

THE STATE  
OF THE WORLD'S  
**FOREST GENETIC RESOURCES**  
**COUNTRY REPORT**

**BHUTAN**

This country report is prepared as a contribution to the FAO publication, The Report on the State of the World's Forest Genetic Resources. The content and the structure are in accordance with the recommendations and guidelines given by FAO in the document Guidelines for Preparation of Country Reports for the State of the World's Forest Genetic Resources (2010). These guidelines set out recommendations for the objective, scope and structure of the country reports. Countries were requested to consider the current state of knowledge of forest genetic diversity, including:

- Between and within species diversity
- List of priority species; their roles and values and importance
- List of threatened/endangered species
- Threats, opportunities and challenges for the conservation, use and development of forest genetic resources

These reports were submitted to FAO as official government documents. The report is presented on [www.fao.org/documents](http://www.fao.org/documents) as supportive and contextual information to be used in conjunction with other documentation on world forest genetic resources.

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Department of Forests and Park Services  
Ministry of Agriculture and Forests  
Royal Government of Bhutan



# State of Forest Genetic Resources of Bhutan

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Country Report

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## Acronyms

BAFRA	Bhutan Agriculture and Food Regulatory Authority
BAP	Biodiversity Action Plan
BBPL	Bhutan Board Products Limited
CORRB	Council of Renewable Resources of Bhutan
DAMC	Department of Agriculture Marketing and Co-operatives
DOA	Department of Agriculture
DOFPS	Department of Forests and Park Services
FGR	Forest Genetic Resources
FMU	Forest Management Unit
FPED	Forest protection and enforcement Division
FRMD	Forest Resources Management Division
GNH	Gross National Happiness
IAPS	Invasive Alien Plant species
ITMS	Indigenous Traditional Medicine Institute
IUCN	International Union of Nature Conservation
MASL	Meter above sea level
MOAF	Ministry of Agriculture and Forests
NRDCL	Natural Resources Development Corporation Limited
NRED	Nature Recreation and Ecotourism Division
NSSC	National Soil Service Centre
NWFP	Non wood Forest Products
PAS	Protected Area system
PHC	Population and Housing Census
RGOB	Royal Government of Bhutan
RNR RDC	Renewable Natural Resources Research and Development Centre
SFED	Social Forestry and Extension Division
TCCL	Tashi Commercial Corporation limited
WCD	Wildlife Conservation Division
WMD	Watershed Management Division

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## 1. Introduction

The term Genetic Resources Conservation refers to the conservation of species, populations, individuals or parts of individuals, by *in-situ* or *ex-situ* conservation methods, basically to provide a diversity of genetic materials for present and future generations. ‘Genetic resources’ implies that elements of genetic variability of the trees and other plants and animals will be used to meet the human needs and objectives (FAO). The genetic resources may be used for immediate needs or future planned programs.

The forests are the world’s most valuable renewable natural resource and also storehouse of terrestrial biological diversity and ecosystem integrity. They are the store houses to meet the future requirements under changing climatic conditions and human preferences. The sustained ability of this storehouse to provide goods and services depends how best conservation and management of forest genetic resources (FGR) are put in place. It is well documented that genetic variation is crucial for species to evolve and adapt to changing environmental conditions. In order to draw effective conservation strategies of FGR, collection and documentation of some critical information such as the status, threats and distribution of forest genetic diversity are very crucial.

Bhutan straddles two major biogeographic realms, the Indo-Malayan and Palearctic and is part of the Himalayan biodiversity hotspot with a diverse array of flora and fauna including 5603 species of vascular plants, 400 lichens, 200 mammals and about 700 birds. It has an extensive network of rivers due to the high level of precipitation, numerous glaciers and glacial lakes and well-preserved forests resulting in upstream and downstream benefits such as water and other ecosystem services (BAP, 2009). The total area under forests is 70.46 percent and 51.32 percent of the country is secured as protected areas and biological corridors. These are not only rich reservoirs of biodiversity but have indirectly served as long-term stores of carbon which mitigate the adverse impacts of climate change. The protected areas system of Bhutan is regarded as one of the most comprehensive in the world. It encompasses a continuum of representational samples of all major ecosystems found in the country, ranging from the tropical/sub-tropical grasslands and forests in the southern foothills through temperate forests in the central mountains and valleys to alpine meadows in the northern mountains (NEC, 2009).

Bhutan is fortunate to have emerged virtually unscathed in the twenty first century in terms of its biological wealth. This is due to the far-sighted vision and leadership of our Kings and our rich tradition of living in harmony with nature throughout the centuries. The Constitution of the Kingdom of Bhutan also mandates the maintenance of a minimum forest cover of 60 percent for perpetuity. In an era where economic goals and developmental needs far outweigh conservation needs, Bhutan firmly perseveres on the development philosophy of Gross National Happiness which categorically states environmental conservation as one of the four pillars of Gross National Happiness ( Biodiversity Persistence and Climate change paper, 2012) and that “*development must be pursued within the limits of the environmental sustainability and carried out without impairing the biological productivity and diversity of the natural environment*” (Vision 2020). This effectively ensures that development is never achieved at the cost of the environment. Most

recently, Bhutan committed to remain carbon neutral during the United Nations Climate Change Conference, COP 15 at Copenhagen. Bhutan emits approximately 1.5 million tons of carbon annually, and its forests absorb approximately 6.3 million tons, leaving it with a carbon emission of -4.7 million tons, distinguishing it as one of the few countries in the world with negative carbon emissions. ([Biodiversity Persistence and Climate change paper, 2012](#)).

## 2. The current status of forest genetic resources in Bhutan

The existing survey recorded for Bhutan shows that there are 4,523 flowering plants species contained in 1,416 genera and 266 families ([Dorji, 2010](#)), of which 94.5 % are said to be native species. The flora records of Bhutan reported 22 species of Gymnosperms contained in 15 genera and in eight families (Table 2-1).

**Table 2-1: Number of taxa of seed plants in Bhutan by major group (Dorji, Y., 2010)**

Group	Family	Genera	Species		Total species	% share
			Native	Exotic		
Gymnosperms	8	15	19	4	22	0.48
Angiosperms	218	1,401	4,257	243	4,501	99.52
<b>Total</b>	<b>226</b>	<b>1,416</b>	<b>4,276</b>	<b>247</b>	<b>4,523</b>	<b>100.00</b>
Dicotyledon	177	1,072	3,109	177	3,287	73.02
Monocotyledons	41	329	1,148	66	1,214	26.98
<b>Total</b>	<b>218</b>	<b>1,401</b>	<b>4,257</b>	<b>243</b>	<b>4,501</b>	<b>100.00</b>

**Table 2-2: Number of plants species categories of Bhutan by IUCN classification system (Dorji, 2010).**

Sl No	Categories of plant species	Number of species	Percent
1	Possibly extinct in the wild	1	0.02
2	Critically endangered	6	0.11
3	Endangered	7	0.13
4	Vulnerable	3	0.07
5	Near threatened	52	1.24
6	Not evaluated	514	11.28
7	Data deficit	988	21.87
8	Least Concerned	2952	65.29
<b>Total</b>		<b>4523</b>	<b>100.00</b>

According to red data list the flowering plants of Bhutan (Dorji, 2010), no imminent threat to the FGRs was observed in the country. Less than 2% of the total flora was under threats

categories (Table 2-2). Nevertheless, 33 % of the plant species do not have sufficient data (Table 2-2) out of which 11% were not even evaluated, even those listed as least concerns may contain species under threats categories. The Orchidaceous family had the highest number of recorded species (440), followed by Graminae (331 species including exotic) (Table 2-5), it is the most genus rich family recorded so far in the country (Table 2-3). The genus rich families, species rich genera and species rich families are shown in Tables 2-3, 2-4 and 2-5 respectively.

**Table 2-3: The most genus rich families in the Bhutanese flora**

Family	No. of species	No. of Genus	Family	No. of species	No. of Genus
Graminae	331	112	Acanthaceae	68	24
Compositae	276	107	Ranunculaceae	99	22
Orchidaceae	440	99	Cucurbitaceae	31	22
Leguminoceae	216	78	Apocynaceae	24	18
Rubiaceae	95	44	Asclepiadiaceae	40	17
Labiatae	90	39	Solanaceae	34	17
Umbelliferae	83	38	Cyperaceae	148	16
Scrophulariaceae	139	32	Urticaceae	75	16
Euphorbiaceae	82	28	Lauraceae	55	14
Cruciferae	77	28	Boringaceae	41	14
Rosaceae	146	25	Verbenaceae	34	14

**Table 2-4: The most species rich genera in Bhutanese flora**

Family	Genus	No. of species	Family	Genus	No. of species
Primulaceae	Primula	66	Moraceae	Ficus	31
Cypreaceae	Carex	66	Rosaceae	Potentilla	28
Scrophulariaceae	Pedicularis	65	Orchidaceae	Dendrobium	28
Saxifragaceae	Saxifrage	62	Compositae	Saussurea	28
Ericaceae	Rhododendron	52	Acanthaceae	Strobilanthes	27
Orchidaceae	Bulbophyllum	41	Balsaminaceae	Impatiens	26
Gentianaceae	Gentian	41	Urticaceae	Elatostema	26
Fumariceae	Corydalis	36	Leguminosae	Desmodium	24
Rosaceae	Rubus	35	Polygonaceae	Persicaria	22
Juncaceae	Juncus	34	Cyperaceae	Cyperus	20

**Table 2-5: The most species rich families of Bhutanese flora according to provenance.**

Family	Number of species		Family	Number of species	
	Native	Exotic		Native	Exotic
Orchidaceae	440	na	Primulaceae	88	
Graminae	288	43	Ericaceae	87	
Compositae	244	32	Umbelliferae	79	4
Leguminaceae	190	26	Gentianaceae	84	0
Cyperaceae	148	0	Cruciferae	79	1
Rosaceae	141	5	Urticaceae	75	0
Scrophulariaceae	135	4	Saxifragaceae	74	0
Ranunculaceae	99	1	Euphorbiaceae	70	12
Rubiaceae	93	2	Acanthaceae	68	0
Labiatae	88	2	Polygonaceae	60	

## 2.1 Endemism of Bhutan Forest Genetic Resources

The endemism refers to that taxon whose entire global native ranges lies within Bhutan. There are 37 families with one endemic species of plants, the highest number of endemic plant species (26 species) were recorded in Scrophulariaceae family, mostly recorded in Pedicularis genus (20 species). The Orchidaceae and Primulaceae have 14 and 11 endemic species each. There are 52 species which may be called regional /near endemic.

In the eastern Himalayas, 353 new species are being discovered between 1998 and 2008, with the average of 35 new species discovery for the last 10 years. The discovery includes, 242 plants, 16 amphibians, 16 reptiles, 14 fish, 2 birds and 2 mammals and 61 new invertebrates, out of which 13 plant species, one amphibian, 6 invertebrates were recorded from Bhutan ([www.wwf.se](http://www.wwf.se)). It clearly shows possibility of finding new species of flora unknown to science in country in future.

## 2.2 Exotic and invasive plant species

Although no comprehensive and systematic study of exotic plant recordings were done for Bhutan. A publication (Dorji, 2010) reported 247 species of exotic plants in Bhutan, which accounts for about 5.6% of the total recorded plant species in the country. These exotics are common in pastures, roadsides and human settlement areas. The highest numbers of exotic species are from Graminae family with 43 species, followed by compositae (32 species), Leguminaceae (26 species), Solanaceae (13 species) and Euphorbiaceae (12 species). For decades biological invasions and its spread had been recognized as one of the biggest threats to the world's biodiversity (Wilcove et al, 1986, Coblenz, 1990, Mooney and Hobbs, 2000, Yates et al, 2003, GISP 2004). In Bhutan, too the invasive plant species are said to be posing problems relating to agriculture, human and animals' health and invasion of forests land.

In a study conducted by national biodiversity centre (NBC, 2009) showed that exotic plants included ornamental plants, fodder species, agricultural crops, fruits and vegetables available in the country exceeded 300 species. Some 14 species were found to be invasive. In addition, 34 plant species were known to be invasive which are naturalized in the country. The 14 species included were *Mikania micrantha*, *Chomolaena odoratum*, *Ageratina adenophora*, *Lantana camara*, *Opuntia vulgaris*, *Parthenium hysterophorus*, *Tithonia diversifolia*, *Robinia pseudoacacia*, *Cannabis sativa*, *Leucaena leucocephala*, *Eichhornia crassipes*, *Ageratum conyzoides*, *Pennisetum clandestinum* and *Trifolium repens*. A recently conducted study along the roadside extending from tropical to temperate regions (Dukpa, 2012) reported the alien plant species constituting 34 species out of 216 total species recorded in the study, a total of 30 species (14% of the total species recorded) were invasive alien plant species. The study also found *Ageratina adenophora*, *Mikania micrantha*, *Chromalaena odorata*, *Ageratum conyzoides*, *Saccharum spontaneum*, *Crassocephalum crepidoides*, *Laportea dioica*, *Paederia foetida*, *Poa annua*, *Sida rhombifolia*, *Alternanthera sessilis*, and *Solanum torvum* were the most common species and constituted more than 90% of the exotic species in subtropical region. In another study of invasive plant in the temperate region (Tshering C. 2012) it was reported out of 237 plant species recorded 44 were exotic plant species out of which 36 species were invasive alien plant species (IAPS). The study also showed 79% of IAPS were herbs; others were shrubs, climbers, grasses and ferns. A simple template of the temperate region from the study was developed (Figure 1) which showed that most of the IAPS were concentrated in human settlement areas and IAPS decreased as altitude increased.

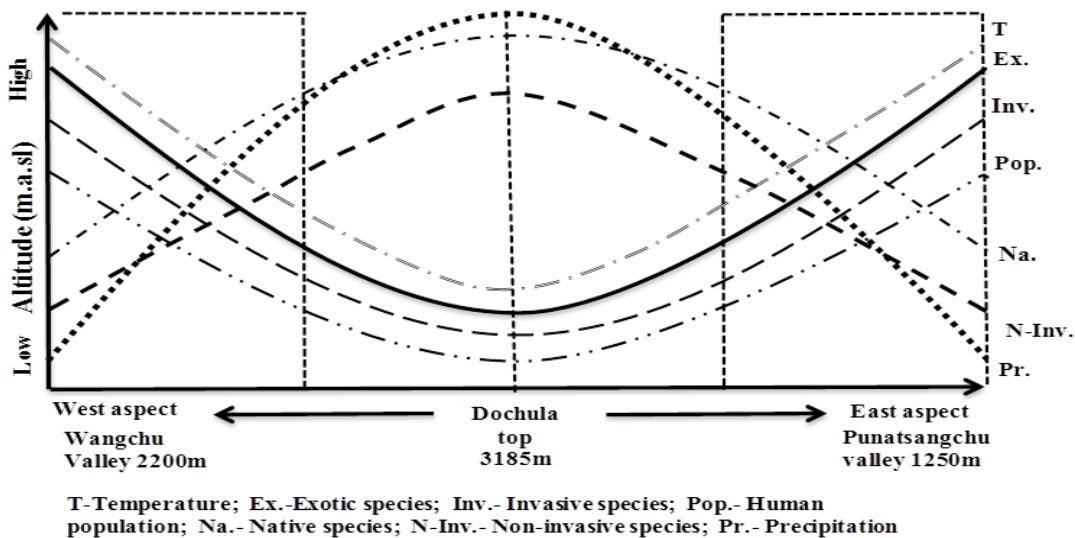


Figure 1. Thematic sketch of the exotic, invasive, population, temperature, rainfall distribution pattern along the Wangchu dry valley and Punatsangchu humid valley (adapted from Tshering, C.2012).

The study reported that the high number of alien species at low altitude may be because of rapid urbanization, constant movement of people and goods, and intensive agricultural practices

along the settlements (Tshering, 2012). Such studies indicate that the invasion by exotic species is happening at alarming rate in Bhutan.

## 2.4 Biogeography

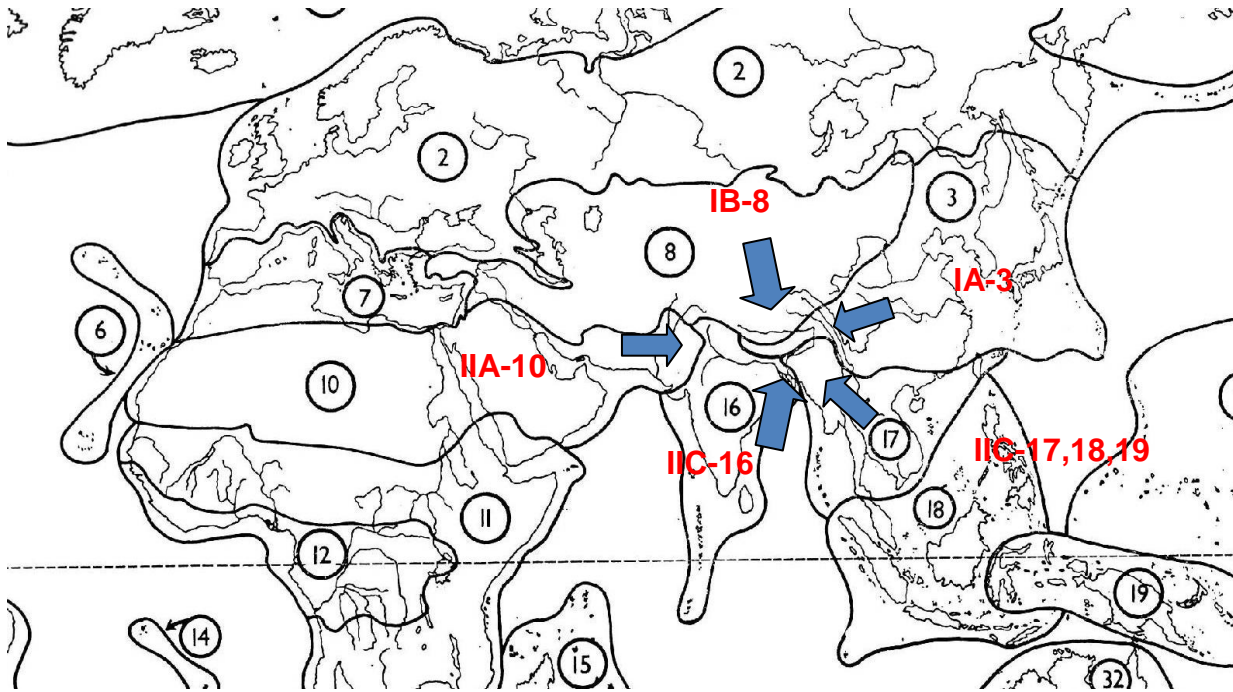
Bhutan has some of the most rugged terrain in the world, characterised by huge variation in altitudes between its southern and northern border. Within a width (north-south) of approximately 170 km, its elevation varies from 200 in the south to 7500 m in its north. This great geographical diversity creates micro-climatic conditions which gives rise to outstanding range of ecosystems and diversity in the country. The country can be divided into three broad physiographic zones. The southernmost belt and often called lesser Himalayas are the foothills of the covered with sub-tropical to warm broadleaved forests, often these forests are mixture of evergreen and deciduous plant species. The region is also habitat for mega-herbivore like elephants and mega-carnivore like Bengal tiger. These hills ultimately descend to northern Indian plains popularly known as Duars.

The Inner Himalayas consisted of mostly cool-broadleaved forests to temperate forests, however the inner valleys are mostly dry and host most of the xeric forest types, such as Chirpine in the lower valleys and Bluepine and associated species on higher inner valleys.

In the very northern most frontiers along the Bhutan-China border, the snow-capped mountains also known as Greater Himalayas reaches upto 7500 m. This region consists of mostly of snow-capped mountains (glaciers). The alpine valleys in this region provide pastures for livestock such as yaks. The region is sparsely populated who practice transhumance as source of livelihood. The region is also habitat for some highly priced medicinal plants and fungi such as *Picorhiza* sp, *Ophiocordyceps sinensis* and other medicinal plants.

## 2.5 Phytogeography

The important phytogeographic elements in the indigenous flora of Bhutan are shown in Figure 2, where significant number of genera and species may be shown to have connection with flora of other part of the world.



**Figure 2: Map of the floristic region of the world (Takhtajan, 1969) in relation to Bhutan Himalaya in pattern of their distribution. II A. African subkingdom ( 10 Saharo-Sindian region), I A, Boreal subkingdom (3 Eastern Asia ( Sino-Japanese) region, I B Tethyan ( Ancient Mediterranean subkingdom ( 8 Irano-Turanian ( western and Central Asiatic region, II C ( Indo-Malesian ( Indo-Malay) subkingdom ( 16 Indian region, 17 Indo-Chinese ( Continental South-East Asia) region, 18 Malesian (Malayan) region, and 19 Papuan region ( adapted from Oshawa, M. 2009).**

The Himalayan region is said to be on the crossroad of various geographical and endemic elements and situated on the ecotone between tropics and temperate forest types and Bhutan is centrally placed in the distribution of the rich Eurasian flora and is home to primitive angiosperms like *Decaisnea insignis* and vessel less primitive angiosperm *Tetracentron sinense* (Oshawa, 2012). It has characteristic dry valley ecosystems along the major north-south valleys, which exhibit one of the richest concentrations of different ecosystems within a limited altitudinal or spatial range. Floristic elements concentrated in the dry valley ecosystems are the so-called Tethys elements which can be regarded as the palaeo-floristic elements once distributed along the coast of the Tethys sea (palaeo-Mediterranean sea) such as *Pinus roxburghii*, *Pinus excelsa*, sclerophyllous *Quercus semecarpifolia* trees ( Oshawa, 2012).

Bhutan's floras are blended from seven known taxa from other part of the world (Figure 2). The present floristic composition of Bhutan is made up of genera and species from SE Asia, Figure 2, IIC-17, 18, 19), some from African continent (figure 2, II A-10), Boreal taxa (Fig 2, IB-8, Sino-Japanese Taxas ( I A-3), the decant ( Indian taxa, IIC-16). The elements from SE Asian region are more evident in Bhutan mostly in warm broadleaved and sub-tropical forests. The common life forms from SE Asian region in Bhutan are many trees, shrubs and climbers. Some of the floral elements that are mostly occurring in SE Asia (Grierson and Long, 1983) and some from African continent and known to occur in Bhutan are listed in Table 2-6.

**Table 2-6: The floral elements that are mostly occurring in SE Asia and some from African continent and recorded in Bhutan (after Grierson and Long, 1983)**

<i>Acrocarpus fraxinifolius</i>	<i>Engelhardia spicata</i>	<i>Michelia champaca</i>
<i>Actinidia callosa</i>	<i>Eria paniculata</i>	<i>Mucuna nigricans</i>
<i>Alcimandra cathcartii</i>	<i>Euchresta horsfieldii</i>	<i>Musa balbisiana</i> agg.
<i>Ampelocissus barbata</i>	<i>Exbucklandia populnea</i>	<i>Myrica esculenta</i>
<i>Antidesma acuminatum</i>	<i>Firmiana colorata</i>	<i>Oroxylum indicum</i>
<i>Baccaurea ramiflora</i>	<i>Garuga pinnata</i>	<i>Plectocomia</i> spp.
<i>Bauhinia purpurea</i>	<i>Gnetum montanum</i>	<i>Podocarpus neriifolius</i>
<i>Bischofia javanica</i>	<i>Hedychium coccineum</i>	<i>Procris crenata</i>
<i>Brassaiopsis glomerulata</i>	<i>Helicia nilagirica</i>	<i>Pterolobium macropterum</i>
<i>Calamus</i> spp	<i>Heliciopsis terminalis</i>	<i>Rauwolfia serpentine</i>
<i>Carallia brachiata</i>	<i>Hodgsonia macrocarpa</i>	<i>Rhaphidophora peepla</i>
<i>Careya arborea</i>	<i>Hydrobryum griffithii</i>	<i>Schoepfia fragrans</i>
<i>Craveta religiosa</i>	<i>Lepisanthes senegalensis</i>	<i>Solanum aguivii</i>
<i>Cycas pectinata</i>	<i>Lithocarpus elegans</i>	<i>Spondias pinnata</i>
<i>Debregeasia longifolia</i>	<i>Macrosolen cochinchinensis</i>	<i>Talauma hodgsonii</i>
<i>Dendrobium aggregatum</i>	<i>Masea montana</i>	<i>Tetrameles nudiflora</i>
<i>Dendrocnide sinuata</i>	<i>Mangifera indica</i>	<i>Toona sureni</i>
<i>Dipterocarpaceae</i>	<i>Meliosma simplicifolia</i>	<i>Trevesia palmate</i>
<i>Dischidia benghalensis</i>	<i>Meyna spinosa</i>	<i>Veronia volkameriifolia</i>
<i>Daubanga grandiflora</i>		

## 2.6. Vegetation types of Bhutan

The detailed and systematic classification of the vegetation of Bhutan had been not been undertaken so far in Bhutan. The British botanists Grierson and Long (1983) roughly classified the Bhutanese vegetation into eleven types based on altitude and precipitation gradients. According to that classification, the sub-tropical, warm broad leaved and cool broadleaved types occur along high precipitation gradient with altitude ranging from 180-3000 masl (see Annex, Table 1) and precipitation above 3000 mm /year upto 4000 mm/year. The broadleaved scrub forest, evergreen oak, hemlock, fir and juniper-rhododendron and various mixture of conifer and broadleaved tree species are found in medium precipitation (1500-upto 3000 mm/year) and altitude ranging from 1000 upto 4300 masl. The most xeric forest types are chirpine and bluepine forests and are found in dry inner valleys. The chirpine forests are found from 900 upto 2000 masl in parts of west central and eastern inner dry valleys of Bhutan. The alpine meadows are the upper-most vegetation zone and are found above 4000 m. The major characteristics plant species of each zones according to the classification by Grierson and Long (1983) are presented in Annex, Table 1. Recently Oshawa (2006) had classified the Bhutanese vegetation considering altitude, precipitation, topography and dominant vegetation types. According to this study, ten types of vegetations types in the country (Figure 3).



### A Scheme of Vegetation Zonation in the Bhutan Himalaya

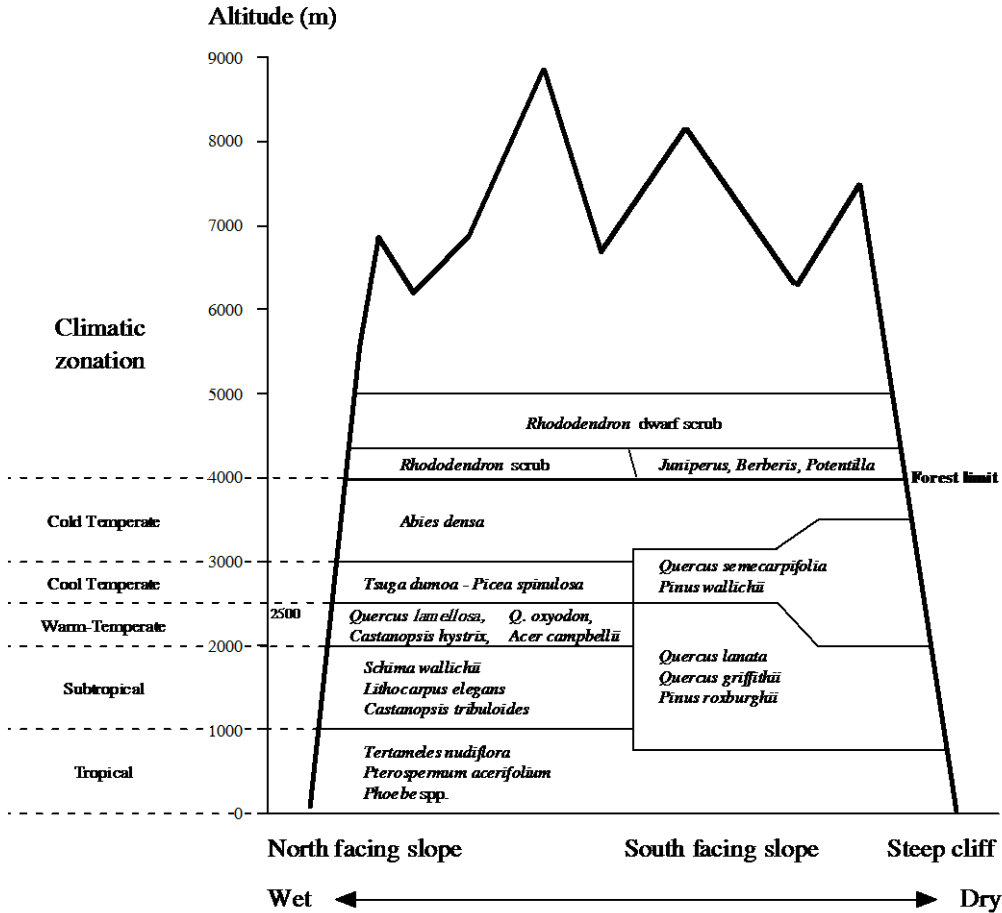


Figure 3: Scheme of vegetation distribution in Bhutan, according to precipitation and altitudinal gradient ( adapted after Oshawa, 2006 )

### 2.7 Major land uses in Bhutan

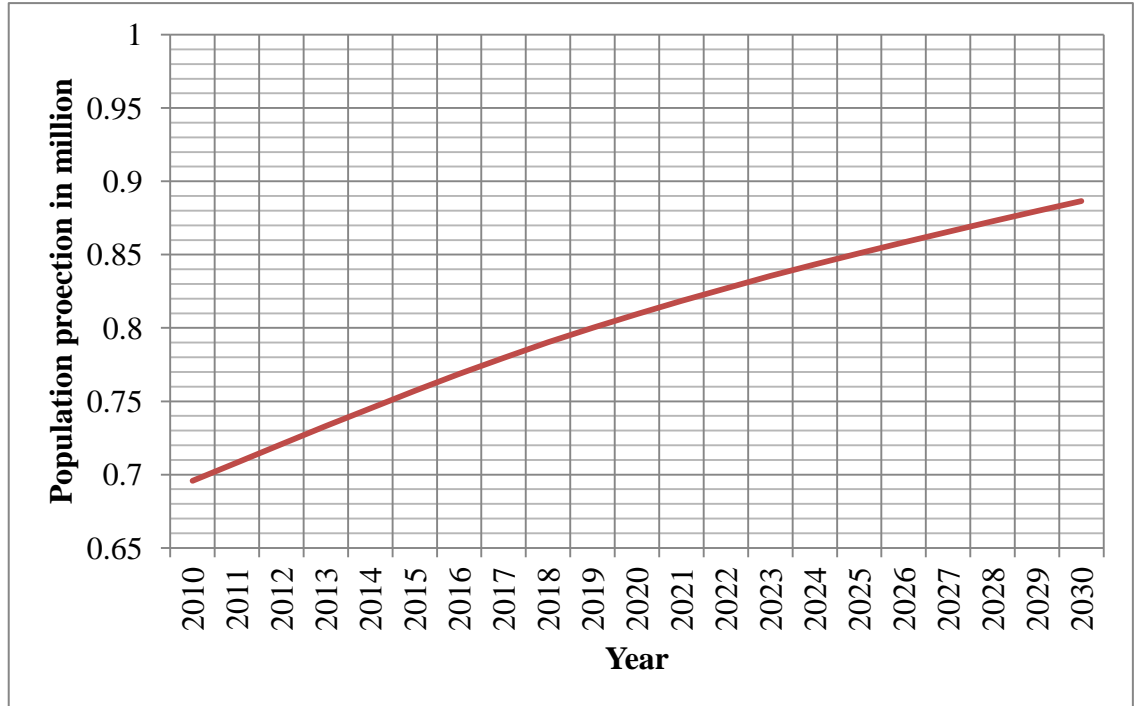
Based on the 2010 Bhutan land cover assessment under taken by National Soil Service Centre, the national forest cover is about 70.5% of the total geographical area (Table 2-7). If scrub cover is added to the forest cover, the forest covers will be about 81% of the geographical area (NSSC, 2010). Agricultural lands decreased from 7.9% in 1995 (MOA LUPP, 1995) to 2.9% cultivable land in 2010. For the Bhutanese people, the forest is the most important natural wealth of the country. The country cannot effort to exploit the forest resources unlike other countries because of the rugged landscape that has been naturally assigned. The future economy of the people and country is very much dependent on its protection, conservation and scientific management. That was one major reason why Bhutan has developed strict rules on nature conservation and putting conservation of biological diversity at the core of socio-economic development.

Table 2-7: Land use statistics of Bhutan (NSSC, 2010)

Land uses	Area ( Sq.km)	Percent share
Fir Forests	1832.08	4.77
Mixed conifers	6139.64	15.99
Bluepine	800.24	2.08
Chirpine	1076.67	2.80
Broadleaved	16889.56	43.99
Broadleaved and Conifer	314.72	0.82
<b>A.subtotal Forest cover</b>	<b>27052.91</b>	<b>70.46</b>
Meadows	4005.26	10.43
Shrubs	1575.69	4.10
Agriculture land	1125.25	2.93
Bare areas	1229.74	3.20
Built up area	61.51	0.16
Non Built up	3.3	0.01
Snow cover	2854.79	7.44
water bodies	275.69	0.72
Marshy areas	3.19	0.01
Degraded areas	206.36	0.54
<b>B sub total other land uses</b>	<b>11340.78</b>	<b>29.54</b>
<b>Total areas (A+B)</b>	<b>38,393.69</b>	<b>100</b>

## 2.9 The current state of human population

According to the Population and Housing Census conducted nationwide in 2005 (NSB, 2011) the current population of Bhutan stand at 720, 679 people which means that there are about 19 persons living in every square kilometre of land. Comparing to other countries, Bhutan is amongst the least populated country in the region. The population is expected to reach 886, 523 by 2030 (Figure 4). This means that there will be increase demands of forests products, lands and associated natural resources which may exert pressure on use of natural resources in coming years. Since Bhutan is mountainous, only limited areas are deemed suitable for cultivation and settlement; such situation puts more people in limited suitable areas, which would mean intensive uses of natural resources around the pockets of settled areas.



**Figure 4: The estimated human population of Bhutan from 2010 to 2030 based on 2005 population and housing census of Bhutan (RGOB, 2011).**

**2.10 The Current issues and problems associated with forest genetic resources**

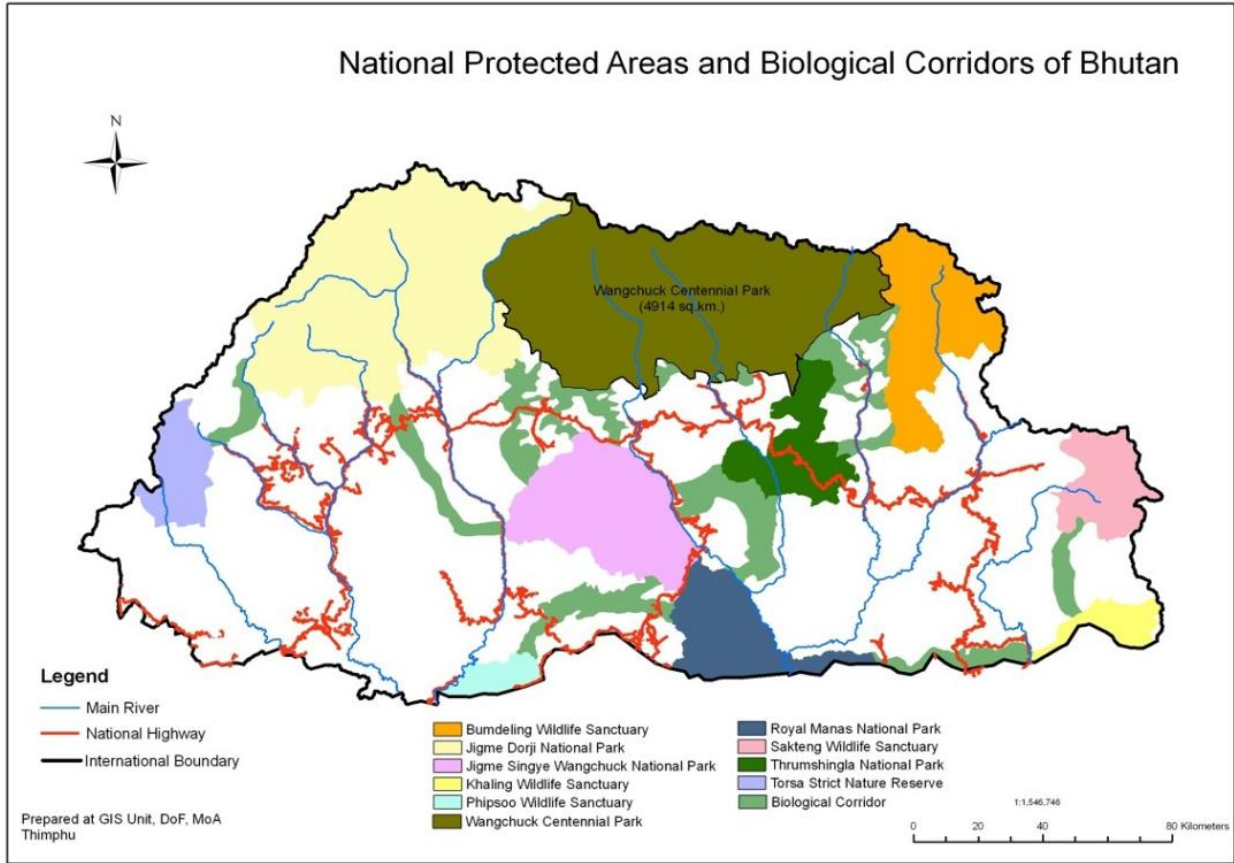
The vegetation zonation based on eco-physiographic characteristics, geology, soils types and climatic information are largely not undertaken in Bhutan. Species distribution and their spatial extent are also not known except for few species such as bluepine and chirpine. These informations are highly required for projecting potential threat to species due to both natural and anthropogenic influences.

The invasive plants pose various threats such as habitat loss of endemic species, hazard to human health. Thus, documentation of invasive alien plant species is very important which remained very poor thus far. Moreover, the existing records of flora of Bhutan was not based on intensive survey rather it was based on exploratory surveys, therefore it is likely that new species of flora could be found within the country. The greater concern is that, there are no comprehensive database on tracheophytes, bryophytes and other lower plants in the country.

**3. The State of In-Situ Conservation of Forest Genetic Resources**

Bhutan has given top most priority to conservation and sustainable management of natural resources. Unlike in other countries, Bhutan does not maintain large gene banks specifically to protect the forest genetic resources. The conservation of FRGs in Bhutan is being done in the form of in-situ management through legislative, proper policies and guidelines. Bhutan maintains 51.44 % of the total geographical area under the *ex situ* conservation with wide networks of national parks , nature reserves, wildlife sanctuaries, recreation park and biological corridors ( Figure 5,

Annex Table 2). These protected areas cover north-south and east –west gradient of the country representing all eco-regions and forest types of the country.



**Figure 5: Protected areas system of Bhutan which includes National Parks, Wildlife Sanctuaries, Strict Nature Reserves and biological corridors of Bhutan ( source DOFPS, 2011).**

Apart from the protected areas, the Department of Forests and Park Services (DOFPS) maintains networks of 12 territorial field divisions which implements the field programs and activities related to protection and management of forestry resources.

### 3.1 Issues and problems related to current state of in-situ conservation

Although there is a strong political will in the country to conserve the natural resources through legislation and programs such as protected area system (PAS), there are various conflicts arising from protected areas system (PAS) such as human wildlife conflicts, development activities being delayed due to conservation activities, poaching, illegal activities etc. Above all, the species level conservation of FGRs is uncertain under in-situ conservation program. The current criteria of zonation in protected areas were developed mostly by expatriate professionals, detailed zonation according to various functions and potential within protected areas had not been done.

#### 4. The status of ex-situ conservation of Forest Genetic Resources

The ex-situ conservation of FGR in Bhutanese context refers to any forest plant materials propagated either through seeds or other means by human population for various reasons such as to meet multiple demand of Bhutanese population such the timber, fuelwood, fodder, food, medicines, recreation and aesthetic, rehabilitation of degraded forest lands, stabilization of land erosions, protection of critical watershed, reforestation of logged over forests , plantation carried out to mark special celebration, plantation for scientific purposes such as arboretum.

Various forms of ex-situ conservation of FGR had been carried out throughout Bhutan at different time, Royal Government of Bhutan (RGOB) carried out regular plantation program since 1947 to replenish the loss of forest genetic resources to different development activities. With the establishment of Department of Forest in 1952, regular plantation programs were taken up especially to reforest the logged areas. However, the plantation forest in Bhutan forms tiny fraction of the total forests compared to natural forests (Table 4-1). Since 1947, different agencies which are related to forestry resources had rehabilitated 23,978.81 ha or 59,251.64 acres of land.

**Table 4-1: Forest plantation (Area in Ha) carried out by different agencies in Bhutan since 1947. Dzongkhags refers to district forests, parks refers to national parks, wildlife sanctuaries and nature reserves, NRDCL = formally logging corporation of Bhutan, presently renamed as natural resources development corporation limited, BBPL = Bhutan Board Particle limited, BCCL = Bhutan chemical and carbide limited. Source of data, social forestry Division, Department of Forests and Park Services, Bhutan, 2010.**

Sl.No	Agencies	years wise plantation ( acres)			Total
		1947-2002	2003-2007	2008-till date	
1	Dzongkhag Forestry	863.98	2157.84	2147.57	5169.39
2	Territorial Divisions	39,302.13	197.16	923.23	40,422.52
3	NRDCL	2,424.35	1006.93	417.76	3,849.04
3	BBPL	3693.9	1533.3	2838.33	8065.53
4	CCCL	1745.16	0	0	1745.16
Total		48029.52	4895.23	6326.89	59251.64

Although planting of trees had been time tested tradition in Bhutan (DoFPS, 2010), there was no clear legal regulatory framework for carrying out plantation forestry until recently. In absence of regulatory framework there was poor production of planting materials, planting schemes and planting methods and overall monitoring and evaluation of plantation forestry. Realizing such issues in plantation forestry, the RGOB framed national plantation strategy in 2010. This document broadly outlined the national policies and legal framework for future plantation forestry in Bhutan. It emphasized the economic, environmental and social benefits of plantation forestry. The document also identifies various plantation programs (Annex, Table 3).

The plantation programs become successful with adequate supplies of planting materials which can be achieved with establishment functioning forest nurseries. The country has total of 102 forest nurseries with different production capacities and managed by different agencies in the country (Table 4-2).

**Table 4-2: The distribution of forests nurseries managed by different agencies in Bhutan ( source DOFPS, 2011).**

Agencies	Number of Forest nurseries
Dzongkhag forest nurseries	31
Territorial Forests Division	17
Protected Areas	8
NRDCL	10
BBPL	2
Private nurseries	27
RDCs	5
Municipalities	2
<b>Total</b>	<b>102</b>

There are many agencies carrying out ex-situ conservation and management of FGR in the country. One of them is Dzongkhag (district) forestry sector, which is mostly responsible for creation and management of community and private forests which are linked with the decentralization policies of the government. Since 2000, MOAF had delegated the responsibility for implementation of plantation forestry activities to Dzongkhag forestry. The activities included in the program are site selection for afforestation, tree species selection, planning, implementation, monitoring and evaluation of created plantations. Some ex-situ conservation (plantations) is carried out by forest industries, private forest owners, community forests owners following specific guidelines developed by DoFPS. Since 1985, government institutions (educational institutions) carried out tree plantation activities.

The renewable resources research and centers which are spread in different ecological zones in the country also maintains FGRs in the form of research trails and arboretums. The National Biodiversity Centre maintains more than 300 species of plants as ex-situ conservation gene bank (NBC, 2011).

#### **4.1 Issues and problems related to ex-situ conservation of FGRs**

Although plantation forestry is more than six decades old in the country, there was no comprehensive planning and research on various aspects of ex-situ conservation of FGRs. Firstly there is no clear cut policies and strategic frame works for ex situ conservation, for example methods to be applied to different levels of biological hierarchy, secondly there are no precise list

of species of concerns that needs to be conserve in suitable methods and no detailed assessment of available resources to provide the highest possible combinations of conservation.

## 5. The state of use and sustainable management of Forest genetic resources

The country has a wide array of timber and non wood forest products (NWFPs) and to date more than 200 medicinal plants, 97 mushrooms, 97 fruits and nuts, 34 bamboos, 14 canes, 25 oil/resin species, 20 spices, 38 fibers, 70 ornamental plants, 181 fodder species, 36 dyes, 12 food crops (yams) and 77 forest vegetables have been identified and described (Forest Resources Development Division, 2006). As shown in Table 5-1, there are as many as 905 species of GFR in active uses for different purposes on daily basis. There could be many others which have no detailed descriptions.

**Table 5-1: The number of FGR resources use by Bhutanese population for different purposes.**

Uses/ FGR products	Number	Remarks
Food from FGR	30	Since no detailed survey by species was done, there could be overlap of uses. A species could have multiple uses or products.
Dyes from FGR	77	
Fodder from GFR	181	
Bamboo and cane	44	
Mushrooms as food	97	
Fruits and nuts	97	
Medicinal	221	
Oil/resin	25	
Ornamental plants	70	
Timber	25 ( special class and class A)	
Fibers	38	

### 5.1 The state of timber productions: production and consumptions

Bhutan had embraced modern scientific forest management when it started its planned development program in early 1960s. Using latest techniques, the DOFPS in 2004 (Table 5-2) estimated that 54.4 percent of the country's forest was unsuitable for timber productions due to technical, ecological and economic reasons and about 28.8 percent cannot be used by virtue of being within protected areas system (PAS). This leaves only about 16.8 percent of country's forests suitable for timber production. However timber is not only the primary focus of DOFPS, there are large number of FGRs that constitutes other products from the forest (Table 5-2).

**Table 5-2: Forest resources potential assessment of Bhutan 2004. ( DOFPS, 2011).**

Potential use	Forest area (Ha)	Percentage of total forest area
Unsuitable for timber production	1, 590, 573	54.4
Manageable for timber production	492,458	18.8
Commercially manageable for timber production	240,463	8.2
Suitable for local use	251, 995	8.6

Generally the forests in Bhutan occur on steep and rugged terrain and very small fraction of the total forest area can be effectively harvestable and that too depending on degree of slope and the extent to which accessibility through road construction can be attained. The effectively operable area needs to be estimated at the beginning of the planning process and should be considered the most important yield regulation parameter. Thus the commercial harvesting with approved FMUs constituted about 7 to 10 percent of the forest land in the country (Figure 6). Currently the total commercial forest stands at about 7 % (202697.65 ha) of the forest land and 5 % of the total land of the country. The logging in those designated areas is done following detailed management guidelines and approved management plans. The FMUs have fixed annual allowable cut (AAC) calculated based on the total area of the FMUs, rotation period and available volume or basal area. The harvesting is regulated based on AAC. The harvesting operations are carried out in FMUs with cable yarding system, following prescribed silvicultural system. The group selection is the most suitable silviculture system prescribed so far in the country. The logged over areas are replanted with regional or site specific endemic tree species considering their commercial values. Recently thinning guidelines for thinning bluepine stands were incorporated in management plans which were developed after two decades of experimental trails on bluepine stands across the country.

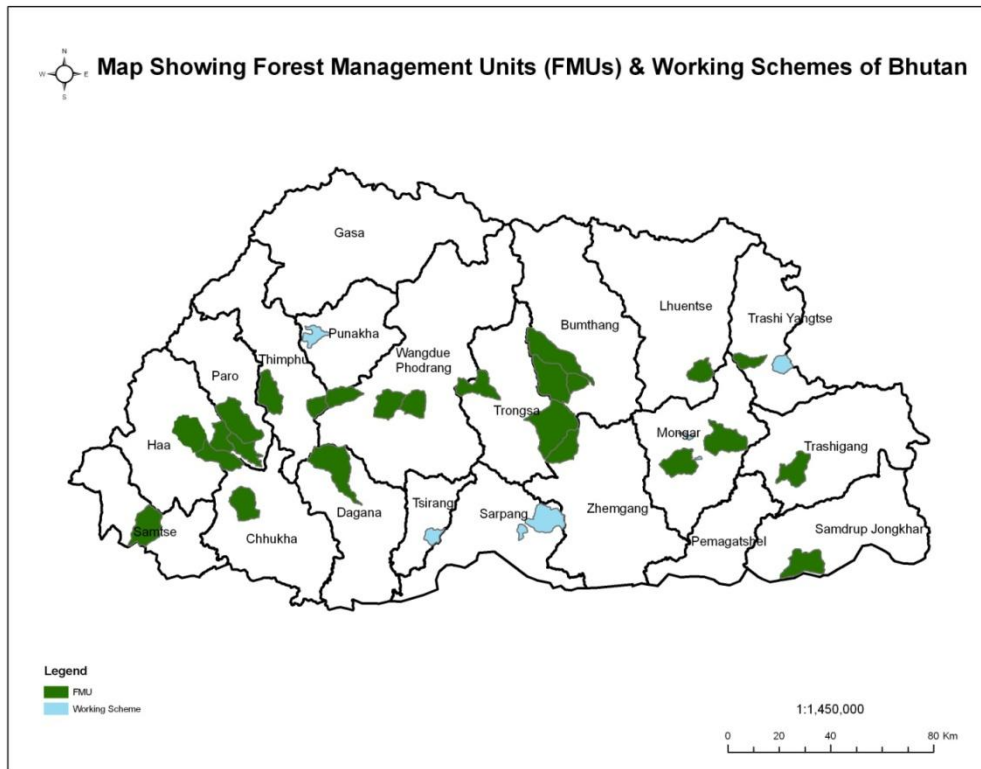
**Table 5-3: Management plans and working schemes created to cater timber demands for the Bhutanese populations in Bhutan. (Source of Data, DOFPS, 2012).**

Forest management units	No of FMUs	Total area ( Ha)	Net operable area( Ha)	Total ACC (M <sup>3</sup> )	Average Gross Vol/Ha (M <sup>3</sup> )
	20	188,675.52	57,503.35	128,147.31	5,325.23
Working Schemes	17	14022.13	-	114,798.67	-
				(total volume in m <sup>3</sup> )	

The FMU plans are prepared by Forest Resources Management Division (FRMD) and leased out to Natural Resources Development Corporation Limited (NRDCL) which is the only

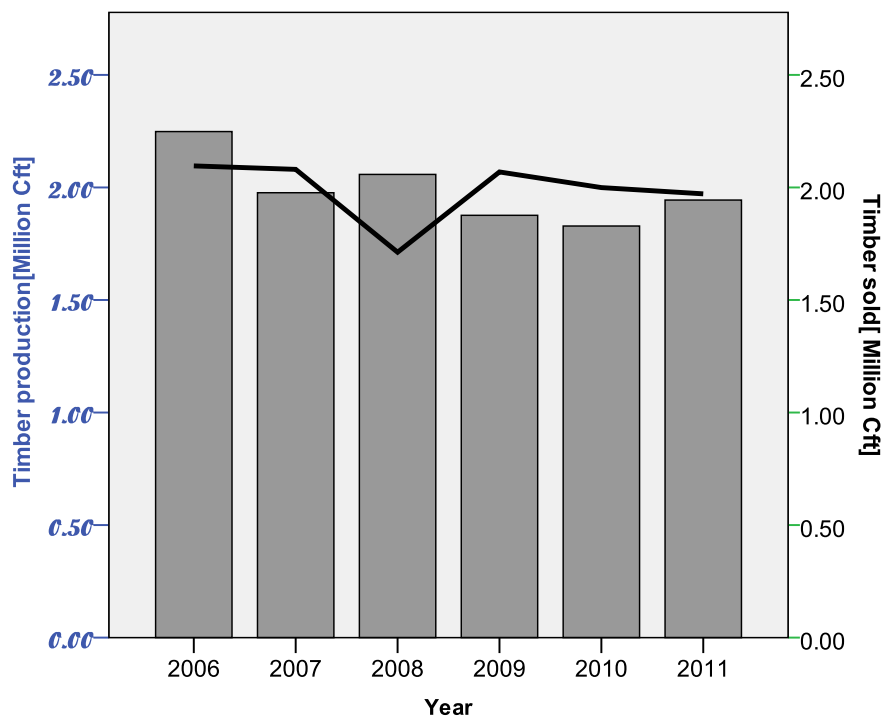


corporation responsible for timbers logging in the country. The logged timber is sold in the open auctioning system and is limited to Bhutanese bidders. The export of timber to other countries in round form (raw form) had been banned since 1999. The FMUs are prepared in such way that they fulfilled the domestic commercial of the timbers for Bhutanese construction industries. As part of the social obligation the forest management units also o provide subsidised timber to the rural communities residing close by the FMUs. Beside the production and supply by NRDCL from FMUs, the DOFPS through its territorial divisional offices and park offices also supplies timber for various types of rural construction and other non timber products to rural population. These supplies come in various forms such as standing trees, logs, fallen trees, sawn timber, poles, firewood etc.



**Figure 6: The commercial forests under forest management units and working scheme (existing and logged over) in Bhutan.**

The total area and gross timber production of the forest management units and working is shown in Table 5-3. Currently there are 20 FMUs and 17 working circles spread across the country (Figure 6 and Table 5-3). Out of 188,675.52 ha of total FMU areas, only 57, 503.35 ha are operable (30% of the total FMU areas).



**Figure 7: The amount of timber produced and sold from different forest management units in the country by NRDCL from year 2006-2011. ( Chhetri, A. 2012, NRDCL).**

**Table 5-4: Other wood products sold by NRDCL for last six years ( source Chhetri, A. NRDCL, 2012)**

Year	Firewood ( Truck load)	Briquette in Kg	Woodchips in M <sup>3</sup>
2006	3,358.00	383,933.00	-
2007	4,563.50	491,600.00	-
2008	4,222.00	453,060.00	15,732.52
2009	5,077.00	470,795.00	21,538.95
2010	4,253.00	529,915.00	16,641.43
2011	3,795.28	306,015.00	20,516.99

In order to managed the timber resources in sustainable basis the trees are classified into three categories i.e. special class trees which are limited in natural distribution and have very high social as well as high economic value are permitted to be used after obtaining special permits from DOFPS. As of now DOFPS had listed nine such species in the country (Annex Table 4). The trees which have high demand as commercial timber are classified as class A. The former is levied very

high royalty fees according to size of the timber,( bigger the size higher the royalty fees) and this class of trees are harvested only for special purposes. The Class A trees species are commercially important trees species which are high in demand for various purposes such as construction, furniture, handicrafts etc but limited in their natural distribution as well as abundance. The timber productions forests are managed with written management plans which take into account the ecological, social and economical balanced of timber production from the specific forest types and area. The forests for timber productions are managed mostly with two types of silviculture systems (i) single tree selection system and (iii) group selection system, the former is applied mostly for rural timber supply and later on commercial forest management units.

Generally, the production and consumption of wood for various purposes varies from year to year however the quantities of timber (in log form) (Figure 7) and other timber products (Table 5-4) produced by NRDCCL remained fairly constant, whereas demand in some year remained above the supply line (Figure 7). The higher demand for timber is attributed to unprecedented growth of construction industries; there are reports of acute timber and other wood products such as firewood in the country (<http://www.kuenselonline.com>). Given that country is undertaking huge infrastructure development throughout the country, the demand for timber in the country will not decreased in foreseeable future.

## 5.2 State of wood based industries (WBI)

Wood base industry in this paper is defined any enterprise that employ people for the purpose of extracting timber from forests to processing into useable timber products. The wood based industries comprise of sawmills, furniture houses (workshops), wooden box manufacturers, small veneer and plywood mills and wooden handicraft workshops (Table 5-5). Generally WBIs are not properly developed in the country, most of these sawmills are small and labour intensive equipped with Indian manufactured horizontal band saw (Dhital, 2009) and produces very crude sawn timbers with relative low recovery ( 60-70 %). There are about 113 saw mills spread across the country (Table 5-5), one particle boards, four plywood units and one government owned wood craft centre. The wood craft centre serves dual purpose of training of manpower as well as manufacturing furniture and all these wood based industries employed over 3000 people as permanent employee and many seasonal and contract workers in logging activities.

**Table 5-5: Some statistics of wood based industries of Bhutan, the data on employee and production capacity per day (PCPD) has to be authenticated. FH = furniture house, BBPL = Bhutan board particle limited is a govt owned particle board factory , NRDCL = Natural resources development corporation limited is also government owned corporation responsible for catering timber, sand, stone and other products to commercially as well as at subsidized rate to rural population.**

Region	Type of WBI	No of WBI	PCPD(cft)	Employee	remarks
East	Sawmill	12	1850	40	Private
Central	Sawmill	13	1815	90	Private
Central	FH	15		44	Private
West	Sawmill	10	2897	77	Private
West	FH	47		300	Private
West-central	Sawmill	8	1123	69	Private
South	Sawmill	10			Private
South	FH	9	NA		Private
Wood craft centre	Training Centre	1	NA	94	Govt
BBPL	Particle Boards	1	NA		
<sup>1</sup> NRDCL	Mostly logging	1	-	355	Govt

The proper development and streamlining the proper production of wooden products system in the country remains challenging and there are many rooms for improvement of production system such as use of modern technologies and improvement in management of timber waste.

### 5.3 The state of non-wood forest products

The Forest genetic resources play very important in the socio-economic development of Bhutan. With close to 69 % of the population still depends on subsistence farming activities ( DOFPS, 2011) , forestry plays major play a major role in overall productivities of the farming lands and its contribution in improving the socioeconomic development of rural population as well as business development of urban dwellers through their sale outlets or through trading of non wood forest products.

While Bhutan is largely covered with natural forests, a detailed systematic survey of forest products has not been carried out thus far. The accurate and authentic data on the various types forest produce, such as edible products, dyes, resin, oil, medicines etc are scant and still have to be ascertained. To fulfill these information gaps, DOFPS have initiated nation-wide national forest inventory.

<sup>1</sup> NRDCL is a government logging company empowered to extract timber, stones, sands and process wood and timber products.

At the current state, collection and processing of NWFPs is mostly done based on traditional practices and knowledge, except for few NWFPs which will be highlighted later in this paper. Improvement of knowledge on different aspects of NWFPs would undoubtedly lead to sustainable management which will increase in both micro and macro economy. The application of sustainable management of NWFPs will create jobs and other unseen economic opportunities especially to the rural population. At the household level NWFPs are used for subsistence purposes as well as sold in the local markets for cash income. The forest and nature conservation rules 2006 gives legal rights to collect and sale of certain non wood forest products (NWFPs) to individuals or farmers groups ( example Annex Table 5). In 2008, the DOFPS, enacted national strategy for development of non wood forests products 2008-2018. This document reflected more than 60 plant species used for different purposes such as food, medicines, dyes, fruits and nuts etc and projected to have economic potential if developed on sustainable basis (Annex Table 5). After the launch of this documents, some 74 farmers group were formed and were awarded certificates for management of nwfps and some of the immediate results of implementation of the strategies document are availability of cash income earned by beneficiary farmers (Table 5-6), some 1674 households generated sum of Nu 2,337,180.00 (equivalent to USD 46,743.6 at current average exchange rate) in 2011 and Nu 3,682,538.00 (equivalent to USD 73,650.76 at current average exchange rate) in 2012 respectively (SFED, unpublished 2012). For many of these species specific management guidelines based on empirical evidences either through experimental evaluations and or literature reviews combined with compilation of indigenous knowledge of the communities on particular species were developed.

**Table 5-6: The quantities of different nwfps sold and revenue generated by registered farmer groups across the country. (Source SFED, DOFPS, 2012).**

Number of farmers group	No. of Beneficiary HH	Species	Qty sold (kg)		Income generated (Nu)	
			2011	2012	2011	2012
13 (6)	212	<i>Rubia cordifolia</i>	58,301.50	6,504.50	1,551,290.50	195,022.5
2	103	<i>Pouzolzia spp</i>	739.00	739.00	41,892.50	22,170.00
1	30	<i>Persea gamblei</i>	133.50		2,670.00	
1 +(1)	30	<i>Thysanoleana latifolia</i>	163 (bundles)	23 (bundles)	4,890.00	700.00
1	30	Endata rheedii	40.00		600.00	
5	593	Swertia chirayata	3,300.00	1,177.0	579,240.00	298,659
5	322	<i>Phyllanthus emblica</i>	1,356.00	722.50	125,097.00	57,800.00
1	19	<i>Illicium grifithii</i>	450.00	na	31,500.00	
1	59	<i>Cinnamomum tamala</i>	na	887.00	na	19,514.00
1	59	Mushroom	na	6440.00	na	2,272,000.00
4	217	<i>Piper sp</i>	na	6200.55	na	816,672.5
<b>Total</b>	<b>1674</b>		<b>64,320.00</b>	<b>22,670.00</b>	<b>2,337,180.00</b>	<b>3,682,538.00</b>

## **5.4 Issues and problems related to use and sustainable management of FGRs**

The forest management units (FMUs) reported failure of natural regenerations especially in broadleaved FMUs and in absence of long term observation data on logged over forests it is difficult to ascertain the future composition of such logged areas. Grazing of logged over areas further aggravate the problems. Although guidelines had been developed for many non wood forests products, however these guidelines are mostly developed based on very short period experimental or observed data in most cases the ecology and biology of non wood and even tree species are largely uncertain. Harvesting with very little knowledge on biology and ecology of concern species might pose great uncertainty for their sustainability in future. The tree breeding programs especially to reforest logged over areas are still very poor. In nut shell there are many areas where research has to be undertaken and research results should be the basis of sustainable management of FRGs in the country. The most worrisome areas are medicinal plants which are traded without having proper chemical constituents database. The existing infrastructure and human resources to conduct research on FGRs is still remained bottle neck.

## **6. The state of National Program, Research, Education, Training and Legislation**

### **6.1. National programs**

Bhutan's policies is robust on conservation and sustainable management of natural resources, as Bhutan's constitution under article 5, section III mentions explicitly requirement to maintain a minimum of 60% forest cover all the time. The Ministry of Agriculture and Forests (MoAF) with its Department of Forests and Park Services (DoFPS) is the primary agency accountable for formulation of rules and regulations, policies and administration of FGR including its ex-situ conservation. The country's FGRs are managed following the principle of sustainability. In order to conserve and managed the country's FGRs fulfilling the constitutional mandate RGOB had instituted number of central agencies which are either directly or indirectly responsible for conservation, sustainable use and management of forest genetic resources.

### **6.2 Ministry of Agriculture and Forests**

The Ministry of Agriculture and (MOAF) was instituted in 1985, bringing together agriculture, livestock and forestry sub-sectors which is popularly known as renewable natural resources sector (RNR sector). It is overall responsible for making appropriate legislations, regarding the overall governance of Forest Genetic Resources on sustainable basis. The MOAF had instituted many agencies which are responsible for sustainable management and uses of FGRs. The MOAF had enacted number of legislations which had strengthened the overall governance, sustainable management and conservation FGRs in the country.

#### **6.1.1 Department of Forests and Park Services (DOFPS)**

Royal Government of Bhutan had established the Department of Forests in 1952, since then it is the main custodian of FGRs of the country. It is the main agencies which frames

strategies and policies for conservation and sustainable management of FGRs in consonance with national laws and priorities. It is also entrusted with the responsibility of management and resource allocation for forestry sub-sector. Since its creation DOFPS had gone strength to strength in conservation and sustainable management of forestry resources of the country. With its creation, the country could maintain more than 60 % forest cover upto today.

DOFPS implements its various FGRs related programs through its functional division offices located at strategic locations around the country. There are six functional divisions under DOFPS which directly or indirectly contributes towards conservation and sustainable management of FRGs in the country.

### **6.1.2 National Biodiversity Centre**

One of such organization which is more or less fully devoted to look after plant genetic resources is National Biodiversity Centre (NBC). The Ministry of Agriculture and Forestry instituted the NBC in 1998 to act as a nodal agency for biodiversity conservation and sustainable utilization programs of genetic resources. Following the institution of NBC, National plant gene bank was established towards the end of 2005. At the current state, NBC had developed and implemented strategies, involving both ex-situ and in-situ conservation for field crops, however there are no specific programs to conserve genetic materials from the forests except some collection of plants species in its botanical garden. It maintains data base as well as herbarium specimens for all plant genetic resources recorded in the country. It is also responsible for access and benefit sharing processes in the country. Currently, the herbarium houses more than 10,000 collections of angiosperms, gymnosperms, pteridophytes and bryophytes samples

### **6.1.3 Bhutan Agriculture and Food Regulatory Authority (BAFRA)**

The Bhutan Agriculture and Food Regulatory Authority (BAFRA) was established on August 5, 2000. The agency was institutionalized as a perpetual, public-sector instrument to promote the quality and safety of goods and products related to the Ministry of Agriculture. It also coordinates and liaises with other national, regional and international agencies that are related to regulation of quality and safety of agricultural products including foods. As far as the FGRs is concerned BAFRA regulates its movement either of products or live materials through regular quarantine programs at designated border crossings and airports.

### **6.1.4 National Environment Commission (NEC)**

The NEC was first instituted in 1989 by His Majesty the fourth king decree as a national environmental committee under then Planning Commission (PC). In 1992, it was delinked from PC and became autonomous government body. It was further empowered in 1998 with responsibility as a high level policy decision making body on matter related to environmentally sustainable development and institution of measures to integrate environment management in overall development process. It has the overall responsibility for maintaining good environmental qualities in the country though formulation and implementation of environmental laws. Currently it is the national focal agency for CBD and UNFCCC. Armed with legal office, it is empowered to

develop, revise and amend environmental laws and regulations. It also prepares country's documents to facilitate the ratification of international treaties and conventions.

### **6.1.5 Natural Resources Development Corporation Limited (NRDCL)**

The harvesting of timber was carried out by allocating working coupes to contractors through open auctions up to 1979. However, such practice of logging was found unsustainable as the contractors' main motives remained maximization of profit, without regarding the sustainability of the forest resources, in order to attain both economic and environmental targets, the forest logging was institutionalized under Department of Forests then, with establishment of Logging Division.

However the logging under departmental operation was not found suitable due to lack of financial autonomy, since the financing for logging activities came annually with fixed amount and such financial arrangement made the day to day logging operations difficult. In order to overcome this difficulty, the logging division was upgraded to logging corporation in 1984 under the Royal charter. Under this arrangement Bhutan Logging Corporation (BLC) was given financial autonomy and mandated to function as commercial venture at the same time required to fulfill the forest resources sustainability and also cater the social obligation such as supply of subsidized timber to rural households from the forest management units. In 1996, the BLC was upgraded to Forestry Development Corporation Limited (FDCL) with same mandates. In November 2007, FDCL was restructured and named as Natural Resources Development Corporation Limited (NRDCL) with the mandate to manage sand, stone and other natural resources in addition to timber. It is owned by Druk Holding and Investments (DHI) which is 100 % government owned Investment Company and is governed by the articles of incorporation under the revised Company Act of the Kingdom of Bhutan 2000.

### **6.1.6 Institute of Traditional Medicine and Services (ITMS)**

The health system in the country runs both traditional as well as modern medication systems. The ITMS uses more than 200 species of medicinal plants from across the country to manufacture traditional medicines (TM). As more and more people are opting for TMs, the ITMS will be using more raw materials than it used to in the past. The ITMS is more users of FGRs than regulator in the country.

### **6.1.7 Ministry of Economic Affairs**

The Ministry of Economic Affairs (MOEA) imparts training on the development of knowledge and craftsmanship related to natural resources like bamboo and cane, wood curving etc and also supports Essential Oils Development Program (EODP). It also develops trade policy guidelines and promotes bilateral and regional trade through bilateral and multilateral trade agreements. It also regulates the issuance of business licenses. The MOEA is a focal point for development of for all entrepreneurship and small business promotion activities in the small and medium enterprise (SME) sector through its Entrepreneurship Promotion Centre (EPC). It also facilitates registration of intellectual property rights including company trademarks, brand names



and labels. The overall role of MOEA in relation to FGRs is governance of its trade and development of FGRs related enterprises.

### **6.1.8 Tourism Council of Bhutan**

The Tourism Council of Bhutan (TCB) is a governmental agency which governs and regulates tourism activities in the country. Bhutan is known for good environmental conservation practices and TCB promotes sustainable ecotourism also popularly known as Nature Base Tourism (NBT) in the country. TCB harnessed the aesthetic and educational values of FGRS through NBT.

### **6.1.9 Bhutan Trust Fund for Environmental Conservation**

The Bhutan Trust Fund for Environmental Conservation is an independent grant-making organization that uses its annual investment income to finance conservation activities. Grants are awarded to eligible Bhutanese individuals and institutions on natural and life science, impact on environment due to developmental activities, climate change, integrated watershed resource management, awareness and education protected area system and green technologies. In the natural and life sciences the topic covers basic, baseline and critical research which entails discovery and inventory of flora and fauna, traditional knowledge in the areas of environmental conservation, aquatic eco-systems, populations' perceptions and knowledge of environmental issues. More information about this organization can be found in (<http://www.bhutantrustfund.bt>).

### **6.1.9 NGOs and INGOs**

There are number of NGOs and international NGOs supporting RGOB in sustainable management, conservation and utilization of FGRs in the country. Royal Society of Protection of Nature (RSPN) had been one of the most instrumental in advocating protection and conservation of FGRs as well as fauna protection in the country. Some of the most prominent NGOs and INGOs are briefly describe.

#### **i. Tarayana Foundation**

Tarayana Foundation is an NGO working to uplift and enhance the lives of vulnerable individuals and communities in Bhutan. It was established in 2003 by Her Majesty the Queen mother, Ashi Dorji Wangmo Wang chuck, to help bridge local needs of disadvantaged remote communities with larger national initiatives. Tarayana complements and supplements the efforts of the Royal Government in poverty reduction by espousing the national goal, Bhutan 2020: A Vision for Peace, Prosperity and Happiness. The organization had been carrying out skill development of poor communities in remote Bhutan through trainings on product development using the timber and non wood forest produces. More information about this organization can be found in (<http://www.tarayanafoundation.org>).

#### **ii. Royal Society for Protection of Nature (RSPN)**

The Royal Society for Protection of Nature was established in 1987 as a citizen based non-profit, non-governmental environment organization to support environment conservation in

Bhutan. RSPN works on environmental education and advocacy, conservation and sustainable livelihoods, research and emerging issues like climate change, solid waste and water. Regular advocacy programs on emerging environmental problems are also carried out with the help of local volunteers, stakeholder organizations, partners and members.

### **6.3 Legislation**

In the current state, Bhutan's protection and conservation of the environment and the safeguarding of forest and wildlife is ensured under the Constitution of the Kingdom of Bhutan Article 5. The Constitution directs every Bhutanese citizen to protect environments and natural resources. The constitution under Article 5, section 2(d) mandates Bhutan to maintain 60% forests cover all the time. Over the years, set of strong laws and policies have evolved to ensure the protection, management and sustainable use of FGRs. These legislations are essentially geared towards contributing towards the development philosophy of Gross National Happiness (GNH). The constitution of Kingdom of Bhutan as mentioned earlier enshrines environmental conservation as constitutional mandates and Bhutan 2020, the country's vision document to maximize the GNH, serve as principal policy instruments. To harmonize these two documents several laws and policies exist related to FGRs conservation in the country.

The Forest Act, 1969 and National Forestry Policy 1974 were two earliest legislation and policy statements which provided legal and policy framework for successful implementation of FRGs in the country. However these legislations were more centralized system of governance, as decentralized and devolution of power evolved through time, RGOB had identified people's participation and decision making on natural resources as an effective instruments to promote conservation and sustainable utilization of FGRs, the Forest Act of 1969 was replaced by Forests and Nature Conservation Act 1995 Kingdom of Bhutan. Likewise the National Forestry Policy which was first formulated in 1974 was revised in 1991, both of these policies aims at maximization of conservation and lesser exploitation of natural resources. Since 1995, several legislations and policies documents were enacted which directly or indirectly supports the conservation of FGRs of the country. To name few the Biodiversity Act of Bhutan 2003, Forests and Nature Conservation Rules 2006, the National Forest Policy 2011 are some of the policies documents which are directly related to conservation and sustainable utilization of FGRs in the country. The different legislations related to conservation and the uses of FGRs are given in Annex, Table 6.

### **6.4 Research, training and education**

The forestry research program was formally started in 1987 under the Department of Forests then, although some research activities were initiated early 1980s. Since its inception the program generated information on different concerns of the department of forests, many of the field development works such as silviculture system, sustainable harvesting of non wood forests products, ecological management of forestry resources were tested and verified by forestry research. The national forestry program is coordinated by national forestry research nodal centre, based in Research and Development centre at Yusipang, and implementation across the country by

other research and development centers spread strategically at different agro-ecological zones. Currently there are five research and development centers and five sub-centres which cater research and development needs in renewable natural resources (RNR) sector. The forestry researches are clubbed into four research programs namely (i) Nature conservation research, (ii) sustainable forest management research, (iii) watershed research and (iv) socio-economics of forestry resources related research. The forestry research priorities are set in research and planning meeting held every three years with all concerns stakeholders. The RDC Yusipang strategically maintains close relationship with regional and international universities and institutions for better research input and as well as output. Additionally other educational institutes such as Ugyen Wangchuck Institute Conservation of Environmental based in Bumthang, periodically offers certificate training courses to foresters as well as conducts basic research in forestry (UWICE) and College of Natural Resources (CNR) under Royal University of Bhutan (RUB) conducts research as well as training of forestry students upto Bachelor of Science in Forestry. The RDCs also trains farmers and individuals on management of forestry resources in the country. A recently established Rural Development Training Centre at Zhemgang imparts training on basic management of forestry resources to farmers and interested individuals on regular basis.

The overall research impact assessment of technologies, field programs and also quality of research is monitored by Council of Renewable Natural Resources Research of Bhutan (CORRB). Although forest research is one of the oldest, there are still many challenges ahead, especially proper co-ordination between stakeholders and many research results are still not incorporated into management practices. Currently there are many organization which are conducting various research related to FGRs (Annex, Table 8)

### **6.5 Problems and issues related to legislation, research and training**

Policies and plans in the forestry sector had evolved from the start of the development process in the country in 1961. Regulations pertaining to forest produces are still based on conservative policy outlook. The strict and sometimes cumbersome regulations and procedures for harvesting forest products for commercial purposes have discouraged people from harvesting these products. The manufacturing of incense provides a valid example. The incense industry uses more than 40 herbs and aromatic plants as ingredients for manufacturing incense sticks. Although 90% of these species grow and are available in Bhutan, the industry obtains 80% of raw materials from India, simply because of cumbersome bureaucratic procedures to obtained permits (Pelmo, 2006; Tideman, 2006).

Although several legislations and policies governing the FGRs were enacted in the country, some concerns remained such as weak co-ordination between different agencies weak implementation, monitoring and evaluation of the policies and guidelines. All these issues are correlated with relatively lower educational level of most of the forestry professionals. The country`s FRGs are managed by the lowest level forestry professionals such as forest guards. These professional are the lowest in the hierarchy of bureaucracy and also have the lowest level

of professional training. The research on FGR remained weak due to weak infrastructure and professionals and also weak synchronization of activities and co-ordination between agencies and stakeholders.

## 7. The state of regional and international collaboration

Bhutan is one of the very active member states in South Asian Association for Regional Cooperation (SAARC) since it was founded in 1985 in Bangladesh. The member states of SAARC are Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. As a member state, Bhutan is host of SAARC forestry centre. Bhutan is signatory to number of international treaties related to regarding safety of environments and conservation of forest genetic resources (Annex ,Table 7).

Bhutan had participated, signed and ratified number of international treaties and convention (Annex, Table 7) more so after its participation in UNCED at Rio de Janerio in 1992. Knowing that there is growing need to address forest genetic resources and other biological diversity conservation and environmental concerns, Bhutan is seeing the relevance of international co-operation in dealing with conservation of FGR. In adherence to convention on biological diversity, the country had published its first Biodiversity Action plan in 1998 and subsequent updated in 2002. Bhutan presented National Assessment of Agenda 21 (NAA21) in 2002 at World summit on Sustainable Development held in Johannesburg, South Africa; likewise as required National Biosafety Framework had been produced under the framework of Cartagena Protocol on Biosafety. In recent times Bhutan is seeking memberships on key international convention which are concerning sustainable uses of natural ecosystems. Recently Bhutan has ratified Ramsar Convention for conservation of wetlands in the country. Bhutan is also seeking the permanent membership for UN REDD plus mechanism. It is also member of WWF since 1992 and also active member in IUCN. In climate submit at Copenhagen in 2009, Bhutan had committed to remain carbon neutral.

In the regional level Bhutan is one of the most active member states of south Asian Association for Regional Cooperation (SAARC) since its formation in 1985. Bhutan has initiated regional initiative called Living Himalayas Initiative to combat climate change on food, water, energy and biodiversity at regional scale. The initiative had four member countries namely Bhutan, Bangladesh, India and Nepal enclosed within Hindukush Himalayas. The initiative so far had declared and endorsed framework of cooperation and implementation mechanism of the initiative. In November 19<sup>th</sup> 2011, a climate change summit was organized in Bhutan to enhance the effectiveness of this organization (see <http://www.bhutanclimatesummit.org.bt>). This initiative was under taken at regional level in response to slow progress made on climate change issue internationally.

Bhutan is also active member in South Asia Wildlife Enforcement Network (SAWEN), this organization is responsible to curbed out illegal trade of wildlife products in the region as well as in the world, it was formally launched in Bhutan, in January 2011.

## **8. Access to genetic resources and sharing of benefits arising from their use**

Bhutan became Party to the International Convention on Biological Diversity (CBD) in 1995 after ratification by the 73<sup>rd</sup> Session of the National Assembly and signed the Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization in September 2011. A draft ABS policy is already in place awaiting formal endorsement. The Ministry of Agriculture and Forests is the competent authority for giving Prior Informed Consent on the access to genetic resources of Bhutan. The National Biodiversity centre is the authorized agency facilitating the ABS agreements. The ABS policy encourages meaningful long term ABS collaborations with ethical and committed users and directs the benefits to be ploughed back into conservation through communities for the long term viability of conservation initiatives in the country. Currently two collaborations are in place working on insect fungi and an orchid on the principles of ABS.

## **9. The contribution of Forest Genetic Resources to food security, poverty alleviation and sustainable development**

In Bhutan due to its mountainous topography set limits to agriculture cultivatable land for agricultural production. With almost 70% of its population living in rural areas (DOFPS, 2011), forest genetic resources, form a major source of peoples' livelihoods. In 2003, 17% of registered enterprises were based on agricultural products, whereas some 46% were found forest-based (Wangyal, 2005). About 70 % population Bhutanese population lives in rural areas and depends on forests for bio-energy, housing materials, timber, fodder, medicines, food etc. The demand for forest products and services in the country is increasing with the rapid economic growth and demands for various goods and services from the forest sectors. In future it is projected that both urban and rural population will continue to grow, this factor will be important from the point of view of forestry and genetic conservation. The increased demand for forest products, along with population growth and poverty is putting great pressure on all resources, including forests.

The Renewable Natural Resources (RNR) sector comprises of agriculture, livestock, and forestry. According to data from the National Statistical Bureau 2010, the contribution of RNR sector to the national GDP was the same from 2001 to 2006. Averaging the contribution during this period, the agriculture sector contributed 44%, the livestock sector 30%, and the forestry sector 25% within RNR sector. According to 2011 estimates, agriculture's share to GDP decreased to 16.8% from 53% in 1985 (NSBB, 2010). The contribution of forestry sector as reflected in national accounting system maintained by NSBB showed that generally the direct contribution of forestry sector to national GDP consistently declined over a decade (Annex Table 9) and lowest its contribution was 3.5% in 2010. The decline was attributed to change in economic and general development policies in the country. The forest is not seen as the major sources of

income generating resources rather more from conservation of other vital resources bases such water. The declined also attributed to budget allocation as less than six percent of the total budget was allocated to RNR sector in the 10<sup>th</sup> five year plan (2008-2013). The country is aspiring to have hydro-power base economy; however forestry indirect benefits are many folds.

Moreover, those contribution as reflected by NSBB are mainly from royalties fees levied on tangible forests products , on timber and non timber products, sale of round logs, wood products, and commercially important non-wood forest products (NWFPs). However, forestry contribution which are not monetized are many folds, the contribution of forests-based ecosystem services is currently undervalued, which otherwise could increase the RNR sector's contribution to the national GDP. For example, a study by Wildlife Conservation Division in 2010, which monetized all the goods and services provided by the national showed that the park contribution to national GDP was in fact about two percent of the total GDP in 2008 ( Table 9-2). It was just a case of one national park, there are 10 such protected areas in the country. The forestry contributes a lot to forest-dependent communities in rural areas which is largely not accounted in the present accounting system. Those contributions comes in the forms supplying of subsidies timber for construction, fuel-wood, fodder, leaf-litter and many non-wood forest products. Also, the protection function of forest is increasingly gaining public popularity, as well-preserved watersheds are indispensable to generate sustained hydro-electricity, which is at present the one of highest revenues earner in the country ( Annex Table 9) .Therefore, the goal of forest management is to provide these diverse functions and services in perpetuity through ecosystem conservation and careful utilization of forest resources including Non-Wood Forest Products (NWFP) within the limit of sustainability.

Table 9-1: Contribution of RNR sector to national GDP 2005-2010 ( NBS, 2011)

Year/sector	Year					
	2005	2006	2007	2008	2009	2010
RNR sector	22.33	21.41	18.67	18.42	18.23	16.80
agriculture	45.68	45.09	47.40	50.22	50.79	53.62
Livestock	28.03	28.33	27.41	26.05	25.94	25.54
Forestry	26.28	26.59	25.19	23.75	23.26	20.84
	100.00	100.00	100.00	100.00	100.00	100.00

**Table 9-2: Matrix of contribution at different levels from JDNP in 2008, (source WCD, 2008).**

Contribution level	Benefits	Contribution	Revenue contribution	
	Activities Cluster	Type of activity	Value (USD)	% Share from total
Local	Resources utilization	Collection of Timber and non timber products	1,577,123	5.59
	Ecosystem services	Drinking water	1544	0.01
		Irrigation water	3,671	0.01
	Conservation	Fines	5231	0.02
	Tourism	Handicraft sales	5262	0.02
		Pottering-tourist	169,242	0.60
		Pottering-local	112422	0.40
	subtotal		1874495	6.65
Regional	Ecosystem services	Drinking water	39,760	0.14
		Irrigation water	334034	1.18
	Tourism	Food and lodge	82675.86	0.29
		subtotal		456,470
National	Resources utilization	Royalties	4094	0.01
	Ecosystem services	Hydropower	25197011	89.36
	Tourism	Royalties, transport, food and lodge	664842	2.36
	Conservation	Fines and penalties	395	0.00
		subtotal		25866342
Grand total			<b>28,197,307</b>	100.00
Contribution to GDP in 2008				2.00%

### 9.1 Contribution of FRG in Poverty Reduction

The RGOB has identified non-wood forest products development as the major activity for poverty reduction and also as a means to achieve economic growth in the 10<sup>th</sup> five year plan (2008-2013). Over the decades the importance of nwfps with regards to income generation, food security and conservation of biodiversity had been widely accepted in the country (FAO, 2008).

Bhutan has the estimated population of 635,000 of which 69.1% were found living in rural areas (PHC, 2005). According to the poverty analysis report of 2007, on average 23.2% of the Bhutanese live under the poverty line (Households consuming in real terms less than the total poverty line of Nu. 1,096.94 per person per month are considered poor (Tenzin et al, 2012), with a higher incidences in rural areas accounted for between 29.0% to 32.9% of the poverty. Poverty is most prevalent in Samtse, Zhemgang, Mongar, Lhuentse and Samdrup-Jongkhar Dzongkhags. The

poor typically rely on subsistence farming with limited income and employment opportunities (NSB, 2007).

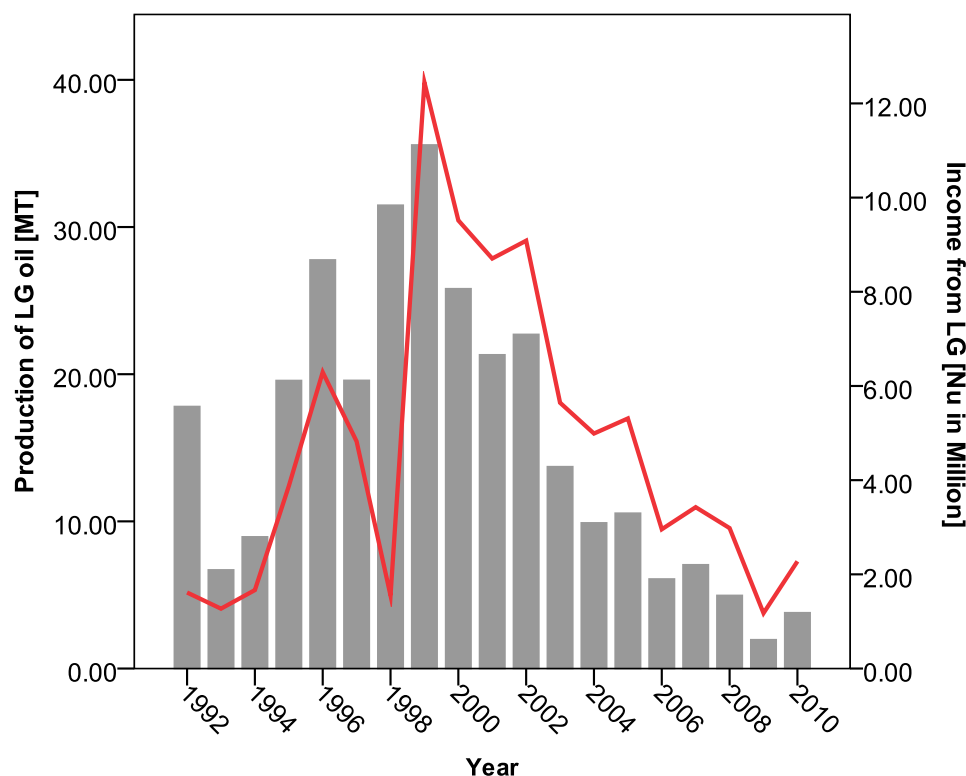
Although Bhutan has not done comprehensive study on contribution of forestry sector at different levels and , however recently there are many interesting studies on the most important forest genetic resources that are directly contributing to food security, poverty alleviation and sustainable development at different level, some cases by specific species are presented .

### **9.1.1 Lemon grass (*Cymbopogon bhutanica*)**

Lemongrass (*Cymbopogon bhutanica*) is a perennial grass which grows naturally under chirpine ecosystem in eastern Bhutan. It is distilled to obtain lemon grass oil which contains an essential oil known as “Citral”. Citral is of primary commercial value which has wide range of application in cosmetic, toiletry, perfumery, pharmaceutical and food industry. Lemon grass oil is highly valued in the international market and therefore is in considerable demand and is a widely sought commodity. Due to its commercial potential RGOB had started distillation of lemon grass oil in 1981 at Kurizampa in Mongar district in eastern Bhutan. It was first initiated private company (Bhutan Aromatic and Phytochemicals (BAPC) of the Tashi Group of Companies. Initially, BAPC controlled the distillation. The farmers could only harvest and sell the lemon grass to BAPC. The firm thus had the major share of the benefits from the lemon grass. BAPC introduced the mild steel distillation unit which was also known as Tashi-type. This type of distillation unit produced poor quality oil which fetched low price in the international market.

Recognizing that the small farmers did not get much benefit beside the poor production and quality of lemon grass oil, the RGOB through the Ministry of Trade and Industry (MTI) then, intervened in the lemon grass oil distillation. Firstly it did away with Tashi type distillation unit and introduced improved stainless-steel distillation units which had greatly enhanced the distillation efficiency and quality of the oil (Dungyel, 2012). Simultaneously, MTI also liberalized the harvesting and distillation of lemon grass to local farmers. It organized the farmers into groups and supplied the distillations sets to those groups. From 1993 onwards, it supported the marketing of lemon grass to Europe through the Essential Oil Development Project. Since then, apart from generating revenue to the government, the lemon grass industry (LGI) had provided substantial income to rural population of four districts of Mongar, Trashigang, Lhuntse and Trashy Yangtse in eastern Bhutan.





**Figure 8: Production of lemon grass [LG in metric tons] and income gross generated [Nu in million] in eastern Bhutan (source Dungyel, D. 2012, RNR RDC, Yusipang).**

A study conducted by RNR RDCs Jakar, Wengkhari and SFD in 2005, reported lemongrass oil distillation industry (LGODI) created about 900 to 1300 jobs in about three months especially in four eastern districts. The study also showed that about 30% (Table 9-3) of the total share of the income of the farmers was from lemon grass distillation industries which were 12 % of the total work share. The study also found that 70.6% of the total work forces in LGODI were women. The study also reported that the distillation unit owners earned between Nu 20,000 upto 120, 000 annually. Currently there was declined in lemon grass oil production (Figure 8) the decline may have been attributed to availability of off farms jobs to farmers in various development projects.

**Table 9-3. Income by sources among farmers involved in Lemongrass oil production (Source, Wolfgang et al, 2005).**

Categories of activities	Name of sector	Type of income		Income	
		subsistence	cash	Work share	Share
On farms	Agriculture	59%	41%	34.9%	40.0%
	Livestock	55%	45%	33.5%	20.0%
	Timber	100%	0%	10.0%	10.0%
Off farms	<b>Lemon grass</b>	<b>0%</b>	<b>100%</b>	<b>12.3%</b>	<b>30.0%</b>
	Weaving	100%	%	3.7%	1.0%
	Wage labor	0%	100%	4.8%	8.0%
	Pottering	0%	100%	0.7%	1.0%

### 9.1.2 Resin tapping from Chirpine (*Pinus roxburghii*)

The tapping of resin from chirpine trees started in Bhutan in the year 1972, with Tashi Commercial Corporation (TCC) and the Royal Government of Bhutan, signing a lease agreement for a period of fifty years. The lease allowed TCC to tap Chirpine forest from the five eastern Dzongkhags. TCC has its resin factory set up in Samdrup Jongkhar since 1974. Resin from other Dzongkhags are brought to the factory to Samdrup Jongkhar for processing into rosin and turpentine as its by-products.

Few pockets of Chirpine forests under Tsirang, Zhemgang, Mongar, Pemagatshel, Trashigang, Mongar, and Lhuntse Dzongkhags are under resin tapping. The total resin requirement for the resin factory is 2000 metric ton per year where as the average resin collection per year for last 7 years was 139.9 metric ton (Table 9-4). There has been a drastic decline in the production of resin in recent years due to the fact that more and more resin tapping areas are included in the National Parks, biological corridors and Community forests where commercial resin tapping is restricted as per the forest and nature conservation rules and more over there are other work opportunities for the cash income. On average the resin tapping employed about 160 people (contracts farmers identified by TCC in those Dzongkhags mentioned earlier) per year and earned Nu. 14,263.70/ year/ person (Table 9-4). Apart from contract farmers for collection of resin, the factory currently employed 13 skilled and semi-skilled people.

Table 9-4 : Some basic statistics of resin production by Tashi Commercial Corporation Limited from 2005-2011 ( source TCC, 2012)

Year	Total production (Kg)	No.of collectors	Qty/collector (Kg)	Nu.earned/Collector	Selling Price/kg
2005	156200.00	209	747.37	8430.32	36.67
2006	177500.00	215	825.58	9329.07	38.95
2007	187500.00	225	833.33	10183.33	37.63
2008	135800.00	198	685.86	8436.06	37.53
2009	167200.00	192	870.83	10772.21	42.4
2010	84400.00	45	1875.56	23688.27	51.33
2011	70700.00	36	1963.89	29006.64	69.63
Average	139900.00	160	1114.63	14263.70	44.88

### 9.1.3 Collection and sale of mushrooms

The wild edible mushrooms has been collected and consumed by Bhutanese population from times immemorial. Some of the most commonly collected mushrooms are *Ophiocordyceps sinensis*, *Tricholoma matsutake*, *Cantherellus cibarius*, *Pleorutus ostreatus*, *Lentinus edodes*, *Lyophyllum shimeji*, *Auricularia auricula*, *Clavaria spp*, *Polyporus sulphureus* (Peldon et al, 2008). Some of these mushrooms are highly priced e.g. *O.sinensis*, *T. matsutake* etc. and are exported to other countries (Figure 9). These mushrooms have been collected by rural people for their livelihood supports.

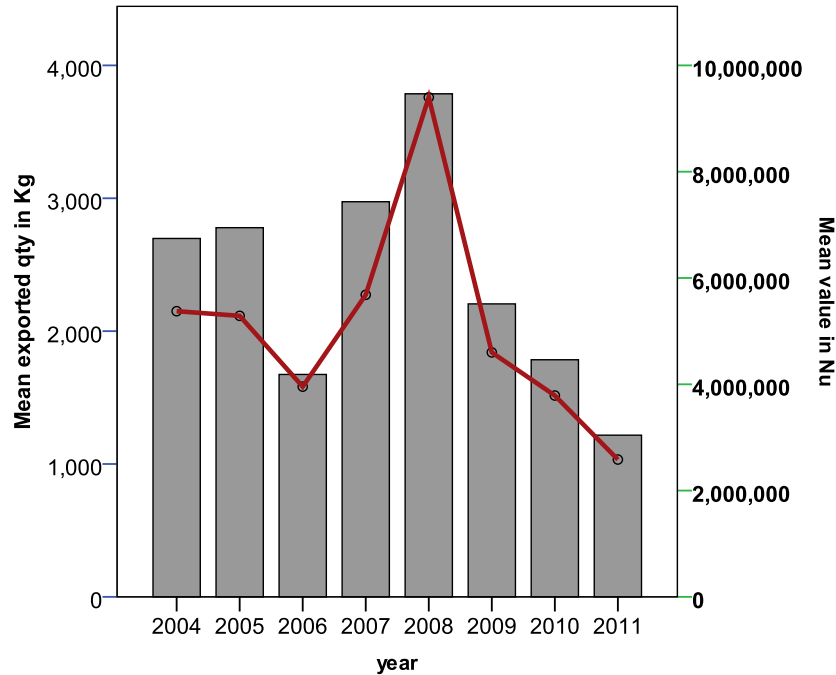


Figure 9: The exported figure of *Tricholoma matsutake*, one of the highly priced mushrooms in international market from Bhutan. Source of data from National Mushroom Centre Semtokha, 2012.

#### 9.1.4 Collections and sale of *Ophiocordyceps sinensis*

The *O. sinensis* is a parasitic fungus which grows on larvae of ghost moth of genus *Thitarodes*, is commonly known as *Yartsa Guenbub* (winter-worm summer-plant), in Bhutan. The host caterpillars usually get infected during early stages of life cycle by the discharge and dispersal of ascospores of *O. sinensis* which in turn emerges the elongated fruiting body from the head capsule of the former caterpillars during spring seasons. The infected caterpillars live underground as worms in winter and in early summer emerge as grass (mushroom) and uninfected ones even hibernate deeper into the soil (Winkler, 2008). After infection, the hyphae of the mycelium develop inside the caterpillar's body and eventually get completely mummified exoskeleton filled with *O. sinensis* mycelium and the reproduction and occurrences of fungi depends on widespread distribution of host caterpillar larvae.

It had been traditionally been used as medicines for healing various human ailments in Asia. Today it remained highly valued Asian traditional medicines. The important medicinal treatments explained through many research studies are the improvement of physical performances, reproductive functions, cardiovascular and circulatory system, respiratory system (Holliday and Cleaver, 2008), kidney and renal function and treating cancer (Li, et al, 1996), stimulating overall health and recovery from illness and building up strength and restore energy (Jiang and Yao, 2002).

It is mostly found in Himalayan alpine regions of Asian continent . In Bhutan, the habitat for *O. sinensis* is characterized by treeless alpine grasslands at an elevation range of 4200-5200 masl in the cold temperate region (Maczey, et al, 2010 ). The growth of *O. sinensis* has very restricted habitat and the production are steadily decreasing annually (Holliday and Cleaver, 2008) could be due to various environmental and ecological factors and its increasing demand worldwide.

The most valuable *O.siensis* which fetches the best price is the biologically immature ones then matured ones (Winkler 2009). The specific host range of *O. sinensis* is not certain and most of the Thitarodes species spend their lives under the surface of the alpine grasslands soil and feed on the roots of the plants (Cannon *et al.*, 2009). The occurrences of host larvae of the fungus are restricted to the range of the food plant genera. Recently, two types of Thitarodes ghost moth species (*Thitarodes namnai* and *T. caligophilus*) were identified and described from Bhutan comparing with the closest relatives from the neighboring countries of Nepal, Japan and China (Maczey *et al.*, 2010).

The *Ophiocordyceps sinensis* is one of the most important non wood forests products which is considered as green gold. It is protected under Schedule 1 in Nature and Conservation Act 1995. However, due to lack of income opportunities for the highland population, In 2004 His Majesty the fourth Druk Gyalpo had issued Royal Degree (Royal Kasha) legalizing the collection of *Ophiocordyceps sinensis* to those residing in alpine region of the country. Since its legalization in 2004, people of alpine region had collected 3302.83 kg of *O.sinensis* (Table 9-5) amounting to total revenue of Nu 619.48 million (USD 12-13 million at different exchange rates). This has immensely helped to generate income to transhumance communities of alpine region.

Table 9-5: Yearwise production of *Ophiocordyceps sinensis* and revenue generated through its sale from 2004-2012.

Year	Total production (Kg)	Total revenue (NU in Millions)
2004	178.00	11.57
2005	200.00	15
2006	505.67	42.92
2007	140.37	41.15
2008	685.17	95.31
2009	594.73	77.79
2010	594.00	112.38
2011	169.00	72.67
2012	235.89	150.69
Total	3302.83	619.48

### 9.1.5 Collection and sales of other non-wood products by farmers' groups

The forest genetic resources play an important role in the daily lives and overall well-being of the Bhutanese people especially among the rural farming community; for instance they are a major source of off-farm income, food, medicinal and aromatic products, fodder, fiber, and also used for local construction materials. Very often especially the non wood forest products (NWFPs) are a safety net for poor people in the off-farm season and/or whenever needed as a food security measure. NWFPs offer a lifeline for many rural Bhutanese households. The poor and landless turn to the forest resources for materials and produce with which to make a living. Many forest products for handicrafts, dyes, waxes, tools, clothing, medicines, food and fodder comes

directly from forests. As mentioned in earlier sections that RGOB had shifted its focused from state controlled to people's participatory approach, in doing so many legislations and policies frameworks were enacted passed favoring people participation in resources management. With putting in place the national strategy of non wood forest products document 74 farmers groups were formed around different non wood forests products 3158 households generating immediate cash income to these farming communities (Table 9-6) for income information)

**Table 9-6: Number of farmers groups and beneficiaries households based on some FGRs in Bhutan as of October 2012.**

non wood types	No.of farmers	
	groups	Beneficiary households
Bamboo and cane	13	577
Mushroom species	2	103
<i>Broom species</i>	2	7
Dyes species	9	359
Medicinal plants species	33	1921
Spices	3	60
Others	12	131
<b>Total</b>	<b>74</b>	<b>3158</b>

A very good example of Non-wood Forest products playing a vital role in providing livelihood to the communities can be seen in the remote part of Bhutan such as Lauri Geog. In this remote part of Bhutan, one of the most important non-wood forest produces is chirata ( *Swertia chirayata* ). More than 40% of the household incomes come from the sale of the chirata (Pradhan, et al, 1998). Beside chirata, the farmers of this geog also collect and sale star anise (*Illicium griffithii*), mangitho (*Rubia cordifolia*) which are important sources of household cash income.

#### 9.1.6 Sales of timber from community forestry

Currently there are 413 Community Forestry Management Groups (CFMGs) with 19,559 rural households and manages 49'673 ha of Community Forests (CFs) in the country (CF database maintained by SFED, 2012). This CFs had the potential of timber production and earned cash income .There are also 627 private forests spread over the country with potential to generate cash income for rural people.

#### 9.1.7 Employment in wood based industries

There are about 113 different woodbased industries in the form of saw mills, wood craft centre, particleboard, furniture houses, plywood unit etc. These industries provide employment opportunities 3500-4000 people at different professional levels.

## 10. Current FGRs conservation and Management Challenges

Although large part of Bhutan is under different conservations and protection regimes however the conservations efforts are being face with number of challenges such as human

wildlife conflicts, forest fires, forest land conversions to some other land uses, poaching of both flora and fauna etc.

### 10.1 Human wildlife Conflicts

The human wildlife conflicts is one of the serious issues confronting the conservationists, the farmers lost crops, livestock and even human to wild animals. The conflicts had been reported in all parts of the country. The database maintained by DOFPS (2011) showed that there are 1,770 cases of livestock predated by wild animals in ten years (since 2002 upto 2011) which amounts to Nu. 7,471,850.00 (USD 149,437) and about 40-50% of total crop losses to wild animals ( MOAF, 2011).The conflicts is aggregating to several socio-economics problems such as rural-urban migration, abandoned of agricultural and farmers which severely hitting the food security and self reliance policy of the Government. Moreover, the conservation of some key stone wild animals (tiger, leopard, elephants) and their associated habitats which harbor many important FGRs are also at stake.

### 10.2 Forest Fires

The forest fire engulfed thousands of acreages of forest lands every year. Despite stringent forest fire related legislation and also public awareness programs, forest fire has persisted as a major environmental conservation challenge in the country. The database maintained by DOFPS (1997-2011) showed about 62 incidences of forest fires occurred annually. The report also showed that about 18,188.23 acres (7423 Ha) of forests land destroyed every year. Many FGRs may be get extinct in the wild due to forest fires.

### 10.3 Forest land Conversions

Since Bhutan is developing nation and it had been investing on infrastructure development such as roads, buildings, hydropowers amongst other, the conversion of forest lands to these developmental activities is also increasing sharply. The database maintained by DOFPS showed in three years some 9080 ha of forests land had been converted to some other land uses of which 37.08 percent was lease out, about 24% was lost to the hydropower transmission lines (Table 10-1).

Table 10-1: Forest land conversions to different landuse 2008-2011 in Ha. ( source DOFPS, 2011)

Types of allocation	2008-2009	2009-2010	2010-2011	Total	Percent
Transmission Line	760.038	618.502	794.718	2173.26	23.93
Road	309.524	656.363	912.649	1878.54	20.69
Govt.Institutions	360.296	320.071	179.545	859.912	9.47
Lease	1021.83	378.661	1966.36	3366.85	37.08
Others	330.694	145.89	325.369	801.953	8.83

Total	2782.38	2119.49	4178.64	9080.51	100.00
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## 10.4 Poaching and Illegal Activities Associated with Forest Resources

Various forests related illegal activities (not in conformity with existing forests legislations) had been reported across the country on annual basis. The DOFPS reports (2011) showed that 1,273 cases of illegal activities had been detected since in a period of six years (2006-2011) of which 44% were reported transgression of timber. Other reported cases were setting of forest fires, poaching and trade of wildlife products.

## 10.5 Forest Grazing

The grazing of domesticated animals had been traditional practice in Bhutan, given the subsistence nature of Bhutanese farmers (69 % of the total populations) and rearing of animals is indispensable component of farming system and most of these animals graze in the forests. The database maintained by Department of Livestock (DOL) estimated 433, 021 animals (Table 10-2) which are depending directly or indirectly on forest grazing resources. Grazing forests had both positive and negative impacts. The livestock associated activities also impact the forests negatively such as the herder's usages of firewood, construction of huts, intentional setting of forest fires for better grass for cattle etc.

Table 10-2: Total number of animals which depends on forest grazing or forest resources ( source DOL, 2010)

Types of animals	Number of animals	Percent
Cattle	309277	71.42
Goat	43134	9.96
Yak	40374	9.32
Horses	17996	4.16
Sheep	12699	2.93
Mule	5265	1.22
Goleng	3186	0.74
Buffalo	928	0.21
Donkey	162	0.04
Total	433,021	100

## 10.6 Forest Pests and Diseases

Although forest pests and diseases had never been serious issue in the past in the country except for occasional out-break of bark beetles especially in conifer belts of the country. So far no comprehensive study of forest pest and diseases had been under taken, in absence of such studies, there are large risks of forest decline due to such epidemics.

## 10.7 Other FGRs management challenges

Bhutan is rapidly developing its socio-economics through development of essential infrastructure and other engines of economy such as large scale construction of hydropower. Government is also considering bringinning in more tourists. In light of all these developments forests resources such as timber, fuelwood etc are increasing on daily basis. This development will certainly put lot of pressure on forest genetic resources.

The forest management units (FMUs) reported failure of natural regenerations especially in broadleaved FMUs and in absence of long term observation data on logged over forests it is difficult to ascertained the future composition of such logged areas. Grazing by domestic cattle of logged over areas further aggravate the problems. Although guidelines had been developed for many non wood forests products, however these guidelines are mostly developed based on very short period experimental or observed data in most cases the ecology and biology of non wood and even tree species are largely uncertain. Harvesting with very little knowledge on biology and ecology of concern species might pose great uncertainly for their sustainability in future. The tree breeding programs especially to reforest logged over areas are still very poor. In nut shell there are many areas where research has to be undertaken and research results should be the basis of sustainable management of FRs in the country. The most worrisome areas are medicinal plants which are traded without having proper chemical constitutes database. The existing infrastructure and human resources to conduct research on FRs is still remained bottle neck.

There are studies which showed, there are concerns regarding the conservation and sustainable use of FGRs. For example, the traditional medicine system is highly valued since ancient time in Bhutan and is incorporated into modern health system too. The raw materials used in traditional systems are plant parts, minerals and parts of animals. According to Indigenous Traditional Medicine Institute (ITMS), there are 129 high altitude plants species (Meijboon and Norbu, 2009) used in ITMS and 113 from lower elevations (Wangchuck, 2011). Out of 129 high altitude medicinal plants, ITMS had identified 16 of them as concerned species which includes *Aconitum orochryseum*, *Chrysosplenium forrestii*, *Corydalis flabellata*, *Corydalis stracheyi*, *Dactylorhiza hatagirea*, *Delphinium brunonianum*, *Fritillaria delavayi*, *Gentiana urnula*, *Meconopsis horridula*, *Meconopsis simplicifolia*, *Nardostachys grandiflora*, *Neopicrorhiza scrophulariifolia*, *Onosma hookeri*, *Rhodiola himalensis*, *Saussurea gossypiphora* and *Veronica himalensis* ( Meijboon and Norbu, 2009). Likewise there are some species of FGR which are constantly used for handy crafts are under threat due to lack of knowledge in management of resources as case reported from Kangpara, Trashigang *Neomicrocalamus andropogonifolius* ( Long et al, 2009). This species of bamboo was in used for weaving of local handicrafts for very long period of time, however the resources was observed depleted in recent years due to overharvesting of bamboo. The over harvesting was due to higher demand for products in the market. Similarly the same authors who studied the bamboo and cane in two Sarpang and Samtse Dzongkhag found improper management (cutting), planting, processing and marketing of rich bamboo resources from the southern region. Currently, the bamboo and cane management in the country is poorly documented as well as poorly managed FGR as indicated by some recent studies.



## 11. Conclusion

Bhutan is committed to a strong national conservation mandate not only for its national well-being but also to add to global well-being in line with its development philosophy of Gross National Happiness. However this commitment is not without its challenges when we consider the fact that 69% of the population still lives on subsistence agriculture and there is increasing demand for wood and non-wood products for domestic consumption as well as industrial uses. There is also an increasing trend of developmental activities in the country with the rapid economic development taking place in recent years. These factors lead to tremendous pressure on the forest genetic resources and in some cases, loss of forest habitats to development activities. To offset this increasing trend, far-reaching forestry plans and programs based on sound forestry principles and practices are crucial for optimal use of forest genetic resources as well as to engender political support for the conservation of forest genetic resources. Nevertheless, inadequate information coupled with poor information sharing mechanism, inadequacy in the knowledge of forests themselves and associated interactions are the main constraints to develop sound and improved management practices for forest genetic resources in the country.

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## Annex

**Table 1: Vegetation zones/types in Bhutan (After Grierson and Long 1983).**

Eco-zone (masl)	(altitude	Characteristic species
Sub-tropical region (200-1000 (1200) m		<i>Acrocarpus fraxinifolius</i> , <i>Ailanthus grandis</i> , <i>Bombax ceiba</i> , <i>Crateva religiosa</i> , <i>Delenia pentagyna</i> , <i>Daubanga grandiflora</i> , <i>Gmelinea arborea</i> , <i>Musa spp</i> , <i>Pterospermum acerifolium</i> , <i>Shorea robusta</i> , <i>Tetrameles nudiflora</i> and <i>Dalbergia sisoo</i> .
Warm-broadleaved zone ( 1000-2000 (2300) masl		<i>Alangium chinenses</i> , <i>Altingia excels</i> , <i>Bichofia javanica</i> , <i>Callicarpa arborea</i> , <i>Castanopsis indica</i> , <i>Cordia obliqua</i> , <i>Dichroa febrifuga</i> , <i>Dendrocalamus hookeri</i> , <i>Engelhardia spicata</i> , <i>Entada pursaetha</i> , <i>Euodia fraxinifolia</i> , <i>firmiana colorata</i> , <i>Helicia nilagrica</i> , <i>Maclura cochinchinensis</i> , <i>Maesa spp</i> , <i>Schima wallichii</i> , <i>Macaranga pustulata</i> , <i>Musseanda roxburghii</i> , <i>Ostodes paniculata</i> , <i>Pouzolzia sanguine</i> , <i>Stereospermum personatum</i> , <i>Trevesia palmate</i> , <i>Wendlandia puberula</i> , <i>Calamas spp</i>
Chirpine zone 900-1800 ( 2000) m		<i>Buddleja asiatica</i> , <i>B.bhutanica</i> , <i>Cycas pectinata</i> , <i>Cymbopogon flexuosus</i> , <i>Euphorbia royleana</i> , <i>Ficus oligodon</i> , <i>Grewia sapida</i> , <i>Indigofera dosua</i> , <i>Osyris lanceolata</i> , <i>Pinus roxburghii</i> , <i>Rhus paniculata</i> , <i>Securinega suffruticosa</i> , <i>Solanum erianthum</i> , <i>Woodfordia fruticosa</i> , <i>Zizyphus incurve</i>
Cool broadleaved (2000-2900		<i>Acer campbellii</i> , <i>A.sterculiaceum</i> , <i>Betula alnoides</i> , <i>Brassaiopsis alpine</i> , <i>Chirita lachenensis</i> , <i>Ciryloopsis himalayana</i> , <i>Elastostem monandrum</i> , <i>E.obtusum</i> , <i>Exbucklandia populnea</i> , <i>Helwingia himlaica</i> , <i>Ilex fragilis</i> , <i>Lecanthus penducularis</i> , <i>Lindera nesiana</i> , <i>L.pulcherrima</i> , <i>Persea clarkeana</i> , <i>Pilea bracteosa</i> , <i>Rosa moschata</i> , <i>Rubus lineatus</i> , <i>R.pentagonus</i> , <i>R.treuleri</i> , <i>Schisandra grandiflora</i> , <i>Symplocos dryophila</i> , <i>S.ramosissima</i>
Evergreen oak (1800-2600)m		<i>Acer campbellii</i> , <i>Castanopsis hystrix</i> , <i>C. Tribuloides</i> , <i>Elastostema hookerianum</i> , <i>E.sessile</i> , <i>Galeola lindleyana</i> , <i>Juglan regia</i> , <i>Pilea symmeria</i> , <i>Quercus lamellose</i> , <i>Skimmia arborescens</i> , <i>Symplocos lucida</i>

*Continued—Table 1*

Bluepine zone (2100-3100)m	<i>Arisaema consanguineum, Beriberis asiatica, Berchemia edgeworthii, Cotoneaster griffithii, Elaeagnus parviflora, Euonymus grandiflorus, Indigofera heterantha, Jasminuim humile, Leptotodermis scabrida, Lonicera quinquelocularis, Lyonia ovalifolia, Ophiopogon intermedius, Philadelphus tomentocus, Pinus wallichiana, Polygala sibirica, Prinsepia utilis, Quercus griffthii, Q.semecarpifolia, Rhododendron arboretum, Rosa sericea, Spiraea canescens, Zanthoxylum armatum</i>
Spruce zone (2500-3200)	<i>Acer cappadocicum, A.pectinaum, Beriberis praecipua, Enkianthus deflexus, Larix griffithiana, Linder a heterophylla, Osmanthus suavis, Picea brachytyla, Picea spinulosa, Pyrola sikkemnesis, Ribes takare, Rosa macrophylla, Salix daltoniana, Salvia campanulata, Taxus baccata</i>
Hemlock zone (2800-3200)	<i>Arundianaria racemosa, Betula utilis, Buddleja colvilei, Gaultheria fragrantissima, Larix griffithiana, Litsea sericea, Maddenia himalaica, Magnolia globosa, Panax psedo-gingseng, Rhododendron falconeri, R.hodgsonii, R.Keysii, Rubus calophyllus, R.pentagonus, Sorbus thebetica, Tsuga dumosa, Viburnum mullaha</i>
Fir zone (3100-3800) m	<i>Abies densa, Arundianaria maling, Betula utilis, Bryocarpum himalaica, Daphne bhlu a, Juniperus psedosabina, Maddenia himalaica, Primula denticulate, Prunus rufa, Rheum acumin ate, Rhododendron cinnabarnum, R.hodsognii, Ribes takare, Rubus fragariodes, Skimmia laureola, Sorbus foliolosa, Viburnum nervosum</i>
Juniper rhododendron screub zone (3700-4200)	<i>Gaultheria trichophylla, Puniperus recurvaSqumata, Morina nepalensis, Pedicularis megalantha, Phlomis tibetica, Potentilla arbuscala, Primula sikkimensis, Rhododendron lepidotum, Thalictrum chelidonii, Trollius pumilus</i>
Dry alpine scrub (4000-4700)	<i>Aconitum orochryseum, Astragalus acaulis, Chesneya nubigena, Cremanthodium thomsonii, Ephedra gerardiana, Meconopsis simplicifolia, Picrorhiza scrophulariifolia, Primula calderiana, Rheum nobile, Rhododendron anthopogon, Salix lindleyana, Saussurea gossypiphora, S. Obvallata, Saxifraga moorcroftiana, Tanacetum gosspinum, Thermosis brabata</i>

**Table 2: The protected area system of Bhutan (sq.km) which includes national park, wildlife sanctuaries, nature reserve, botanical garden (DOFPS, 2011).**

SI No	Name of protected area	Type of protected area	Region	Estb.Year	Total area (sq.Km)	% share of total area	Remarks
1	Bomdeling	Wildlife Sanctuary	East	1998	1,520.6	3.96	
2	Jigme Dorji	National Park	North-West	1995	4,316	11.24	
3	Jigme Singye Wangchuck	National Park	central	1995	1,730	4.51	
4	Khaling	Wildlife Sanctuary	South-East	NE	334.73	0.87	Notified 1993
5	Manas	National Park	South	1966	1,057	2.75	
6	Lamperi	Botanical Park	West	2004	47	0.12	
7	Phibsoo	Wildlife Sanctuary	South	2010	268.93	0.70	
8	Sakteng	Wildlife Sanctuary	East	2003	740.6	1.93	
9	Toorsa	Strict Nature Reserve	West	2010	609.51	1.59	
10	Thrimshingla	National Park	East-Central	2000	905.05	2.36	
11	Wangchuck Centennial	National Park	North-central	2008	4,914	12.80	
12	Others	Biological corridors		Since 1993	3,307.14	8.61	
<b>Total area protected area</b>					<b>19,750.56</b>	<b>51.44</b>	
<b>Total area of Bhutan</b>					<b>38,394</b>	<b>100.00</b>	



**Table 3: The different plantation programs of FRGs plantation by different agencies in Bhutan.**

Type of plantation	Purpose of plantation	Species type planted	Responsible Agency
Avenue plantation	Beautification (aesthetic) of landscape, providing shade, windbreak	Ornamentals	Municipality, department of Road, Schools, DOFS, private individuals
Industrial plantation	To meet the demand of wood base industries	Mostly timber species	Industries mostly by BBPL
Plantation in Forest Management Units	To replenish the logged over areas	Timber species endemic to the FMU only	Mostly by NRDCL
Normal/regular plantation	To rehabilitate degraded land, enrichment planting in critical watershed etc	Any species suitable to the areas	Dzongkhag forestry, Territorial division, national parks, and other agencies
Community Forestry plantation	Enrichment plantation	Any kind as per the wish of the community members	Community forestry members
Private plantation	To meet private demand	Any kind	Land owners
Special plantation program	To rehabilitate and conserve rare or threatened species	Threatened or rare species of plant	DOFPS
Payment for environmental service plantation	Rehabilitate critical areas within watershed of major hydro-power plants e.g. Wangchu and Puna-Tsangchu	Any endemic plant species suitable for the region	DOFPS
Arboretum and gene bank plantation	Education and recreation purpose	Any species	Research and Development Centre and National Biodiversity Centre

**Table 4: Some special tree species and important timber tree species of Bhutan (DOFPS, 2010). CCTS = common commercial tree species, MPTS = multiple purpose tree species, STF= subtropical forest, WBLF = warm broadleaved forest, CBLF = Cool broadleaved forests, MCF= mixed conifer forests.**

Scientific name	Categories	Uses	Distribution
<i>Acacia Catechu</i>	Special	MPTS	Limited in STF
<i>Aquilaria calamensis</i>	Special	Medicines	Limited in STF and WBLF
<i>Carpinus viminea</i>	Special	Timber	Sparsely in WBLF to CBLF
<i>Cupressus corneyana</i>	Special	Mostly timber	Mostly planted and few pockets of lower dry valley
<i>Dalbergia sissoo</i>	Special	Mostly timber	Limited in STF and WBLF
<i>Dalbergia latifolia</i>	Special	Mostly timber	Limited in STF and WBLF
<i>Shorea robusta</i>	Special	Mostly timber	Limited in STF
<i>Taxus baccata</i>	Special	Medicinal	Sparsely populated from WBLF till MCF
<i>Tectona grandis</i>	Special	Mostly timber	Planted forests in subtropical areas
<i>Duabanga grandiflora</i>	A	Mostly timber	Sparsely populated in STF and WBLF
<i>Gmelina arborea</i>	A	MPTS	In STF to WBLF also planted
<i>Michelia champaca</i>	A	Mostly timber	Sparsely populated in WBLF to CBLF
<i>Michelia excelsa</i>	A	Mostly timber	Sparsely populated in WBLF to CBLF
<i>Phoebe goalparensis</i>	A	Mostly timber	Populated in WBLF to CBLF
<i>Pinus wallichiana</i>	A	Mostly timber	Abundant in dry upper valleys
<i>Pinus bhutanica</i>	A	Mostly timber	Very sparsely populated in eastern Bhutan
<i>Terminalia myriocarpa</i>	A	Mostly timber	In STF to WBLF
<i>Terminalia tomentosa</i>	A	Mostly timber	In STF to WBLF
<i>Pinus roxburghii</i>	CCTS	Resin+timber	In dry valleys of west central and eastern Bhutan
<i>Alcimandra catcathii</i>	CCTS	Mostly timber	Sparsely populated from STF upto CBLF
<i>Acer spp</i>	CCTS	Mostly timber	Sparsely populated in CBLF
<i>Quercus spp</i>	CCTS	MPTS	Sparsely populated in WBLF to MCF
<i>Symplocos spp</i>	CCTS	MPTS	
<i>Castanopsis spp</i>	CCTS	MPTS	Abundant in WBLF to CBLF

Continued Table 4

Cinnamum spp	CCTS	MPTS	Moderately available in WBLF to CBLF
Abies densa	CCTS	Mostly timber	Abundant as stand in higher altitude
Tsuga demosa	CCTS	Mostly timber	Abundant as stand in higher altitude
Celtis spp	CCTS	Mostly timber	Sparsely populated in WBLF and CBLF
Sloanea tomentosa	CCTS	Mostly timber	Sparsely populated in WBLF and CBLF
Toona ciliata	CCTS	Mostly timber	Sparsely populated in WBLF
Persea spp	CCTS	Mostly timber	Moderately populated in WBLF and CBLF
Altingia excels	CCTS	Mostly timber	Sparsely populated in WBLF and CBLF
Schema wallichiana	CCTS	Mostly timber	Sparsely from STFs to CBLF
Michelia spp	CCTS	Mostly timber	Sparsely from STFs to CBLF
Bomarea regulosa	CCTS	Handicraft	Mostly in dry areas sparsely populated
Phoebe species	CCTS	Mostly timber	Moderately populated in WBLF and CBLF
Alnus nepalensis	CCTS	Particle boards	Mostly in WBLF to CBLF in disturbed areas
Macaranga spp	CCTS	MPTS	Mostly in WBLF to CBLF in disturbed areas

*\*This list is not exhaustive, there are many species being used by people for different purposes.*

**Table 5: Some of the commonly used FGR for the purposes other than timber in Bhutan with economic potentials (DOFPS, 2008).**

Common name/categories	Species ( local name)	Uses
Mushrooms	1. <i>Auricularia sp.</i> (Jili namcho)	Food , locally consumed and exported especially <i>Tricholoma matsutake</i>
	2. <i>Cantharellus cibarius</i> (Sisi shamu)	Locally consumed
	3. <i>Lyophyllum shimeji</i> (Ngala shamu)	Locally consumed
	4. <i>Rozites caperata</i> (Dungshi shamu)	Locally consumed
	5. <i>Tricholoma matsutake</i> (Sangay shamu)	Exported and locally consumed
Bamboo	1. <i>Bambusa sp.</i>	Multiple uses
	2. <i>Borinda grossa</i>	Multiple uses
	3. <i>Dendrocalamus sp.</i>	Multiple uses
	4. <i>Neomicrocalamus andropogonifolius</i> (Yula)	Handicraft
	5. <i>Yushania sp.</i> (Daew yanka)	Bow making
cane	6. <i>Calamus acanthospathus</i> ( Beth)	handicraft
	7. <i>Calamus latifolius</i> ( Beth)	handicraft
	8. <i>Plectocomia himalayana</i> ( Patsha)	Special dish
Aromatic Medicinal plants	1. <i>Aconitum heterophyllum/lacinatum</i> (Tsendhug)	
	2. <i>Acorus calamus</i> (Chudala)	
	3. <i>Cordyceps sinensis</i> (Yartsa guenbup)	
	4. <i>Illicium griffithi</i> ( Lee-shing)	
	5. <i>Phyllanthus emblica</i> (Amla)	
	6. <i>Picrorhiza scrophulariifolia</i> (Hong-len)	
	7. <i>Swertia chirayita</i> (khalu)	
	7. <i>Juniperus squamata/pseudosabina</i> (shup)	
	8. <i>Ephedra gerardiana</i> (Tshe)	
	9. <i>Rhododendron anthopogon</i> (Balu)	
	10. <i>Rhododendron ciliatum</i>	
	11. <i>Rhododendron setosum</i> (Sulu)	
	12. <i>Selenium vaginatum</i> (Tang-kuen)	
	13. <i>Nardostachys grandiflora</i> (jatamansi, pangpoi)	
	14. <i>Inula racemosa</i> (Manu)	
	15. <i>Cinnamomum tamala</i> (Shintsa, Teespata)	
	16. <i>Tanacetum nubigenum</i> (Sanse kaju)	
	17. <i>Terminalia chebula</i> (Aru)	
	18. <i>Terminalia bellirica</i> (Baru)	
19. <i>Cymbopogon bhutanica</i>		
Natural dyes	1. <i>Rhus sp</i>	
	2. <i>Rubia cordifolia</i>	

Continued Table 5

Food and vegetables	1. <i>Asparagus racemosus</i> (Wild asparagus)	
	2. <i>Dioscorea belophylla</i> (Tubers)	
	3. <i>Dioscorea pentaphylla</i> (Tubers)	
	4. <i>Diplazium esculentum</i> (Nakey)	
	5. <i>Elatostema sp.</i> (Damroo)	
	6. <i>Esholia sp</i>	
	7. <i>Girardinia diversifolia</i> (Nettle plant)	
	8. <i>Oroxylum indica</i>	Flowers as vegetables
Spices	1. <i>Piper longum</i> (Pipla long)	
	2. <i>Piper pedicellatum or peepuloides</i> (Pipla round)	medicinal
	3. <i>Zanthoxylum armatum</i> (Sichuan pepper)	Species and medicinals
	4. <i>Illicium grifithii</i>	Medicinal
Oil and resin	1. <i>Acendra (churi)</i>	edible
	2. <i>Symplocos paniculata</i>	edible
	3. <i>Odorata</i>	edible
	4. <i>Pinus wallichiana</i>	Industrial application
	5. <i>Punus wallichiana</i>	Industrial application
	6. <i>Jatropa</i>	Industrial application
Fruits and nuts	1. <i>Juglan regia</i>	Food
	2. <i>Manifera sylvatris</i>	Food
	4. <i>Castanopsis tribuloides</i>	Food
	5. <i>Castanopsis indica</i>	Food
	6. <i>syzyium cumini</i>	Food
	7. <i>Choeropondias auxullairies</i>	Food
	8. <i>Myrica escunelata</i>	Food
	Traditional paper	1. <i>Daphne spp</i>
2. <i>Edgeworthia gardneri</i>		Handmade paper

**Table 6. The Constitution, major legislations, strategies, programs and action plans governing the natural environments in Bhutan.**

Constitution of Kingdom of Bhutan	Article 5 of the Constitution mentioned every aspect of conservations and sustainable management of natural resources and need for appropriate legislation to be put in place for their wise utilization and in section 3 under this article it is mentioned explicitly that the country should maintained a minimum of 60% forest cover all the time.
Policies	Salient features
1.National Forest Policy (2011) First promulgated in 1974, revised in 1991 and again revised in 2011	Regulates , evaluates and monitors through appropriate programs the sustainable management of forest resources both wood and non wood, watershed management, biodiversity conservation, participatory forest , forest protection, science base forest mgt regimes ,rights and responsibilities of stakeholders over the forest resources
2.Subsidized timber and non-wood forests products policy 2011 (draft)	Regulates and empowers to implement rural subsidized timber base on economic status of the individuals especially the farming communities.
3.National Land Policy ( draft) 2010	Adopted for sound governance, administration, sustainable use and development of land to guide all relevant sector policies, programs and planning processes affecting the land resources in the country.
4.Timber pricing policy 1999	Ban of timber export in log forms, regulations of timber prices internally through government reserve price system when logs are bided in open auction
5.RNR research Policy of Bhutan, 2011	Regulates and monitors research undertakings, research outcome monitoring, technology released, impact assessment of technologies under different sections.
6.Water Policy 2003	Environmental safeguards for water quantity and quality, integrated watershed management, user rights

Continued Table 6

7.Economic Development Policy, kingdom of Bhutan 2010	Chapter 6 : Emphasis on green development under deals with all environmental obligations for business ventures
8. Bhutan Hydropower Policy(2008)	Explicitly mentioned about environmental safeguards under Clause 12
9. Bio-safety Policy 2008	This ensure to Bhutanese people, the biological resources, plants and animals are protected from the harmful effects of pests and diseases, invasive alien species,genetically modified organisms, toxic chemicals and food additives. This policy also protects against the uncertainties associated with new technologies, meet international obligations, and take full advantage of opportunities with global food and agricultural trade.
Acts	Salent feaures
1.Forests and Nature Conservation Act  (First enacted in 1969, amended in 1995)	The legislation that governs and regulates the uses of FGRs in the country.
2.National Biodiversity Act of Bhutan 2003	The Convention on Biological Diversity, conservation and sustainable use of genetic resources, fair and equitable sharing of benefits arising from its utilization; regulates the development of products, compounds and substances that have medicinal, industrial and agricultural and related applications from biological resources and protection of traditional knowledge.

Continued Table 6

3.National Environmental Protection Act 2007	Legislative documents which controls and regulates overall governing of FRs on sustainable and equitable basis. Protects tradition way of living and reaffirmed to maintain a minimum of sixty percent of country's land under forest cover in perpetuity; Environment integral part of GNH, respects international environmental laws and has acceded to major international, environment and sustainable development instruments.
4.Plant Quarantine Act 1993	It is an Act to prevent the introduction of pests into Bhutan, which are not present or widespread in the country as well as to control those pests already in the country by restricting their spread and by endeavouring to eradicate them. It will also provide facilities for services for import and export of plants and plant products and extend co-operation in the prevention or movement of pests in international trade and traffic through issuance of phytosanitary certification.
5.Seed Act 2000	regulate import and export of agriculture seeds, to prevent introduction of plants and diseases and to promote seed industry in the country aimed at enhancing rural income and livelihood
6.Anti corruption Act, 2006	Prevent, detect and root out all forms of Corruption in Bhutan. Effective uses of public properties. This act is essential to curve illegal transactions, trade of FGRs.
7.Minerals and mines Act 1995	Protection of environment chapter 3, section 24 which directly or indirectly conserve FGRs in mining areas.
8.Water Act 2011	Regulate, uses , protection and conservations, rights of water through implementation of integrated water resources management.
Rules , regulations and code of practices	
Forest and Nature Conservation Rules 2006 ( 1974, 1991, 2000)	Regulations on uses of FGRs and other natural resources as specified in Forest and Nature Conservation Act 1995.



Continued Table 6

Regulations for the environment clearance for the projects, 2002.	Regulates any development work having to pass environmental clearances
Timber pricing guidelines 1999	Regulates the timber prices and also banned the export of timber to other countries in log/ unprocessed forms
Interim guidelines on lease of GRF to commercial agriculture 2011	This guidelines which helps in streamlining the leasing of government reserve forests to commercial agriculture
Forest management codes of Bhutan, 2004	The codes address all aspects of sustainable forest management appropriate for FMUs in Bhutan. The Code also supports the work of the Territorial Divisions in fulfilling their role in implementing the Forest Policies, Acts and Rules and forest management plans.
Mines and Minerals management Regulations of Bhutan, 2002	Regulates mining activities specifically with regards to environmental conservations

Table 7: International and regional treaties signed/ratified/acceded by Bhutan related to forest genetic resources (source DOFPS 2011 and BAP, 2009).

Forest genetic treaties/ agreement	Signed year	Ratified Year	Acceded year
UN Convention on Biological Diversity instrument of ratification	1992	August 1995	
Convention on International Trade in Endangered Species of Wild Fauna and Flora	August 2002		
Cartagena Protocol in Biosafety to UN Convention on Biological Diversity	September 2002		
UN framework on Climate Change, ratified in August 1995	1992	August 1995	
UNESCO World Heritage Convention	October 2001		
Kyoto Protocol to the UN Framework Convention on Climate Change	August 2002		
International Plant Protection convention	June 994		

## Continued Table 7

The Final Act and UN Convention on the Law of Sea	December 1982	
Statute of the Centre for Science and Technology of the movement of Non-Aligned countries and other Developing countries	February 1985	
Vienna Convention for Protection of Ozone Layer	April 2004	
Montreal protocol on Substances that deplete Ozone Layer	April 2004	
UN Convention to Combat Desertification South Asia Co-operative environment program	August 2003 1982	
Statutes of the International centre for Genetic Engineering and Biotechnology (ratification)	April 1985	
Statute of the Codex Alimentarius	March 1999	
FAO International Treaty on Plant Genetic Resources for food and Agriculture	June 2002	September 2003
Ramsar Convention		January 2012
South Asia Wildlife Enforcement Network	January 2011	
Asia Pacific Associations of Forestry Research Institutions		
The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization	November 2011	
Membership in UN REDD program	April 2011	

**Table 8: Major institutions conducting research on FGRs related issues in Bhutan.**

Research Institutions	Mandates
RDC Yusipang	Coordinate national forestry research program (NFRP) Manage ,budget allocation for NFRP priorities setting Research mandates <ul style="list-style-type: none"> <li>• Nature conservation including climate change research</li> <li>• Watershed (PES) research</li> <li>• Sustainable forest management Research</li> <li>• Forest Protection research</li> <li>• High altitude aromatic and medicinal plants (MAP)</li> </ul>
Sub-RDC Darla	<ul style="list-style-type: none"> <li>• Broadleaved management Research</li> <li>• Plantation Forestry Research</li> </ul>
RDC Jakar	<ul style="list-style-type: none"> <li>• Conifer Management</li> </ul>
RDC Bajo and Mithun	<ul style="list-style-type: none"> <li>• Agro-forestry and nwfp ( ornamental, bamboos, fruits and nuts) research</li> </ul>
RDC Wengkhar/Khangma/Lingmethang	<ul style="list-style-type: none"> <li>• Non wood Forest Products Research</li> <li>• Non wood forests products development</li> <li>• Participatory Forests research</li> <li>• Low altitude MAP research</li> </ul>
RDC Bhur	<ul style="list-style-type: none"> <li>• Bamboos research</li> <li>• Agarwood research and development</li> <li>• Subtropical ( teak)</li> <li>• Wood products research and development</li> </ul>
UWICE	<ul style="list-style-type: none"> <li>• Training certificate courses</li> <li>• Basic forestry related research</li> </ul>
Royal University of Bhutan ( CNR, Sherabtse collage	<ul style="list-style-type: none"> <li>• B.Sc Forestry courses, environmental diploma courses and research on FGRS and environments</li> </ul>
Institute of Traditional medicines	<ul style="list-style-type: none"> <li>• Chemical properties and medical related research</li> </ul>
National biodiversity centre	<ul style="list-style-type: none"> <li>• Gene conservation (both in situ and ex-situ )</li> </ul>
Royal Institute of Management	<ul style="list-style-type: none"> <li>• Policy Research</li> </ul>
Council of RNR Research of Bhutan	<ul style="list-style-type: none"> <li>• Apex research screening body</li> <li>• Impact assessment of released innovations</li> </ul>

**Table 9: Share on GDP from important sectors in Bhutanese economy (2000-2010) MOAF = Ministry of Agriculture and Forests, source (National Statistical Bureau of Bhutan, 2005 and 2010).**

Sectors	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
RNR SECTOR	27.7	26.4	26.1	24.8	24.3	22.6	21.4	18.7	18.4	18.2	16.8	NA
Crops	12.5	11.7	11.4	10.9	10.8	10.1	9.5	8.9	9.2	9.3	9.0	NA
Livestock	8.7	8.4	7.6	7.4	7.2	7.0	6.6	5.1	4.8	4.7	4.3	NA
Forestry & logging	6.5	6.2	7.1	6.6	6.3	5.5	5.3	4.7	4.4	4.2	3.5	NA
Mining & quarrying	1.5	1.8	1.7	2.0	1.4	1.5	2.3	1.8	2.3	2.3	2.2	NA
Manufacturing	8.3	8.1	7.4	7.2	7.3	7.0	7.1	8.2	8.4	8.2	8.7	NA
Electricity and water	11.2	10.0	10.1	11.4	9.5	10.0	12.4	20.4	21.1	19.3	17.6	NA
Construction	13.3	16.7	17.8	17.1	17.8	17.0	14.5	13.7	11.4	12.2	14.2	NA
Wholesale & Retail Trade	5.2	4.6	4.9	4.9	5.3	5.7	5.7	5.0	4.9	4.8	5.2	NA
Hotels & restaurants	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.7	1.0	0.9	0.8	NA
Transport, storage & Communication	9.4	9.1	9.3	8.9	10.2	10.6	10.8	9.0	9.8	9.8	9.6	NA
Financing insurance & real estate and business services	6.8	6.8	6.0	6.6	7.1	7.9	8.2	8.3	8.4	8.1	7.7	NA
Finance & Insurance	3.7	4.0	3.3	3.5	4.0	4.8	5.4	5.7	5.8	5.7	5.5	NA
Real estate & dwellings	3.1	2.8	2.7	3.1	3.1	3.0	2.8	2.6	2.5	2.4	2.1	NA
Business services`	NA	NA	NA	NA	NA	NA	NA	0.0	0.1	0.1	0.1	NA
Community, Social services	14.0	13.3	12.6	12.5	11.8	12.2	12.1	10.7	10.8	13.0	12.8	NA
Public administration	13.1	9.9	9.7	9.5	8.9	9.5	9.1	6.8	6.9	7.7	7.6	NA
Education & health	0.9	3.4	3.0	3.0	3.0	2.8	3.0	3.9	4.0	5.3	5.2	NA
Private social, personal & recreational services	0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.4	NA
Plus: taxes net of subsidies	2.5	2.4	3.3	3.6	4.3	4.5	4.3	2.9	2.9	2.8	4.0	NA

NA = data not available