1.89
Amphibia (Amphibians)	16	206	5,145	4.00	7.77
Reptilia(Reptiles)	33	485	5,680	8.54	6.80
Aves(Birds)	550	1.228	9,672	12.69	44.78
Mammalia	150	372	4,629	8.03	40.32
Total	7,312	126.656	1,719,183	7.36	5.77

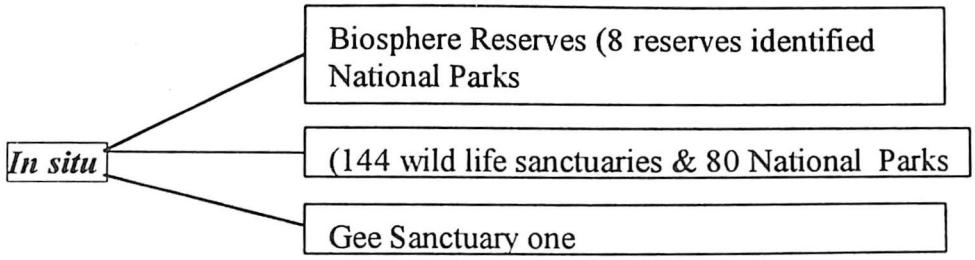
Source: UNEP-GBP (1995), MoEF (1997), ZSI and BSI, Govt. of Sikkim

Besides, having 356 domesticated species of economic importance and 326 species of their wild forms/relatives native to this subcontinent, over 9,500 other species of ethno-botanical interest are also available here. These resources have formed the mainstay of agricultural/economic growth of the country since centuries. Such plants have been used either directly for cultivation or as source of useful traits for breeding of improved varieties/strains of the cultivated species.

In order to derive appropriate benefits from plant genetic wealth, it is necessary to promote augmentation, conservation and sustainable utilization of plant genetic resources for food and agriculture. The Global Plan of Action of the Food and Agricultural Organization (FAO) of the United Nations, the Agenda 21 of the United Nations Conference on Environment and Development (UNCED) and the Convention on Biological Diversity (CBD) comprise the global principles/guiding mechanisms for conservation of biological diversity, its sustainable use and also an equitable sharing of benefits accrued from the use of biological resources.

Agro-biodiversity is recognized at three levels, viz., within species, between species and among the agro-ecosystems. The competing ability of a species and its survival in face of abiotic and biotic stresses depend largely upon the genetic variability available in its gene pool. Hence, the augmentation and conservation of gene pool diversity is of utmost importance for crop improvement. Survey and collection of plant genetic resources (PGR) including herbarium specimens is an essential pre-requisite for their conservation/use. The conservation involves *in situ* (in natural habitats) and *ex situ* (by maintaining/preserving variability away from natural habitats in gene banks/field repositories) strategies.





Source: Adopted from Khushro, 1997.

In situ conservation approach simultaneously permits continued evolutionary development under natural selection pressures, thereby promoting the fitness of the species but cannot safeguard it in the face of unforeseen natural calamities. On the other hand, *es situ* conservation minimizes the further evolutionary processes but ensures safe conservation of existing genetic variability and its sustainable use. The most common *ex-situ* conservation approach for orthodox seed species comprises their long-term preservation in seed gene banks at –20 ^{0}C. Other approaches, namely, cryo-preservation (conserving the samples of seeds, including recalcitrant seeds, embryos, embryonic axes and pollen grains in liquid nitrogen at – 196 ^{0}C), in vitro conservation (by using tissue culture techniques for preservation of clonally propagated materials) and field repositories for tree/vegetatively propagated species are also adopted depending upon the characteristics of the species. Now, conservation of DNA fragments in DNA Banks is also attracting attention.

Sustainable use of conserved genetic resources can be effectively regulated by appropriate documentation and information management. Although the international/ national gene banks holdings have often reported by the FAO, the International Plant Genetic Resources Institute (IPGRI) and the System Genetic Resources Programme of the Commonwealth Group Centres (SGRP) has computerized the data to a considerable extent, yet such information bas(s) are by far inadequate. A lot more is required to be done in terms of planning and standardization of database globally and, in particular, for the National Gene Banks.

Indian subcontinent is one of the 12 mega biodiversity centres and represents two of the eight Vavilovian centres of origin and diversity of crop plants. Two "hot spots" of biological diversity also occur in India, one in the western ghats and the other in the north-eastern Himalayas. More than 20 crops have originated here out of 356 domesticated/native species of economic importance. These along with 326 species of their wild forms and close relatives as well as 9,500 species of ethno-botanical interest constitute an invaluable reservoir of genes as follows:

The Indian Gene Centre

- 1,27,000 species of plants, animals and microbes: 4,00,000 species yet to be identified;
- 17,500 Species of higher plants;
- About 33% of the prevalent species are endemic:
- 356 major and minor crop plant species;
- 326 wild related species of crop plants;
- 25 major and minor crop plant species domesticated;
- 15,000 wild edible plant species, including,
  - 145 species of roots and tubers;
  - 521 species of leafy vegetables/greens;
  - 101 species of bulbs and flowers;
  - 647 species of fruits;
  - 118 species of seeds and nuts;
- 9,500 plant species of ethno-botanical importance, including 3,900 for edible purposes used by native tribals;
- 7,500 for ethno-medicinal purposes;
- 4,000 endogamous communities, representing one billion population and variety or traditions and life-styles.

The diversity in crop species genepools exhibits preponderance of variable landraces/primitive types in the eight diverse phyto-geographical/agro-ecological regions of the country. Crops in which rich diversity occurs include, rice, wheat, barley, pigeon pea, chickpea, mung-bean, urd-bean, small millet, horse-gram, moth-bean, rice-bean, cluster-bean, amaranth, buckwheat, rapeseed-mustard, sesame, sugarcane, forage grasses, okra, eggplant, cucumber and melons, parval, citrus, banana and plantain, jack fruit, mango, tamarind, jamun, jute, cotton, ginger, turmeric, pepper, cinnamon, cardamom etc. Among tuberous crops rich variability exists in sweet-potato, taros and yams. Native resources are available in orchids, Coleus species, sword-bean, velvet-bean and plantation crops including areca-nut and coconut. Diversity also occurs in several minor fruits such as ber, berries and nuts. India is well known for its medicinal and aromatic plants. The wild species and putative ancestral forms of plants may contain

valuable genes of immense genetic value in crop breeding programmes for exploitation through conventional and modern biotechnological tools/techniques.

Concentration of genetic diversity comprising native species and landraces occurs more in tribal pockets and is the result of ecological diversity suprimposed with ethnic diversity, plant usage and rituals. These valuable resources are becoming increasingly threatened because of the continued habitat degradation and due to the rapid replacement of locally adapted indigenous cultivars by modern high yielding varieties. The fast shrinking genetic diversity of the commercially grown crops renders them increasingly vulnerable to widespread epidemics and pest rampage. Hence, duly realizing that a scientific management of these valuable resources is of prime importance today, survey/exploration, collection, characterization and evaluation, conservation and management of PGR of various agri-horti-silvi-pastoral crops and other economic plant species for their sustainable use has been proposed, under the National Agricultural Technology Project (NATP), through a mission mode approach and in partnership with different categories of stakeholders along with prioritization of the activities to be undertaken.

The Indian Council of Agricultural Research (ICAR) leads the National Agricultural Research System (NARS) spearheading and coordinating all activities relating to agricultural research and education. Ever since its inception on 16 July, 1929, the Council has safeguarded and promoted the country's interests on PGR collection, introduction/exchange, conservation and use. The NBPGR is the nodal organization spearheading the PGR activities in the country, including planning, conducting, coordinating and promoting collection, introduction, exchange, evaluation, documentation, conservation and management of genetic resources of crop plants and their wild relatives with a view to ensure their continued availability for sustainable use.

Since 1991, the NBPGR has been operating the Indian National Plant Genetic Resources System (IN-PGRS) in collaboration with over 30 other institutes/centres of the ICAR and state agricultural universities which function as the National Active Germplasm Sites (NAGS) and co-operate in maintenance of active/working collections and their medium term conservation as follows:

National Active Germplasm Sites and Their Germplasm Holdings:

NAG Site	Crops	No. of accessions
Directorate of Wheat Research (DWR), Karnal	Wheat	18,000
Central Rice Research Institute (CRRI), Cuttack	Rice	42,000
Directorate of Maize Research, IARI, New Delhi	Maize	2,500
Directorate of Wheat Research (DWR), Karnal	Barley	11,030
National Research Centre (NRC), Srghum, Rajendra Nagar, Hyderabad	Sorghum	5,160
All India Coordinated Pearl Millet Improvement Project (AICRPSM), Pune, Maharastra	Small Millets	8,572
Indian Institute of Pulses Research (IIPR), Kanpur	Pulses	9,310
National Research Centre (NRC) for Soybean, Indore	Soybean	2,500
Directorate of Oilseeds Research (DOR), Rajendranagar, Hyderabad	Oilseeds	15,629
National Research Centre (NRC), Rapeseed and Mustard, Bharatpur, Rajesthan	Rapeseed & Mustard	8,082
National Research Centre (NRC) for Groundnut, Timbawadi, Junagarh	Groundnut	6,432
Sugarcane Breeding Institute (SBI), Coimbatore	Sugarcane	3,979
Cetral Institute of Cotton Research (CICR), Nagpur	Cotton	6,896
Central Research Institute of Jute & allied Fibres (CRIJA&F), Barrackpore	Jute & Allied	3,226
Indian Institute of Vegetable Research (IIVR), Vanarasi	Vegetables	16,139
Central Potato Research Institute (CPRI), Shimla	Potato	2,375
Indian Grassland & Fodder Research Institute (IGFRI), Jhansi	Forages	6,267
Indian Institute of Spices Research (IISR), Marikunnu, Kozhikode, Kerala	Spices	2,847
Central Tobacco Research Institute (CTRI), Rajahmundy	Tobacco	1,500
Central Plantation Crops Research Institute (CPCRI), Kasaragod	Plantation Crops	307
National Research Centre (NRC) on Medicinal & Aromatic Plants, Boriavi, Anand, Gujrat	Medicinal & Aromatic Plants	375
National Research Centre (NRC) for Agro-Forestry, Jhansi	Agro-Forestry	40
National Research Centre (NRC) on Arid Horticulture, Bikaner, Rajasthan	Fruits(Arid)	541

NBPGR Regional Station, Phagli, Shimla	Fruits(Temp.)	454
National Research Centre (NRC) for Citrus, Nagpur	Citrua	51
Indian Institute of Horticultural Research (IIHR). Banglore	Fruits	13,118
Central Institute of Subtropical Horticulture (CISH). Lucknow, U.P.	Fruits	587
Central Tuber Crops Research Institute (CTCRI). Sreekariyam, Kerala	Tuber Crops	3,586
NBPGR Regional Station, Phagli, Simla	Pseudo-cereals	3,682

Source: Vision – 2020:NBPGR

The NBPGR also acts as single window for safe germplasm exchange for research purposes in the country.

For the purpose of exploration and collection, the country has been divided into 10 collection zones. These zones have been further divided into 39 sub-zones for operational feasibility as follows:

Zones/Sub-Zones	**Phyto-geographic Regions**
Zone I: Arid region	
1. Western Plains, parts of Kathiawar peninsula, hot arid region	NBPGR RS (Jodhpur);NRC (AH); DC(Bikaner);RAU(Bikaner)
2. North Western Gujarat plains, hot arid region	NRC(G) (Junagarh)
3. Central, Eastern and Southern Rajasthan including Aravali region	GAU (SK Nagar); SPU(Gujarat)
4. South Kutchh and North Kathiawar, western Malwa plateau	NRC (M & AP) (Anand)
5. Malwa region	
Zone II : South-west coastal region and A&N and Lakshadweep Islands	
6. Andaman & Nicobar Islands, Lashadweep hot humid to per humid	CARI Port Blair
7. Western ghats, coastal plains, hot humid region	KAU (Trissur);MSSRF(Madrass); NBPGR RS(Trissur);
8. Karnataka pleateau,	AICSMIP (Bangalore); IIHR

hot moist semi-arid region	(Bangalore); UAS(Dharwad)
9. Western coastal region	CPCRI(Kasargod); IISR(Calicut)
10. South east coastal plains, hot humid to semi-arid region	BU(Trichi); NRC(Banana) (Trichi)
11. Central and North Tamilnadu uplands	TNAU(Coimbatore);SBI (Coim.) SB(Iduki)
Zone III: Humid moist tropical east coastal region	
12. Chhatishgarh/Mahanadi basin, eastern plateau	BCKVV(Kalyani)
13. Dandkaranya and eastern ghats, hot humid/sub-humid region	NBPGRRS(Cuttack); CRRI (Cuttack); CRIJAF(Barakpore); BI(Calcutta); OUAT(Bhubaneswar)
14. Eastern ghats, hot moist sub-humid region	
Zone IV: North-eastern region	
15. Sikkim Himalayas and Darjeeling Hills	NRC(Orchids), Sikkim
16. Middle Bhramputra plains and Meghalaya plateau region	NBPGR RS Shillong; NEH Shillong;AAU(Jorhat); AU Silchur
17. Arunachal Pradesh, warm to hot per humid region	NERIST (A.P.)
18. North eastern hills of Manipur, Tripura, Nagaland, warm per-humid region	
Zone V: Central Himalayan region	
19. Kumaon and garhwal hills of western himalayas, warm sub-humid region	NBPGR RS(Bhowali); VPKAS(Almora); GBPIHED (Almora)
20. Submountain region of Kumoan and Garhwal	DARL(Pithoragarh)
21. Mountain and alpine region of Kumaon	

and Garhwal hills	
22. Tarai and Foot hills	BSI(Dehradun)
Zone VI: North west Sub-Himalayan and High altitude Himalayan region	
23. West Himalayas, cold arid and warm sub-humid region (J&K hills&Plains)	CITH (Srinagar); SKUAT(Srinagar)
24. Leh/Ladakh/Lahul & Spiti region of H.P.	FRL(Leh);
25. Mandi/Kullu & Manali region	
26. Shimla & Chamba region	NBPGR RS(Shilma); CPRI (Shimla); IARI RS (Shimla);;YSPAUF(Solan); HPKVV(Palampur)
Zone VI: North –west Plains	
27. Plains of Punjab and Hariyana, hot semi-arid region	NBPGR(N. Delhi); IARI(N.Delhi) AICRP(UUC);DWR(Karnal); TERI(N.Delhi); PAU(Ludhiyana)
28. Ganga Yamuna doab and Awadh plains, hot moist semi-arid region	NRC-RM(Bharatpur); NBRI(Luck.) NDUA&T(Faisabad); CISH(Luck.) RBS College (Agra)
29. Madhya Bharat Plateau, Bundelkhand upland, hot semi-arid region	NRC-AF(jhansi); IIPR(Kanpur); CIVR(Vanarasi);BHU(Vanarasi) IGFRI(Jhansi)
30. Western U.P. plains	
Zone VIII: Sub-tropical/sub-humid region	
31. Easternplateau (Chota Nagpur), hot sub-humid region	NBPGR RS(Ranchi);BU(Bhagalpur) RAU(Pusa)
Zone IX: Central Indian region	
32. Western Maharastra, hot dry semi-arid region	

33. Eastern Maharastra plateau, hot moist semi-arid region	JNKVV(Jabalpur); IGAU(Raipur)
34. Northern Maharastra region, hot semi-arid region of M.P.	NBPGRRS(Akola); CICR(Nagpur) NRCC(Nagpur);JNKVV(Gwalior) JNKVV(Morena)
35. Southern Maharastra, Konkan, sub-humid region	KKV(Dapoli)
Zone X: South-east coastal region	
36. Coastal Andra Pradesh, eastern ghats (south), hot moist semi-arid region	AU(Vishakhapatnam)
37. Telangana region	
38. Rayalseema region	NBPGRRS(Hyderabad); DOR(Hyd.) DRR(Hydr.); NRCS(Hyderabad)
39. Baster and Chhatisgarh region	

Source: Jai Vigyan National Science & Technology Mission, NBPGR 1999

Biodiversity in the Sikkim Himalayas

In the absence of University/Basic Research Institute in the State of Sikkim, the rich resources of its biodiversity of the state is endangered. The rich biodiversity of Sikkim such as Bacteria, Virus, Algae, Fungi, Lichens, Bryophyta, Protista, Mullusca, Arthropoda, Other Invertibrates and Protochorda have not been studied so far. Only a superficial study of Gymnosperms (ferns and allied), Angiosperms (flowering plants), Orchids, Medicinal and Aromatic plants, Butterflies, Pisces (Fishes), Amphibia (Amphibians), Reptiles, Aves (Birds) and Mammals studied so far, reveals the presence of enormous wealth of biodiversity in Sikkim. For instance, 350 species of Gymnosperms have been reported from Sikkim against the report of only 64 species in the country; 25.71% of Angiosperms, 34.33% of Orchids, 50% of Medicinal and Aromatic plants, 46.43% of Butterflies, 1.89% of Pisces, 7.77% of Amphibians, 6.80% of Reptiles, 44.78% Aves(Birds), 40.32% of Mammals constituting, about 5.77% of total biodiversity of the country in the geographical area representing only 0.22% of the country. There is an urgent need to establish a multidiscipline full fledge University in Sikkim to initiate study of the rich and vulnerable biodiversity of Sikkim, which otherwise many of the endangered biodiversity is vanishing day by day. Detail study of each valuable species and arrangement to establish both *In situ* and *Ex situ* Conservation Centres is the **Most Urgent Task of the State Government today**. If this is neglected today, the future generation will never forgive us (Intellectuals, Planners and the Government).

Agro-biodiversity

There is an enormous richness in agro-biodiversity in Sikkim. There is a rich agro-biodiversity on paddy which can be grown right from foot hills to the alpine area like Tsungthang, North Sikkim. For instance, the landraces adopted at different agro-climatic regions of Sikkim could be mentioned as follows:

Rice: Attey, Marshi, Bhuindhan, Taprey, Tsungthangey, Sikrey, Kalchanti, Krishnabhog, Lal Bachi and many others.

Maize: Sikkim is one of the centres of maize origin and is very rich in agro-biodiversity. The landraces available here could be mentioned as Murali Makai, Farashi, Kali, Rati, Panhenli, Adequaba, Pangri, Seti, Himali etc.

Wheat: Similarly, landraces of Wheat are Tho, Mashi, Si, Toksongsi, etc.;

Barley: Landraces of Barley are Hoksi, Tingsi, etc.;

Finger millet: Land races of Finger millet are Nangkatuwa, Murkey, Bhadaurey, Pangdur, Tangsere, Panchaunle, Kartikey, Mangsire etc.;

Buckwheat: Landraces of Buckwheat could be mentioned as Mithey, Kere, Tite, Yapha, Tambhung Kere, etc.

Horse Gram: The landraces of pulses such as Horse gram are Gahat;

Bean: The landraces of beans are Ghew Simi, Singtamey, Harey,;

Soybean : Napali, Kali Bhatmash, Seti Bhatmas, : The Limboo Mundhum records that soybean is the first crop domesticated by the human beings while starting settled cultivation on earth. Since, there were no other crops for variety, the primitive man ate it in a variety of ways resulting the product as Kenima.

Ricebean: Masyam, Pangri Masyem, ;

Mung Dal: Pahenli, Kali, Seti, ;

Pea: Dentamey, Damthangey etc.;

Oildeeds: **Rape and Mustard** – Kalo Tori, Seto Tori, Pahenlo Tori, ;

Leafy Mustard – Phoppa rayo, Rayo, Chringla Rayo, Chille Rayo, Chinese cabbage etc.

Vegetables: Similarly, there are enormous landraces of Vegetable crops; to mention a few in radish – Lachungey Mula, Seti Mula, Rati Mula, Hattipailey Mula etc.

Nakima: Lekh Nakima, Aul Nakima, Thulo Nakima, Sano Nakima etc;

Potato: Rato Alu, Seto Alu, Bomboy Alu, Sanu Alu, Thulo Alu, Hilley Alu, Uttarey Alu, Lachungey Alu, Sangdorjee,;

Sweet Potato: Seto Sakarkhanda, Rato Sakarkhanda,;

Tapioca: Seto Simaltarul, Rato Simaltarul;

Yams: Ghartarul, Bantarul, Patalle, Wakhey, Su, Logo, etc.

Fruits: Sikkim has very rich agro-biodiversity on fruit crops such as orange, banana, guava, avocado, kiwi (Thekiphal), Passion fruits, Peach, Plum, Pear etc.

Spices: On spice crops ginger landraces such as Bhaisey, Gorubathaney, Jorthangey, Majhauley, Mango-ginger and many such types;

Lange cardamom : Ramsai, Golsai, Ramla, Bharlangey. Seremna etc are all land races of this crop.

Turmeric: Similarly, Rao Haldi, Pahenlo Haldi are the land races of turmeric.

Cucumber: Land races of Cucumber such as Bhadaure. Asare, Mangsire;

Pumpkin: Landraces of pumpkin Kalo pharsi. Seto Pharsi, Thulo Pharsi etc.

There is no relevance to mention all the landraces of each and every crop in this chapter. The most important point is that, these landraces are endangered due to continuous introduction, multiplication and cultivation of improved and higher yielding varieties of these crops. DNA finger printing, *Ex situ* and *In situ* conservation measures of all these landraces of these crops of Sikkim is yet to be done.

The native crop cultivars are the landraces which have been in cultivation since time immemorial. These landraces had supported the food-needs over a long period of time, and many such landraces are under cultivation, meeting the food-need of the people of Sikkim. Such indigenous landraces have been well adjusted to the ecological conditions. Now, with the introduction of many improved varieties of agricultural and horticultural crops, many such landraces have been replaced completely. The Sikkim Primitive Maize (Murali Makai), a popcorn type with highly prolific in cob-bearing and with immense breeding value, has been more or less extinct. In the same manner the Darjeeling Red Round potato grown extensively in Sikkim has now been replaced by other varieties, though the landrace has very good taste and good yielding capacity. These landraces need to be identified with DNA finger printing, protected under plant property right act, and conserved in germplasm conservation seed banks for use in posterity. Sikkim needs to set up both *in situ* and *ex situ* conservation infra-structures to conserve and protect its vast resources of agri-horti-livestock biodiversity.

The history of the mankind is closely linked with the history of animals. The mankind lived by hunting wild animals and gathering wild crops. The domestication of animals began only 10,000 years ago. There were more than 40,000 species of vertebrates and only 40 were selected by mankind for their use and these are the ancestors of animals that we see today. Today domestic animals account for 19 per cent of the world's food directly as meat, milk and blood. Conservation of Siri cattle, yak, banpala and gharpala breed of sheep *in situ* in the native habitat and in cryogenic sperm or DNA storage as *ex situ* is very essential in Sikkim.

The Bee landraces such as Ghar mauri (*Apis cerena indica*), Bhir mauri (*Apis dorsata*), Little bee (Putka), Dammer bee (Khateuri) need proper identification and both *in situ* and *ex situ* conservation.

Conclusion

In the absence of University/Basic Research Institute in Sikkim, the rich resources of its biodiversity of the state is endangered. The rich biodiversity of Sikkim such as Bacteria, Virus, Algae, Fungi, Lichens, Bryophyta, Protista, Mullusca, Arthropoda, Other Invertibrates and Protochorda have not been studied so far. Only a superficial study of Gymnosperms (ferns and allied), Angiosperms (flowering plants), Orchids, Medicinal and Aromatic plants, Butterflies, Pisces (Fishes), Amphibia (Amphibians), Reptiles, Aves (Birds) and Mammals studied so far reveals the presence of enormous wealth of biodiversity in Sikkim. For instance, 350 species of Gymnosperms have been reported from Sikkim against the report of only 64 species in the country; 25.71% of Angiosperms, 34.33% of Orchids, 40% of Medicinal and Aromatic plants, 46.43% of Butterflies, 1.89% of Pisces, 7.77% of Amphibians, 6.80% of Reptiles, 44.78% Aves(Birds), 40.32% of Mammals, constituting about 5.69% of biodiversity of the country in the geographical area representing only 0.22% of the country. There is an urgent need to establish a multidiscipline full fledge University in Sikkim to initiate the study of the rich and vulnerable biodiversity of Sikkim. DNA finger printing and *Ex situ* and *In situ* conservation measures of all these landraces of the crops of Sikkim is of paramount importance which is yet to be done in Sikkim. Detail study of each valuable species and arrangement to establish both *In situ* and *Ex situ* Conservation Centres in Sikkim is the **Most Urgent Task of the State Government today**. If this is neglected today, the future generation will never forgive us (Intellectuals, Planners and the Government).