STUDIES ON NON TIMBER FOREST PRODUCTS AND ASSOCIATED INDIGENOUS KNOWLEDGE SYSTEM OF APATANIS IN ARUNACHAL PRADESH

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY

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CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled ***"Studies on Non Timber Forest Products and Associated Indigenous Knowledge System of Apatanis in Arunachal Pradesh"*** in partial fulfillment of the requirements for the award of the Degree of Doctor of Philosophy and submitted in the Department of Forestry of the NERIST, Nirjuli, is an authentic record of my own work carried out during the period from 2008-2013 under the supervision of Dr. P. R. Gajurel, Associate Professor, Department of Forestry, NERIST, Nirjuli, Arunachal Pradesh.

The matter presented in the thesis has not been submitted by me for the award of any other degree of this or other institute.

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Date: 16th May, 2015

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ABSTRACT

The state Arunachal Pradesh located in north eastern part of India is inhabited by various tribal communities who are mostly dependent on forests. The Apatanis, dominated in Ziro valley or the Apatani Plateau are well known worldwide for their rich Indigenous Knowledge System (IKS) and capable of managing forests for their socio-economic need. The paddy-cum-fish cultivation practice followed by the Apatanis is a unique agricultural system. The forests of Ziro valley are rich repository of NTFPs yielding species and the local people are dependent on various forest resources for their livelihood and income generation. Apatanis are well known for preserving their traditions and cultures, and their traditional practices of harvesting forest resources on a sustainable basis exemplifies their position as efficient resource managers. For documentation of various NTFPs used by the communities along with the associated IKS and assessment of population status of the available NTFPs in the adjacent community forests, a study have been conducted in the Ziro valley.

Records and enumeration of 147 species of plants used as a source of NTFPs is provided here which includes 138 species of Angiosperms, 1 species of Gymnosperm, 6 species of Pteridophytes and 2 species of Fungi. The Angiosperms represented by 58 families and 99 genera where 121 species are Dicotyledons and 17 species are Monocotyledons. The habitat wise grouping shows that the maximum species used are herbs (63 spp.) followed by trees (35 spp.), shrubs (31 spp.), climbers (12 spp.) and fungi (2 spp.). The analysis of taxonomic diversity of the species revealed that the families like Rosaceae, Poaceae, Fagaceae, Asteraceae, Arecaceae, Lauraceae, Lamiaceae, Solanaceae are the most used ones with at least 4 species each. The Poaceae and Asteraceae are recorded as the top most preferred families with 10 species in each. The lone Gymnospermic species represented by *Pinus wallichiana* was found as one of the very useful NTFP producing species.

All the species are classified under 12 distinct categories of NTFPs species on the basis of their utility patterns. The food plants category comprising of vegetable, fruits, salt making plants and mushrooms is found as the major group with 88 species followed by medicinal plants (56 spp.), fodder plants (12 spp), firewood (15 spp), house building materials (14 spp), household items (7spp.), dyes (4 spp), gums (4 spp), ritual and festivals (19 spp), broom and thatches (5 spp), fibre (5 spp) and

miscellaneous (14 spp). Details information of the uses has been provided category wise listing all species in each group.

Three community forests stands selected for understanding the species composition and population status of the NTFPs showed a good floristic diversity representing typical temperate vegetation. Occurrence of a total 138 species under 70 families and 116 genera with minimum representations of 100 species in each study stand has been found. Out of the total species recorded, more than 50 important NTFP yielding species have been recorded comprising all the habit forms. The present study revealed that all the three forests stands harbour numerous NTFPs having socioeconomic value that supports the livelihood of the communities. Although highest diversity of NTFP have been found in the Nyilii forests stand, the density of population was found better in Dura and Gyachi forests stands.

Many of the NTFPs collected and harvested from the forests are marketed in local and outside markets. Some of the NTFPs provide a good sustenance to the local communities in regular basis. The species like *Allium hookerii, Piper pedicellatum, Actinidia callosa, Castanopsis hystrix, Phoebe goalparensis, Phyllostachys bambusoides* etc. are highly priced in the market. The raw mature fruits of *Phoebe goalparensis* and *Magnolia champaca* preferred for pickle and other food stuffs have highest market value and a vendor may earn a good amount by selling of these fruits only.

The Apatanis are found intermingled with the forest resources for fulfillment of various cultural and traditional requirements and are very observant of their rituals and festivals. Their belief on these rites and rituals is deeply connected with their everyday life. Major requirements for preparation of sacred altar and other ritual needs are fulfilled by some selected species such as *Calamus acanthospathus, Castanopsis hystrix, Castanopsis tribuloides* and *Phyllostachys bambusoides* and strongly attached to the culture and tradition of Apatanis. The other species having ritual and cultural values are *Prunus persica, Machilus vilosa, Molineria capitulata, Kavalama urens. Saccharum arundinaceum* . As per their traditional knowledge and cultural linkages, the Apatanis managed and conserved various forests resources that are socio-culturally and ritually closely attached to the community. Species such are *Quercus* spp., *Ficus* spp, *Pyrus* spp, *Berberis aristata, Polygonum, Machilus vilosa, Kavalama urens* etc. are preserved and conserved in sacred grooves based on the

totem and taboos. These sacred groves have been maintained from the centuries and any kind of cutting and extraction of plants and their parts is totally restricted.

Overall the present study has revealed that the Apatanis still prefer to collect and uses various forest species to fulfill their physical, cultural and economic need and large number of species yielding NTFPs have been found socioeconomically strongly attached to the community. They are found conscious in selecting resources for their nutrition. Many of the vegetable and fruit plants can be used for marketing to generate revenue either in the raw form or in preserved. As the community forests are found rich in NTFP yielding species particularly the tree species, they can be managed in more efficient way to increase the productivity and economic gain. The promotion and marketing of bamboo and cane products used as household items would be another good option for the community as these products have wider and higher market value. The cultivation and management of some high value medicinal plants can also be taken up in the community forests for livelihood support.

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ABBREVIATIONS USED

BLM	Bureau of Land Management
BSI	Botanical Survey of India
CBD	Convention on Biological Diversity
CIFOR	Centre for International Forestry Research
FAO	Food and Agricultural Organization
FRA	Forest Rights Act
GFRA	Global Forest Resources Assessment
IKS	Indigenous Knowledge Systems
IVI	Importance Value Index
JFM	Joint Forest Management
MFP	Minor Forest Products
NERIST	North Eastern Regional Institute of Science and Technology
NTFPs	Non- Timber Forest Products
RGU	Rajiv Gandhi University
SFM	Sustainable Forest Management
SFRI	State Forest Research Institute
TK	Traditional Knowledge
TKS	Traditional Knowledge System
UNESCO	United Nations Educational Scientific and Cultural Organization
USFS	United States Department of Agricultural Forest Services

Chapter 1

INTRODUCTION

Forests and its produces have been used throughout the world in various ways and capacities. Forest resources can be treated as backbone of majority of the tribal and indigenous communities for their livelihood and socioeconomic development. Forest produce are classified into two main groups i.e. wood-based and non-wood based materials. The non-wood or non-timber forest products (NTFPs) are also commonly known as minor forest products (M.F.P.) as they are harvested in smaller quantities (Dwivedi, 1993). Forests have traditionally been valued as the source of sustenance of all life forms on earth. Other than providing timber and fuel wood, all other forest products are classified as non-timber forest products. The term NTFPs was coined by de Beer and Mc Dermot in 1989, it consists of goods of biological origin other than wood produced in forests and ever since then many terms are being used as synonyms for NTFPs such as wild products, natural products, minor forest products etc. NTFPs have also been defined differently depending on their interests and objectives. CIFOR (1995) defines NTFPs as one that encompasses wood products, such as woodcarving or fuel. Rijsoort (2000) defined NTFPs as all products removed from forest such as foodstuffs, medicine, coloring materials and other products harvested from forests excluding the industrial timber. It includes all goods of biological origin derived from forests or any other land under similar use and exclude timber of all forms (Belcher, 2003). In boarder sense NTFPs include medicinal plants, wild edible plants, beverages and narcotics, fodder, house building and thatching materials, spices, fibers, tannin, latex etc. (Krishnamurthy, 1993). NTFPs are recognized as a part of culture, identity, myths, and spiritual practices in many areas of the world and the tribal population still stores a vast knowledge on utilization of local plants as food materials and other specific uses (Sundriyal *et al*., 1998). Worldwide these forest produces are being used by various communities for fulfillment of various common requirements. NTFPs contribute a lot to the livelihoods of many people worldwide who are mainly dependent on forest (GFRA, 2005; GFRA, 2010; Ahenkan and Boon, 2010). The wide range of resources emerging from forest has led to considerable complexity in NTFPs sector (Nepstad and Schwartzman, 1992).

Over the years NTFPs have gained a remarkable significance throughout the world not only in terms of rural economy but also in conserving the biological diversity. The shares of non-wood forest products are very high from livelihood point of view. Economic and environmental significance of NTFPs has increasingly attracted the attention of academicians, environmentalists and planners in most of the developing countries (De Beer and Mc Dermott, 1996; Edwards, 1996). Such increasing interest and attention can be marked as recognition of the contribution that NTFPs can make to support the livelihood and economy of large number of population in developing countries (Arnold and Perez 1998). Recognizing the potentiality of NTFPs in socio-economic development particularly of rural and tribal communities, research and development activities has remarkably increased in the country. It has been established that the management of forest if done efficiently for NTFP it can exceed the benefit from timber and agriculture (Peter *et al.*, 1989). Worldwide the people mostly living in the vicinity of forests are dependent on the natural resources (Sills *et al*., 2003). In traditional communities, NTFPs have been used for subsistence, while others are the main or the only source of income (Awasthi *et al*., 1995; Sarmah *et al*., 2003). Harvesting and processing activities of NTFPs not only provide jobs and income sources but also have cultural values and medicinal importance that contributes to community health and well-being (Falconer and Arnold, 1992; Kennedy, 2006).

The role of non-timber forest products (NTFP) in the economic development of local communities and sustainable forest management has been addressed by many researchers from different parts of the world (Arnold and Perez, 2001; Panayotou and Ashton, 1992). NTFPs have the potential to bring about economic revolution for the forest dwellers. In the global scenario more than 2 million people worldwide are dwelling in the forests and depending on NTFPs for subsistence, income and livelihood security (Vantomme, 2003). About 80% of the world population in developing countries depends on NTFPs for their primary health care and food security (Nautiyal and Kaul, 2003). NTFPs are used and managed in complex socio-economic and ecological environments. Most of the population of Southeast Asian countries depends solely on the NTFPs, as their only source of income and livelihood (Nautiyal and Kaul, 2003). The population of most of the Indian states is completely dependent on forest and its resources. In South-Korea the source of income of the

people are mostly dependent on NTFPs and forest resource systems rather than on timber products where 60% area are under forest cover (Youn Yeo- Change, 2009). Native Americans traditionally use forest products for tools, medicine, food, religious ceremonies etc in their daily life (Chamberlain *et al*., 1998). Eighty two million inhabitants in the uplands of Vietnam are dependent on forests, of which nearly 8 million people depend on NTFPs and hunting for their livelihood (Sunderlin and Huynh Thu Ba, 2005). Study of South-West Cameroon has also indicated the value of NTFPs in the income generation of the communities where about 6-15% of the total household is mainly based on the NTFPs (Ambrose-Oji, 2003). The availability and sustainability of the NTFPs is little known, but it is an acknowledged fact that rural people have relied on NTFPs for centuries (Godoy and Bawa, 1993; Hammett and Chamberlain, 1998).

India is a country with high diversity of forest resources and fully dependent on agriculture. In India, 40% of forest revenue and 55% of forest based employment is provided by NTFPs (Tewari and Campbell, 1995). NTFPs in the local, national and international trade can contribute a lot to the household and community in terms of its economy and also can help in poverty alleviation (Tewari, 1993). NTFPs play an important role in the income and employment potential of the local communities (including tribal) in various parts of the country particularly in the area having good forests. The case study from Peechi-Vazhani and Chimmoni Wildlife Sanctuaries in Kerala revealed that about 62% of the NTFPs are collected mainly for roots, stems, bark and whole plant (Muraleedharan *et al*., 2004). Likewise the local inhabitants of Sunderbans, (the largest mangrove in world with highest mangrove biodiversity) depend on forest resources that contribute almost 79% on an average to the income generation of the people and NTFPs like firewood, prawns, fishes, honey etc are mostly collected for subsistence (Singh *et al.*, 2010). Many tribal communities of Madhya Pradesh and Maharashtra are also fully dependent on NTFPs for their livelihood and nutritional requirements (Bhattacharya and Patra, 2007). The forests in India provide all the needful materials to the farming and forest dwelling communities. Particularly the edible plants whose leaves, fruits, seed, roots, etc., are consumed still make an important contribution to the dietary habits of the poor particularly those living near the forest (Krishnamurthy, 1993). Out of about 18,000 flowering plant species found in India, more than 2000 plants species are used only by

traditional herbal healers and about 500 plants species are used by different pharmaceutical companies (Chandel *et al*., 1996; Vibhuti *et al*., 2009). According to the India State Forest Report (2013) out of the 593 districts in India 189 are dominated by tribal districts covering 37.37 % of the geographical area of these districts. About 70% of the total tribal populations are concentrated in Madhya Pradesh, Jharkhand, Gujarat, Chhattisgarh, Maharashtra, Rajasthan, Orissa and North-Eastern States (Sah, 2003; Tewari, 1993). The tribal of all these states by and large are dependent on various forest resources for sustenance. Taking into account the maximum amount of dependence on forest products in many parts of India, the National Commission on Agriculture in 1976 suggested for establishment of Forest Development Corporations. These institutions were mainly set up to make sure that the maximum benefits from forest collection and marketing are passed on to the tribesmen and also to improve the marketing of these nontimber products in a sustainable way (Tewari, 2008). The tribal areas are mostly rich in forest cover and they are closely interwined with nature where they are born and brought up. Because of its importance in livelihood and economic development of tribal communities of the country the NTFP is being well recognized by the govt of India and addressed legally in various policies and Acts (Kanwal, 2014).

With the ever increasing consumption of these forest products in any form other than the timber day by day, it is ultimately leading to shrinkage of forest areas. Such over exploitation of forest resources not only affects the local biodiversity but it poses a threat to the income generation sources of the forest dependent population worldwide. Countries like South Africa have been led to ecological problems (Neumann and Hirsch, 2000). Over-harvesting of such forest products or NTFPs does not only affect the employment income of the forest dependent people but also poses a threat to the genetic diversity The rich natural resources of Eastern Himalayas and Patkai range is facing a grave threat due to over harvesting and other illegal means of earning like smuggling of such forest resources (Joshi, 1996). Increases in illegal extraction of forest products have always been unsustainable and this can be solved only by the active participation of local communities. NTFPs are being overused and degraded due to lack of local control over the resources, social and cultural traditions (Shrestha *et al*., 1998). Traditional Knowledge (TK) plays an important role in addressing the sustainability concerns. The traditional knowledge possessed by

various indigenous communities has been found very useful in selection, utilization and conservation of resources. Most of the wild plant resources selected and used economically today is the result of the traditional knowledge systems of various indigenous communities in the past. Traditional Ecological knowledge has always been used for better utilization of resources. NTFPs in any form have got their own traditional way of utilization and processing in various parts of the world. Different plant species that are obtained from the forest mainly used medicinally in traditional way of treatment for cough, fever, cold, intestinal disorder like diarrhea, dysentery, indigestion, ear diseases, kidney problems etc. With the fast growing technologies and way of modern medicines such old ways of traditional knowledge is fast degrading. Besides the common uses for materials, plants and animals are linked with culture and tradition. The Indigenous and tribal communities around the world are strong believers of nature and accordingly use, worship and conserve the forests and forest resources.

With the shrinkage of forest areas, over-exploitation, increasing human population, market demand and continuous loss of traditional knowledge practices, sustainable production of NTFPs sustainably is no longer assured. Widespread over-exploitation of forests in many places has resulted in the destruction of resources, which has not only left the people without any important income source but has also adversely affected the rich biodiversity. Sixty Six percent of the commercial extraction of NTFPs has shown negative impact from ecological view point (Shankar *et al*., 1996; Neumann and Hirsch, 2000). Nonetheless, with the increase in existing market demand for NTFPs it will also lead to over-harvesting and resource depletion. Sustainable management through proper and minimal utilization can support the income of local communities and uplift their livelihood. The knowledge of the distribution, nature of population and availabilities of the useful species in the forests would be helpful for effective management and utilization of the resources. The Eastern Himalayan state of Arunachal Pradesh is well known for rich biodiversity with diversified forest resources. Due to the wide geographical, climatic and cultural diversity, it provides a repository of flora and fauna and also a wealthy traditional knowledge system. It is inhabited by 26 major tribes like Apatani, Adi, Nyishi, Monpa, Galo, Nocte, Wanchoo etc. and 110 sub tribes which possesses rich indigenous knowledge systems and is very closely associated with the forest and

forest resources for their livelihood and economic development. Since time immemorial the local communities have been dependent on the forest products. Eighty five percent of the tribal populations have their own traditional way of dependence on forest resources be it timber or non-timber forest products (Dollo and Sundriyal, 2003). Availability of these NTFPs varies depending on the forest types and the amount of consumption or procurement from natural forests. Non-timber forest products (NTFPs) play an integral part of the traditional lifestyle of the people of Arunachal and they depend on forest resources for their livelihood and economy. Among the important resources the occurrence of more than 500 different species of medicinal plants, about 73 species of bamboos, 18 species of canes, more than 200 species of wild edibles have been reported in Arunachal Pradesh itself (Sarmah *et al*., 2000; Haridasan *et al.*, 1990; Angami *et al.*, 2006), besides the occurrence of many aromatic plants, spices, condiments, etc. The review of various literature published in documentation of various uses of plants in the form of NTFPs revealed that more than 1200 species of plants were reported to be used by the different communities of the state where more than 600 species are used alone for medicine (Gajurel *et al.,* 2013). Among the various NTFPs used in the Himalayan states, the medicinal plants have got high priority among the entire stake holders. *Panax pseudo-ginseng, Coptis teeta, Aconitum heterophyllum, Taxus wallichina, Podophyllum hexandrum, Swertia chirayita* etc. are some of the highly valued medicinal plants of Arunachal Pradesh, and other state of Himalaya the population of which are being rapidly destroyed as they are harvested in unsustainable ways and no specific efforts have been put for their conservation priorities for future uses (Joshi, 1996).

The uses of NTFPs as vegetable, fruit, medicine etc. by different ethnic communities of the state have been documented mostly through ethnobotanical approach by a number of workers (Kohli, 2001; Murtem and Das, 2005; Tiwari *et al*., 2009; Doley *et al.*, 2009; Rethy *et al*., 2010). NTFPs such as toko leaves (*Livistonia jenkinsiana*), thatch grass (*Imperata cylindrica*), jeng leaves (*Zalacca secunda*), broom grass (*Thysanolena maxima*) canes and different species of bamboos have been playing very important role in building of traditional houses. Bamboo and cane species are also used for making other handicraft and household items that are used by the locals not only for day to day household uses but also for religious and other important customs. Natural dye yielding plants are also used by the people of

Arunachal Pradesh. The Apatanis, Khamptis, Tangsas, Wanchos and Monpas have been using species like *Rubia cordifolia, Rubia sikkimensis, Woodfordia fruticosa, Colquhounia coccinea,* etc. traditionally in combination with other plants for extraction and preparation of dyes utilizing indigenous processes (Mahanta and Tiwari, 2005). It may be mentioned that the sustainable use of NTFP in Arunachal Pradesh has a great potential for poverty alleviation and in creating avenues for employment generation. The mode of consumption or its utilization pattern varies among the tribes.

The Lower Subansiri district of Arunachal Pradesh is very commonly known for the famous Ziro valley. Ziro is the district headquarter and is mostly inhabited by Apatani tribe. It is often called as the Apatani Plateau. Most of the people are still dependent on forest resources for their livelihood and income generation. Ziro is mainly famous for paddy-cum-fish cultivation. In the system fishes are reared along with paddy cultivation. Another area of conservation practiced worthy of mention is the bamboo groove. The stem monopodial bamboo *(Phyllostachys bambusoides)* grown with blue clad pine is one of the exemplary practices of farm forestry followed in this part of the world. The Ziro valley is a rich repository of NTFPs, and numerous species yielding NTFPs are found in its natural habitat. These products are one of the most preferred and highly used forest resources by the people of Apatani who depend on these resources for their day to day uses. The forests are rich in several NTFP yielding species such as species of *Pinus, Rubus, Phyllostachys, Castanopsis, Calamus, Musa, Quercus, Michelia, Rubia, etc.* The Apatanis in particular have been well known for preserving their traditions and cultures on a sustainable basis. They are among the few tribes in the world who continue to worship nature. It is their relation with nature that regulates their cultural practices. Since time immemorial the Apatani tribes have developed unique IKS inhabiting in the remote forested areas closely linked with nature. Apatanis are still very observant of their rituals and festivals and their belief on these rites and rituals is very deeply connected with their everyday life. It reflects the unique and rich culture of the Apatanis. These communities have its own way of traditional land use pattern and traditional knowledge for conservation and management of the available natural resources and are still dependent on the wild plants for their survival and employment generation. However with the arrival of new regime of development initiative the traditional

practices are under pressure. Edible food products and medicinal plants are extracted from the rich biodiversity of the district and used by local tribesmen.

Therefore, this aspect needs more popularization on local cultivation of NTFPs as well as for economic returns. Extraction of NTFPs has gained a lot of significance over the years as a means of income generation. The forests are still playing vital role in supply of these products. However due to the continuous extraction of these resources the population of many species might have reduced. Very little information is known about the community structure of the species and its population. No specific studies have been made to find out the occurrence and availability of species with their community structure and population status in these forest areas which is supplying the resources. The determination of the species composition and understanding the community structure of the forested ecosystem with the analysis of population status of major NTFP species that are most preferred and good sources of forest resources would be of immense value in resource utilization. This will help in management of community forests, particularly non timber forest products which are playing significant role in day to day life of Apatani people. Plant community characteristics play an important role in the vegetation science over the centuries which focus on distribution, composition and classification of communities (Kashian *et al.*, 2003). In addition, species composition and structure are most important characteristics of forests which are evident from the forests health that signify the forest diversity (Roberts and Gilliam, 1995). There is also a necessity of integrating systems of indigenous medicines and modern health care system. This will ensure the best of both the worlds with prospects of economic developments. The local communities have strong enthnobotanical tradition which should be incorporated in the working of forest in Apatani valley. Such traditional knowledge has been found very useful in utilization and conservation of many forest species. Social aspects of tradition and culture of the Apatanis have been studied by some workers (Kani, 1996; Kaning, 2008) which have been found well associated with management of forest and agricultural resources. The district has enormous non-timber forest products which have been used by local people since time immemorial. Local people do take up cultivation of NTFPs in community land, but their extent is not significant due to lack of certification. The rich traditional ecological knowledge system practiced by the Apatani tribe for the maintenance of their sustainable

livelihoods exemplifies their position as efficient resource managers, which has also drawn the attention of the UNESCO to designate the Ziro valley as a World Heritage Site. Although the CBD (Convention on Biological Diversity) provides fair equitable sharing of the benefits of biodiversity and the protection of traditional access to genetic resources, with the advent of modernity, it is feared that there is also loss of traditional knowledge systems in the Apatani Valley. The vast treasure of indigenous methods developed by ethnic tribes for utilization of various plants for their day-to-day needs requires proper documentation. Although some important contribution have been made by various workers in understanding the resource utilization pattern of Apatanis time to time (Kohli, 2001; Kala, 2005; Rai, 2005; Srivastava, 2010; Bamin *et al.*, 2013) and highlighted the traditional ecological and ethnobotanical knowledge of the communities, no comprehensive account is available that document all the different types of NTFPs with the associated Indigenous Knowledge. The status of occurrence on NTFPs in forested areas has never been worked out and the economic potentiality of many of the resources is yet to be analysed. In this context the present study was undertaken to fulfil the gap with following objectives:

1. To document the non-timber forest produce (NTFP) available at the disposal of the indigenous communities.
2. To determine the population status of different plant species yielding non-timber forest produces for its potential utilization.
3. To assess the market and non-market potential of selected NTFPs.
4. To document and analyze the Indigenous Knowledge System (IKS) associated with the NTFPs for sustainable utilization and conservation.

Chapter 2

REVIEW OF LITERATURE

Non-Timber Forest Products (NTFPs) refer to a wide array of economic or subsistence materials that come from forests, excluding timber. These are also termed as non-wood, minor and secondary forest products (FAO, 1992). Belcher (2003) defines NTFPs as all goods of biological origin derived from forests or any other land under similar use and exclude timber of all forms. The term special forest products are also used by the U.S. Department of Agricultural Forest Services (USFS) and the Department of Interior Bureau of Land Management (BLM) to define NTFPs that includes small diameter posts and poles (Jones and Lynch, 2007). Non-timber Forest Products (NTFPs) provide subsistence, income and employment option in both the forested areas and non -forested areas. About 350 million people globally particularly in developing countries depend on NTFPs for food, nutrition, medicine and as primary source of income (Chandrasekharan, 1998; Olsen, 1998; UNDP, 2004). About 80% of the population of the developing countries depends on NTFPs for their primary health and nutritional needs (FAO, 1995). It is therefore paradoxical that in spite of their real and potential value, most NTFPs remain grouped as minor products of the forests.

Plant resources have been utilized in various ways by local communities all over the world as per their tradition and culture. Traditionally they are extremely knowledgeable about the local plant resources on which they are closely and entirely dependent. However much of this wealth of knowledge is lost today as traditional cultures are being eroded (Hamilton, 1995). Documentation of the traditional knowledge about the relationship of man with biodiversity plays an important role in rescuing disappearing knowledge and returning to local people, ultimately reinforcing links between communities and environment leading to the support for conservation (Jain, 2000). The cultural relationship of human with bio-resources keep evolving and changing. NTFPs in recent year have assumed unusual significance as a means to enhance rural income and conserve biodiversity in tropical region (Ros-Tonen *et al*., 1995; Shankar *et al*., 1996). Out of total estimated 3, 20,000 vascular plants (under 511 families), about 3000 (under 173 families) are regularly exploited for food (Hawksworth and Kalin-Arroyo, 1995). Although most of these (2500) food plants

are domesticated, very few (20) are of major importance (Ford-Lloyd and Jackson, 1986). Domestication of NTFP species (other than food and fiber) is a recent phenomenon. The cultivation of NTFP species began largely in the twentieth century, when natural population of the species had been decreased by clear felling for land and timber. The use of NTFPs leads to domestication of many species. The natives of western Africa have domesticated several species of *Dioscorea* like *D. colocasiifolia, D. hirtiflora* and *D. latifolia* in different areas (Arora, 1989). Several minor millets like *Digitaria exilis* and *D. iburua* were domesticated by the African and Asian natives where the species *Digitaria cruciataver, D. esculenta* were also domesticated in the Khasi hills of India (Singh and Arora, 1972). Domestication of species leads not only to the discovery of new variation, but in many cases to a proliferation of new forms and range of forms for variation in the original progenitor wild species (Bisby, 1995). Domestication and commercialization of various wild NTFPs bear the potential of generating income and employment for many poor people of the world (Tewari, 2001).

The wide ranges of resources emerging from forest lead to considerable complexity in NTFPs sector (Nepstad and Schwartzman, 1992). Godoy and Lubowski (1992) have described the sustainability of NTFPs since the indigenous people are more active participants in managing forests for their long term production. In countries like South America, the more emphasis is laid on forest products such as rubber, Brazil nuts etc. which have higher economic value that can contribute to the socio economy of the region. A study was made in the forests of Amazon by Padoch (1992) to observe the marketing systems of NTFPS in such forests area and found that although the NTFPs have potentiality to improve the economy of the poor communities, the middle men enjoyed most of the profits incurred. Panayotou and Ashton (1992) considers NTFPs as amongst one of the oldest trade commodities in the world associated with economic development of communities and has gained significant importance in the rural economy. Besides providing income especially to the forest dependent population it is also a necessity in providing household items having diversity of the forest ecosystem (Butler, 1992; Nepstad and Schwartzman, 1992 and Tewari, 1994). A proceeding of regional consultation conducted in Bangkok, has shown that other than the timber the non-wood forest products plays

significant role in socio-economic and cultural status of communities in Asian and Pacific countries (FAO, 1995).

Rural and tribal populations worldwide have been more dependent on the NTFPs in their day to day activities and livelihoods. Over the years the NTFPs sector has gained a lot of significance in determining the rural economy worldwide (Gunatilake *et al.,* 1993). Because of the potentiality and significant contribution of NTFPs in socioeconomic development, a large number of studies have been conducted worldwide in different aspects of NTFPs. Falconer (1992) and Ros-Tonen (1999) have undertaken studies to document the fact that forest-dependent people often have few options except to gather and hunt NTFPs for their food, medicines and cash income. A participatory method is found important in analyzing the success of NTFPs commercialization and promotion. Proceedings of workshop organized by CIFOR (1995) on NTFP have clearly highlighted the importance and the contributions of NTFPs to humankind besides providing economic lift in their lives. It also proposed for better understanding of the NTFP-based systems and to optimize their future benefits. Studies have also shown that NTFPs have more demand among the people and generates greater source of income than that of timbers (FAO, 1995, Peters, 1999). Muniz-Miret *et al.* (1996) conducted studies on NTFP extraction in the Amazon estuary and evaluated the economics of harvesting *Euterpe oleracea*, a predominant palm species of the Amazon flood plains and found that it has a high value production system even at higher rates of interest. In south Cameroon the management of NTFPs has been considered as an option for multiple use in management of forest and forest resources (van Dijk *et al.,* 1999). Proper management and harvesting of NTFPs along with harvesting of timber may provide better economic gain but need effective skills (Ros Tonen, 2000 and Ticktin, 2004). The tropical forest zones of south-west Cameroon shows how NTFPs contributes to the daily livelihoods of the poor and forest dependent populations (Ambrose-Oji, 2003). A study in the forests of Guatemala and northern Bolivia shows that specific legislation, education and management of projects, informal training of the foresters were the main steps that could help in managing and extraction of both NTFPs and timber products and find the compatibility of timber and NTFPs (Larsen *et al.*, 2000). Springate *et al.* (2003) and Guariguata *et al.* (2008) have conducted studies in Himalayan countries like Nepal where the local communities were found to have

more responsibility towards management of forests than that of management NTFPs species.

The trades in non-timber forest products have been widely promoted as an approach to rural development. The work of Marshall *et al.* (2003) has indicated that commercialization of NTFP is often not successful. To find out the economic contribution of specific forest resources, Nakazono *et al.* (2004) conducted a 3-year experiment of the Amazonian plant *Ischnosiphon polyphyllus* used by traditional and indigenous populations in the Amazon for the construction of baskets, mats, and other handicrafts used in manioc cultivation. The results suggested that current harvesting strategies for better economic gain may not be conservative enough to ensure long term population survival. The work of Belcher and Kusters (2004) in the mainland south-east Asia has documented the role and importance of NTFPs as safety nets and buffers in relation to food supply and income generation in times of change and security. They documented the importance that NTFPs provide as buffers and also as a means of safety during the times when food was insecure. Ruiz-Perez *et al.* (2004) contributed a lot in understanding the role that NTFPs play in rural development. He pointed out that the rural economy can easily be improved through effective management. A comparative analysis of 61 cases of commercial NTFP production in Africa, Asia, and Latin America were done by Belcher *et al.* (2005) using a standardized set of descriptors organized into categories describing various aspects of the production-to-consumption system. Among the other significant works on NTFPs worldwide the work of Pulido and Caballero (2006) on the impact of shifting agriculture on the availability of non-timber forest products and Trauernicht and Ticktin (2005) on the effects of non-timber forest product cultivation on the plant community structure and composition of a humid tropical forest in the Mexico were very significant. The study of Jakobsen (2006) from the uplands of north central Vietnam revealed that the area under shifting cultivation was reduced since the other means of using the land like for rearing cattles, commercial exploitation of NTFPs and it was found that this has generated more income as compared to the shifting cultivation practiced. Marshall *et al.* (2006) studied on the impact of commercialization of non-timber forest products in poverty reduction and improvement in the status of household of Mexico and Bolivia. Apart from timber and firewood that are conceived as major forest produces, non-timber forest products

include all products obtainable from forest. Thus, NTFPs are used and managed in complex socio-economic and ecological environments. Besides, the work of Peters, (1994), Wickens (1991) and Panayotou *et al.* (1992) found as valuable works on NTFPs that contributed in understanding and realization about NTFPs management with analyses of sustainable forests exploitation having least ecological destruction. Extraction of NTFPs in sustainable manner and their conservation importance have been highlighted by various workers. Among these the works of Anderson (1990), Hall and Bawa (1993) and Peters (1996) were found very significant that highlighted the various values and the extraction of non-timber forest products for its potential compatibility with conservation. Apart from these, the other significant contribution made in understanding the economic importance's and values of NTFPs, sustainable development of forest produces and their conservation importance are De Beer and Mc Dermott (1989); Anderson and Loris (1992) and FAO (1995) from Amazon region; Taylor (1996) and Ros-Tonen (2000) from Pacific Northwest, Alexander *et al.* (2001), Ambrose-Oji (2003) and Ros-Tonen and Wiersum (2005) from tropical countries. Ojha (2000) deals with the current policy issues in development of NTFPs in Nepal and the implications these policy issues have on the management, utilization and trade of NTFP resources.

Traditional Knowledge System plays an important role in pattern of utilization of forest resources by a community. Considering the importance of the traditional knowledge for the welfare of human being, a number of researches have been undertaken in this field worldwide with various aspects. Bennett (2005) worked on ethnobotanical education and needs in USA focusing the value of TKS. Kizilarslan and Sevg (2013) studied the ethnobotanical uses of genus *Pinus* in Turkey to explore the different utilization pattern. Galeano (2000) investigated the forest use of Pacific Coast of Colombia and discussed the TKS in relation to utilization of various NTFPs. Besides the recent works of Megersa *et al.* (2013) on medicinal plants in Oromia regional state of West Ethiopia, Singh *et al.* (2012) on ethnomedicinal uses of plants species from Terai forest of Western Nepal, Popovic *et al.* (2014) on medicinal importance of wild plants species in Serbia and Song *et al.* (2013) on traditional knowledge of wild edible plants on Jeju Island in Korea contributed in understanding of traditional knowledge systems of the various communities where a large number of wild plants have been found effectively utilized by the communities and with

traditional management practices. The work of Pieroni *et al.* (2011) on cross-cultural ethnobotany among Albanians and Serbians communities of South-Western Serbia were found very useful in understanding the relationship among the communities in forest resource utilization. Youn Yeo- Change (2009) conducted a case study in South Korea on the use of forest resources, traditional forest-related knowledge and livelihood forest dependent communities and indicated that mere existence of forest resources and related cultural heritages are not enough for local communities to obtain income from forest resources. Pant *et al.* (2009) studied on the diversity and indigenous remedies followed by the locals of Mornaula Reserve Forest in West Himalaya in which 33 plant species were found to be used for different purposes which in turn helps in conserving the data base of the plants used and also help in preserving the traditional knowledge.

In India, the NTFPs have played a vital role in the livelihood and the economy of the tribal and rural communities and has become an important subject in policy and planning issues of forests management. In India, NTFP has been defined legally under 'Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006' popularly known as Forest Rights Act (FRA) under the heading minor forest produce (MFP) [Section 2 (1) of the act]. NTFP sector is one of India's largest unorganized sectors having a dependent population of about 275 million and business turnover of more than Rs.6000 crores per annum. However, this sector has unfortunately been neglected since the pre-independence period. NTFP contributes to about 20% to 40% of the annual income of forest dwellers who are mostly disadvantageous and landless communities with a dominant population of tribals (Kanwal, 2014). Because of the manifold impacts of NTFPs on the livelihood of rural and tribal communities in the country in one hand and diversification of the forest species and traditional knowledge system on the other has gained importance among the researchers. Accordingly, various important contributions have been made by different workers from different parts of the country.

Women have always played a major role in the usage and collection of NTFPs for procuring food for their family in many parts of the world. Toksoy *et al.* (2010) conducted a major study in forest villages of Trabzon, Turkey where 611 questionnaires were conducted by polling face to face in 68 forest village especially involving women groups. The results showed that 24.4% of the plants gathered by

different women were used for food (19 species) followed by 9.2% for medicinal purposes (16 species) including 4 species used for livestock treatment and 2 species in the hand weaving. Studies done by Malhotra *et al.* (1989) and Tewari (1994) shows that participation of women and child labour plays the most important role in generating income sources on number of site-specific studies undertaken through the Joint Forest Management research network. So the role played by women folks of a community in the collections and utilization of NTFPs is very important and need to be addressed while conducting research and developmental activities related to NTFPs.

Pioneering work on NTFPs in India was done by Gupta and Guleria (1982) on the management and economic aspects of Tendu leaves with reference to Maharashtra and Orissa. Myers (1988) did a tremendous work on NTFPs and shows an increasing realization about NTFPs management and its representation in sustainable forests exploitation and less ecological destruction. The potential role of NTFP in conservation of forest was suitably supported by several studies including Malhotra *et al.* (1993), Nepstad *et al.* (1992) and Chopra (1997). The long-term financial return from harvesting NTFP sustainably could far outweigh the net economic benefits of timber production or conversion of the same area of land to agricultural fields. A study conducted in states like Bihar, Orissa and Madhya Pradesh shows that 80 percent of forest dwellers in these states are mostly depended on forests for 20-25% of their annual food requirement (Dwivedi, 1993). The creation of Centre of Minor Forest Products in India was one of the significant milestones for NTFP- oriented sustainable forest management. This could be largely possible because of continuous efforts and contribution made in research and development work of Shiva (1992, 2000) and other researchers. Chopra (1993) and Sharma (1995) in their studies indicated that collection of NTFPs has played a very important role in the improvement of economic activities of the tribal communities. NTFPs as are closely attached to the livelihood of the tribal and rural communities can play important role to improve the socio economic condition of the poor people as well as the region (Tewari and Campbell 1995). Shankar *et al.* (1996) opined that documentation and understanding the species used for NTFPs helped a lot in conservation of biological diversity especially in the tropical regions. A case study on the income and employment generation opportunities and potential of non timber in Gujarat was undertaken to show the amount of benefit the local people get from these NTFPs

besides providing employment (Tewari, 1999). In another case study it had shown that 40 percent of the gain from the collection and value addition of some of the selected NTFPs such as *Buchnania lanzan* (Chironji), *Madhurea latifolia* (Mahua), *Emblica officinalis* (Aonla) etc, goes to the benefit of the local collectors (Prasad *et al*., 1999).

The domestication and commercialization of various wild NTFPs has the potentiality of generating income and employment for many poor people of the world (Tewari, 2001). In many cases domestication of species leads not only to the discovery of new variation, but also to proliferation of new range of forms for variation in the original progenitor of wild species (Bisby, 1995). In India, there are about 500 million people living in or near the forests, being solely dependent on these forest products for their daily livelihood needs and accordingly they collect and domesticate various useful resources (Nautiyal and Kaul, 2003). Sadashivappa *et al.* (2006) have undertaken a work to examine the role of non-timber forest products in the rural household economy and the demographic and economic factors which determines the participation behavior of gathering forest products in the dry deciduous forests of Karnataka. The study revealed that the daily return obtained from collection of NTFPs was found much higher than that obtained from other sources. In India the analysis of managing the NTFPs during the last 30 years was made to see how economically these forest products are being managed for sustainable uses (Tewari, 2008). NTFPs indeed play a very significant role in the rural economy in terms of providing employment, income potential and life support sustenance (Negi *et al.*, 2011). Rao *et al.* (2014) in his study from West Godavari district of Andhra Pradesh to find out the importance of plant based NTFPs showed that about 500 households mostly comprising of tribals were dependent on NTFP for their livelihood through sale and use of these forest products. According to Tewari & Campbell (1995), most of the village communities of West Midnapur district of West Bengal obtain about 17 to 50% of their annual household incomes from NTFPs harvesting. Many works comprising Malhotra *et al.* (1992) and Roy (2003) have also studied on the commercial importance of NTFP collections and indicated the potentiality of NTFPs to improve the livelihood and economy.

Apart from documentation of NTFPs, studies have also been done on the socio-economic importance and the value of NTFPs in the economics of tropical

countries. Some of the important works are Gupta and Guleria (1982), FAO (1991), Chopra, (1993), Chowdhuri *et al.* (1992), Sharma, (1995), etc. It is easier to calculate the monetary value of NTFPs, which are marketed at the local market than those that were normally collected for domestic uses and some value-added products may add made additional income (Ghosal, 2011). In traditional communities, NTFPs have been used for subsistence, while in some others it is the main and only source of income (Awasthi *et al.,* 1995; Sarmah *et al.,* 2003). A study conducted in the Khangchendzonga biosphere reserve, Sikkim, recorded about 100 economically high potential NTFPs from the area (Chettri *et al.,* 2005). However it was observed that 50% of these species are said to be marketed with a minimum price in the local hats, which otherwise have good potential in local economy. It was also indicated that about 10% of the total species distributed in the area needs conservation priority and specific strategic plan is needed for conservation of these valuable resources for sustainable development. The study conducted by Kennedy (2006) showed a total 30 species of NTFPs involved in the commercial collection and gain by the tribals of Palini Hills in Tamil Nadu and it was found that good revenues were generated by marketing of these produces. It is suggested that proper management of NTFP integrating traditional and scientific knowledge, safeguarding regeneration potential, cultivating wild species, making appropriate changes to extraction processes used and establishing more transparency in prices and marketing channels could avert the problems faced due to overharvesting. An attempt has been made by Dattagupta *et al.* (2010) to study the dependency and usage pattern of the NTFPs in Reserve Forest in Cachar, Assam. The study showed that the tribal and the non-tribals residing around this forest areas are fully depended on the forest resources for their day to day survival and benefited by the forests. So understanding the various potential resources of such forests and development of appropriate management strategy of selected forest resources for better sustainable use of the NTFPs may improve the economic status not only of the communities but also of the forestry sector. Basu (2010) in his paper presented at the 18th Commonwealth Forestry Conference on the Bankura District of West Bengal focused how Joint Forest Management (JFM) play an important role in improvements of the sustainable forest management (SFM). Non-timber forest products like fuel wood, food, medicinal herbs, mushroom, honey, mahua etc. are important contributors to the welfare of the households in the JFM areas. Besides, the paper also dealt with important policy implications for forest

conservation, sustainable forest management practices, and rural development. These publications reveal lot of interesting findings on traditional knowledge in relation to biodiversity utilization and highlighted the significance of the study for the sustainable utilization of bioresources and their conservation.

Taking into account the importance of traditional knowledge systems in understanding the welfare of human beings and their relation with the use of different forest products many studies have been undertaken in North East India. Among the various significant studies the studies particularly conducted by Arora (1981) on native food plants of tribals in northeastern states, Rao (1981) on ethnobotany of Meghalaya, Rao (1990) ethnobotany of Nagas, Rao and Jamir (1990), ethnobotany of the Ao and Angami Nagas of Nagaland, Mao (1999) some symbolic and superstitious botanical folklore about Mao Naga tribe, Lokho (2012) folk medicinal plants of the Mao Naga in Manipur, Lokho (2013) ethnobotany of Mao Naga tribe of Manipur; Das and Saikia (2001), Gogoi and Borthakur (2001) from Assam; Dam and Hajra (1990), Haridasan *et al*. (1990, 2003), Umashankar and Khan (1996), Haridasan (2000), Sarmah *et al*. (2000), Bhuyan (1999, 2000), Angami *et al*. (2006), Gajurel *et al.* (2006), Jeri *et al*. (2011), Khongsai *et al.* (2011) from Arunachal Pradesh documented numerous plant used by the local communities of the region focushing the values of these resources in the day to day life of the tribal communities. The ethnobotanical work of Sinha (1996); Singh *et al*. 2003, Singh *et al*. 2007, Singh *et al.* (2009), Devi *et al.*, (2010), Imotomba *et al*. (2011), Sanglakpam *et al.* (2012) from Manipur in the past two decades documented a large number of NTFP species from the state including numerous economic potential species. The recent work of Panmei *et al*. (2014) on NTFPs of Rongmei community of Manipur found a significant contribution. An inventorization on the NTFPs of Mizoram done by Lalremruata *et al*. (2007) where 272 diverse varieties of forest products were found which have its own specific use pattern.

Like other north eastern states, studies have also been undertaken in the state of Arunachal Pradesh. Many works on NTFPs and traditional knowledge and use pattern of different tribes in Arunachal Pradesh have been done by Pandey (1990), Haridasan *et al.* (1995), Hegde (1995), Uma Shankar and Khan (1996), Rawat and Chowdhury (1998), Yobin (1999), Kohli (2001), Tag *et al.* (2004), Murtem (2005), Kar *et al.* (2005), Mahanta and Tiwari, (2005), Yonggam (2005), Angami *et al*. (2006), Namsa *et*

al. (2009, 2011), Sarmah (2010), Srivastava and Nyishi Community (2010), Kagyung *et al.* (2010), Tangjang *et al.* (2011), Nimasow *et al.* (2012) etc. have made valuable contribution where more than 500 species of NTFPs used for food, medicines and other household items have been documented. Rethy *et al.* (2010) documented 88 plant species belonging to 48 families and 57 genera from the ethnobotanical studies on the Membas of Dehang-Debang Biosphere Reserve and highlighted the potentiality of some selected species in economic development of the tribes as well as management of forest resources of the Biosphere Reserve. These species being used for different purposes from medicinal to vegetables and edible fruits, fodder, religious uses etc. Almost all these publications mainly deals with the different types NTFPs being used by the various tribes of Arunachal Pradesh mainly highlighting on their traditional ways of utilizing their forest products. However these studies mainly cover some ethnobotanical aspects of few selected regions and tribes and do not cover the utility pattern of NTFPs of the region. Although some of the publications have been made on the Apatanis, as such no detail studies on the NTFPs used by the tribe has been done so far that include all the wild resources available and used in the Apatani plateau. The works carried out by Sundriyal *et al.* (2004), Mahanta and Tiwari, (2005), Kala, (2005) and Srivastava *et al.* (2010) listed the ethno medicinal plants used by the communities and focussed on the proper documentation of indigenous knowledge systems in relation to utilization and conservation of forests and forest resources. Bamin *et al.* (2013) as a part of the present study has made an attempt to highlight some of the common NTFPs used by Apatanis.

As the NTFPs have been found very supportive worldwide in economic development and livelihood support to the poor communities, the detailed studies of the utilization pattern and their present status of conservation may be very helpful for formulation of action plan.

Chapter 3

MATERIALS AND METHODS

3.1. Study site

3.1.1. Location

The present study site the Ziro valley is located in Lower Subansiri District, in the Central Western part of Arunachal Pradesh (approx. 92°40´ to 94°21´ East Longitudes and 26°55´ to 28°21´ North Latitudes) (Pl.1A). Lower Subansiri District is bounded by Kurung-Kumey and some parts of Upper Subansiri District to the North, West Siang and Upper Subansiri District in the East, Papumpare District and Assam to the South and Kurung Kumey and Papumpare Districts to the West respectively (Fig. 3.1). Ziro, a scenic valley (often called the Apatani Plateau) lies between the Panior and Kamla (Kuru) rivers at an altitude of 1,524 to 2,900 m above sea level. The total geographical area is 3,460 sq.km of which 33 sq.km area are under cultivated land while the rest is under forest cover, plantations and settlement (http:// lowersubansiri. Nic.in /html /forestpractice.htm). The region is also well known for diverse NTFPs species and having many places of tourist attraction, and has been considered as a centre of developmental activities during recent years.

The study is solely based on the Apatani tribes residing in Ziro plateau. Apatanis are one of the major ethnic tribal groups of Arunachal Himalaya inhabiting eco-culturally valued zone in Ziro valley, sharing 2.26% population of the Arunachal Pradesh (Census of India, 2011). The community has distinct traditional land use practices and rich traditional ecological knowledge of natural resources management and conservation, acquired over the centuries through informal experimentation. The Apatani with highly developed age-old valley rice cultivation has often been counted to be one of the advanced tribal communities in the northeastern region of India (Haimendorf, 1962). The high-energy efficiency of Apatani agro-ecosystems is in contrast with that recorded from jhum in northeast India (Kumar and Ramakrishnan, 1990). The highly evolved traditional forest based natural resources management and conservation practice of Apatanis is unique in upland India (Sundriyal and Dollo, 2004).

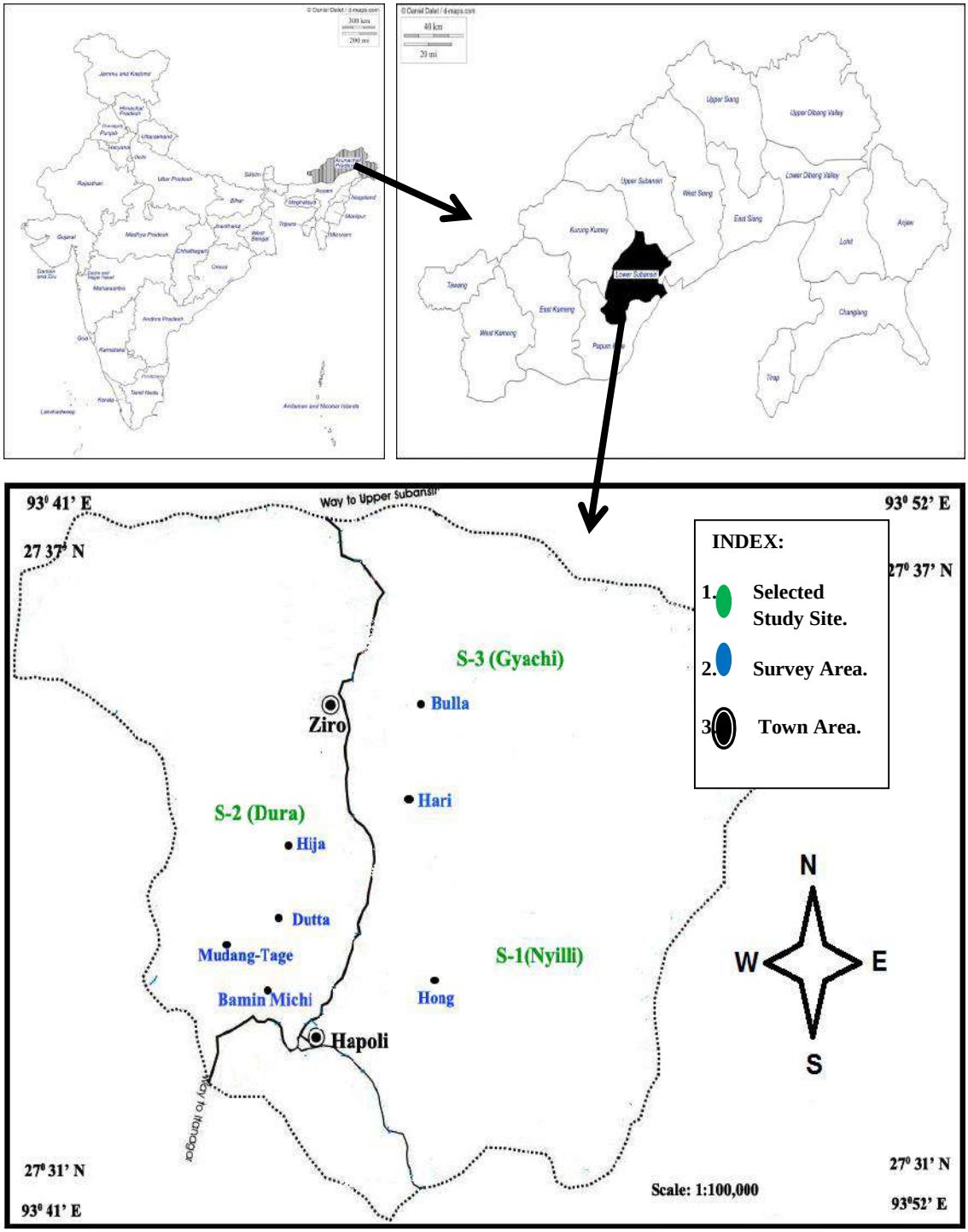


Figure. 3.1. Map of the study sites.

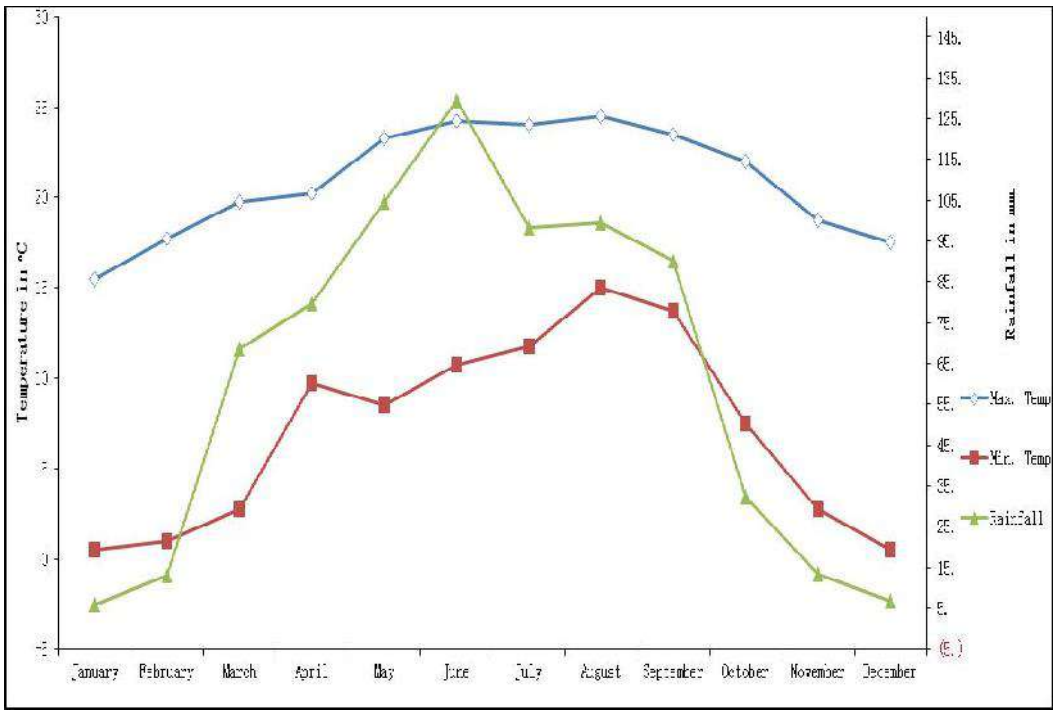
3.1.2. Climate

The climatic condition of the district is varied from season to season. The area falls within the humid subtropical to temperate types of climate depending on the altitudinal variation. The region experiences four types of seasons in a year namely, the cold winter seasons (December to February), the pre-monsoon season (March to May), the South-West monsoon season (June to mid-October) and the post-monsoon seasons (October to November). During winter the months of December and January is generally the coldest wheras during summer in the month of July and August it is warm.

The average annual rainfall of Ziro is recorded as minimum 6.05 mm to a maximum rainfall of 129.6 mm during the months of May-July Depending on the variations in the altitude ranges the mean annual temperature ranges was recorded from a minimum 0.5ºC in winter to a maximum of 24.5ºC in summer (Fig. 3.2.). Average relative humidity ranging from 49.28 % (February) to 87.14 % (September). The relative humidity always remains high throughout the year, except during winters when it slightly goes down.

3.1.3. Soil

The soils of the valley are humid black and reddish lateritic. It is dominantly colluvial to alluvial to developed from genesis and schist overlaid on a wide area with older alluvial deposits. The top soils are sandy loam to clay loam in texture at an altitude of 800 m and above it is loamy to clayey. It is rich in humus at the top of the soil mostly. Soil pH ranges from 5.10 to 5.64, organic carbon from 1.25-2.87%, available phosphorus from 19 to 32 kg ha-1 and exchangeable potassium from 300-365 kgha-1 (Dollo *et al*., 2009).



(Source: Department of Agriculture, Lower Subansiri District, 2013)

Figure.3.2. Ombothermic diagram of Ziro, Lower Subansiri.

3.1.4. Forest types / Vegetation

The physiography and the climatic conditions of the study site plays a very important role in the rich vegetation and is a store house of wide varieties of forest resources. It is mainly characterized under Sub-tropical to Temperate forests with rich diversity of flora and fauna. The forests are intricately linked with crop farming and domestication of livestocks that provides fodder for the livestocks and also food, medicines, firewood (Maikhuri *et al.*, 1996, Sundriyal and Upreti, 2002) and other NTFPs that are not only used in day to day activities but also are commercialized for income sources. Ziro or Apatani plateau is also well known for providing diverse NTFPs besides other important commercial timber and other forest products and is categorized under the following vegetation or forest types (Dollo *et al.*, 2009) (Pl.1D-H).

i. Bamboo forest
ii. Pine forest
iii. Castanopsis forest
iv. Sub-tropical forest
v. Temperate forest

The Bamboo forests are characterized by *Phyllostachys bambusoides, Castanopsis indica, Castanopsis hystrix, Castanopsis tribuloides, Dendrocalamus hamiltoni, Prunus nepalensis*, *Myrica esculenta,* etc. *Phyllostachys bambusoides* locally called 'bije' is mostly cultivated in all the bamboo gardens. The importance and its use in everyday lives are wide and mostly preferred, even though other bamboo species like *Chimnocalamus callosus, Erimocaulon capitatum* are also grown and cultivated. This zone of forests provides timber, fuel wood, food, and other important materials for handicraft, housing and ritualistic purposes.

The pine forests are mostly dominated by *Pinus wallichiana, Pyrus pashia, Prunus nepalensis,* etc. The pine trees are a good source of fuelwood especially the sap and pine cones which are used for producing fire and also has medicinal values.

The *Castanopsis* forests are characterised by different species of Castanopsis (*C. indica, C. hystrix, C. tribuloides*), *Alnus nepalensis, Myrica esculenta,* etc. The different types of *Castanopsis* spp. plays very important role in the livelihood of Apatanis. Every individual forest has this species as it is of importance to them for all round seasons and festivals.

Sub-tropical forests are mainly dominant by species like *Quercus lamellosa, Quercus griffithi, Castanopsis tribuloides, C. indica, C. hystrix, Magnolia champaca, Terminalia chebula, Exbucklandia populnea, Helicia robusta, Cherospondias axillaris, Illicium griffithii, Actinidia callosa, Dendrocalamus hamiltonii, Chimonobambusa* sp. etc., These forest areas are a rich source of wild fruits that are consumed and are also marketed for commercial purposes. Species like *Magnolia, Castanopsis, Actinidia* are mostly collected from wild.

Temperate forests are rich in *Taxus baccata, Pinus wallichina, Cephalotaxus* sp., *Tsuga dumosa, Rhododedndron* sp., *Pleioblastus simoni, Arundinaria* sp. etc. which besides providing fuel wood are also a treasure of medicinal plants. Each of these forest areas are rich in different types of vegetation which are used for timber as well as non timber forest uses. Some of them have got ritualistic as well as economic importance. It comprises of rich plant species grown in wild as well as cultivated, used for fuel wood, handicraft, rituals, wild edible fruits, medicine etc.

3.1.5. Ethnographic profile

Literally the word Apatani is from ‘Apa’ means addressing someone out of affection and ‘Tani’ means the descendents of ‘Abotani’, who is considered as the ancestral forefather of the Apatanis. Haimendorf (1962) in his book stated them “as their racial makeup, the majority of the Apatani seems to confirm to the Palaeo-Mongoloid characteristics of most of the hill tribes of border land and the eastern Himalaya”. They generally speak Apatani dialect.

Apatanis live in a close knit society and initially concentrated in seven villages namely Bulla, Dutta, Hari, Bamin-Michi, Hong, Mudang-Tage and Hija, which are organized in accordance with the traditions of three ancestors, ‘Nichi-Nitii’, ‘Tinii-Diibo-Dre-Hija’ and ‘Talyang-Hao’. However, with the growing population, the settlements have spread across the plateau and currently more than 100 villages are present (Statistical handbook, Lower Subansiri 2012). Over the years even though many Apatanis have started to move out to other districts but they are still dominant in this plateau called Ziro. As per the statistical data, Lower Subansiri, 2012 out of total population of Lower Subansiri, Ziro has a population 42352 comprising of 21346 male and 21006 female. The literacy rate is 73.69% (Statistical handbook, Lower Subansiri, 2012). Majority of the Apatanis have settled around the Hapoli township in the South-East and some others around Old Ziro in the North-east of the plateau. It is a patriarchal society where men are the head of the family and the women members play very important role in the agricultural fields. They live in houses made of bamboo and wodden planks, in earlier times their houses were made of paddy straw, bamboo and pine slabs, but over the years they have shifted to new and modern designs of houses.

Apatanis are mostly believer of the natural god ‘Danyi-Piilo’ but currently many have converted to Christianity following missionary works and still some are ardent believer of Hindu god. Apatanis celebrate many religious festivals of which ‘Murung’, ‘Myoko’ and ‘Dree’ are the main. The tribal laws and village administration are accomplished through clan representatives known as ‘Bulyang’ which is the traditional council of the Apatanis. The ‘Bulyangs’ acts as judges to decide individual cases or meet as a village or inter-village body to adjudicate public disputes (Kani, 1993).

The Apatanis staple food is rice (*Oryza sativa*) or paddy 'Aemo', vegetables 'Hamang' and local rice beer 'O', local salt 'Tapyo'and traditional chutney 'Pikey', 'Pila'. They mostly eat boiled food without any spices and free from oil. And the women members mostly prefer eating wild raw vegetables with chutney made of chilli, pork oil and local salt called 'Tero pila'. Apatanis are well known for their paddy-cum-fish cultivation (Pl.1C). Besides agriculture, forest is the integral part of Apatanis not only for ritual and festival but also for their livelihood sustenance. Apatanis way of bamboo gardening is also considered to be very unique and one of the best techniques followed. They maintain these bamboo gardens not only for use of housing materials but also for other activities like fences around forests, gardens, houses, ceremonies, decorative items, rituals items, edible as vegetables etc. Forests and forest products play a major role in the livelihood systems of the people that provides them with firewood and other day-to-day needs.

3.2. Methodology

3.2.1. Selection of study site and informants

Preliminary phytogeographical and phytosociological survey of the study area Ziro was carried out for identification of each village in the study site. All the seven villages were selected for survey and collection of information related to the topic from the representative villages and collection of species was done. A number of different, complimentary approaches and techniques were used to obtain information and data relevant to this study. Detail information on the study area has been collected from secondary sources like Department of Forests, Department of Agriculture, Administrative offices, Statistical data, books, journals etc.

To fulfill the purpose of the study and research objectives, questionnaire were prepared to collect information on the plants used and its use pattern. Knowledgeable persons, village elders, gaon burahs, priests, daily forest goers were selected for providing informations. Personal interview with village headman and other villagers were conducted. Official information's were also recorded from forest department as well as from civil administration.

3.2.2. Field survey and data collection

Continuous field surveys were made in all the selected villages and households during 2009-2013. Collections of data were made as per standard

ethnobotanical methodology (Jain 1989; Martin 1995) and through regular visits to the household on seasonal basis followed by informal interview and discussion. At least 20 household were randomly selected from each villages. Collection of data from each village was made by personal interviews and discussion with the informants. Both the male and female informants mostly above 30 years age were considered. Specimen collection and field notes were maintained and the utilization pattern of the different NTFPs were recorded such as parts used, use pattern etc along with its local name.

Besides the common household survey, various festivals and rituals performed seasonally and for specific purposes were also observed to document the IKS associated with NTFPs. Questionnaires were also prepared and used for collecting information and knowing the traditional knowledge associated with the use of the plant specimens and other techniques and knowledge involved in using of the plants and other materials as well as the traditional techniques applied in conservation and sustainable use of the forest resources mainly the NTFPs by interaction with priests and knowledgeable elders including ladies.

Market survey was also carried out in all the four seasons i.e. During January-March, April-June, July-September and October-December and the NTFPs sold during these seasons were surveyed. Questionnaires were prepared and used for finding out the price and the highly demanded NTFPs that were sold in the market. The local vendors especially the women's were interacted on how they procure the NTFPs sold and what are the benefits they get from their sale profit and its demand as well its demand outside the Hapoli market.

3.2.3. Collection of specimen and identification

Field survey had been carried out in four seasons and specimens of the NTFPs were collected accordingly following methods of Jain and Rao (1977). All the collected specimen were properly sized and processed for herbarium preparation. Herbarium specimens were prepared for the collected specimen following Jain and Rao (1977).

Identification of these plants was later done by through consultation of experts and herbarium specimens of State Forest Research Institute (SFRI), Itanagar, North

Eastern Regional Institute of Science and Technology (NERIST), Nirjuli, Botanical Survey of India (BSI), Itanagar and Rajiv Gandhi University (RGU), Doimukh and also through consultation of relevant taxonomic literatures. The entire herbarium specimen thus prepared have been deposited in the Forestry herbarium of NERIST.

3.2.4. Plant community characteristics and population status

To study the species composition and community characteristics the sampling of the vegetation was done using the quadrat method. Three community forest stands were selected for the present study based on the availability and extraction of NTFPs by the Apatani community for their day to day uses. Among which first study site (Nyilii) was selected in Hong community forest, second study site (Gyachi) in Bulla community forest and third study site (Dura) in Hija community forest. Geographic location, forest types, etc. are given in Table 3.1

Study sites	Community forest	Geographic location		Forest types
		Latitude N	Longitude E	
Nyilii	Hong	27°33'27.56"	93°50'33.50"	Temperate
Dura	Hija	27°35'57.91"	93°50'21.68"	"
Gyachi	Bulla	27°34'48.38"	93°49'23.55"	"

Table 3.1. Study sites for phytosociological studies.

Twenty five quadrats of 10 m × 10 m were laid randomly in each study stands. Trees and shrubs were recorded within the same 10 m × 10 m quadrat, whereas herbs were recorded by laying 1m × 1m quadrat within the same quadrat area of 10 m × 10 m.

Community characteristics of each of the forest stands were studied following quantative analytical methods. Various important ecological parameters like basal area, density, frequency, importance value index (IVI) were worked out by following Misra (1968) and Mueller-Dombois and Ellenberg (1974). Girths of each of the adult tree species within the quadrats were measured at 1.37 m above the ground level. Basal areas of each of the adult individuals were calculated using the formula g/4. Importance value index (IVI) of tree species was calculated by summing up the values of relative frequency, relative density and relative dominance while, for shrubs and herbs it was obtained by summing up the values of relative frequency and relative density (Curtis, 1959).

Species richness ‘S’ was calculated by listing all the species occurring in the study stands following Whittaker (1972). Species richness index was calculated by following Menhinick (1964) as:

$$d = S/\sqrt{N}$$

Where ‘S’ is the total number of species and ‘N’ is the number of individuals.

Species diversity index H’ was calculated by method given by Shannon and Weiner (1963) as:

$$H' = -\sum (ni/N) \ln (ni/N)$$

Where H’ is Shannon Weiner diversity Index, ‘ni’ is importance value index of the i^{th} species and ‘N’ is the total importance value index of the community.

Simpson’s dominance index was calculated following Simpson (1949) as:

$$D = \sum (ni/N)^2$$

Where ‘D’ is Simpson’s index, ‘ni’ is importance value index of the i^{th} species and ‘N’ is the total importance value index of the community.

Sorenson’s similarity index was calculated by following the formula of Sorenson’s Similarity index (Sorenson, 1948) as:

$$S = (2C/A+B) \times 100$$

Where ‘A’ is the total number of species in site A, ‘B’ is the total number of species in site B and ‘C’ is the total number of common species in both A and B.

Pileou’s evenness index (E) was calculated following Pielou’s index (Pielou, 1969) as:

$$E = H'/\ln S$$

Where ‘E’ is Pileou’s evenness index, H' is Shannon Weiner diversity index and S = total number of species.

Spatial distribution pattern of various plant species was calculated following Whitford index (Whitford, 1949) as:

$$WI = Abundance/Frequency$$

If the value is < 0.025, which indicates regular distribution, 0.025-0.050 indicates random distribution and if the value is > 0.050 indicates clumped distribution.

Chapter 4

RESULTS

4.1. Documentation of NTFPs used by Apatanis: Enumeration

All the plant species used as Non-timber Forest Products are identified and enumerated. For easy indication and reference the species are arranged alphabetically with their botanical names followed by family given in brackets, vernacular names given in inverted commas, collection no., description, phenology, habitat, distribution, and details of the ethnobotanical uses. The two species of fungi has been placed separately at the end. For proper description and record different literatures like Flora of British India (Hooker, 1872-1897), Materials for the Flora of Arunachal Pradesh Vol. I-III, (Chowdhery *et al*., 1996, 2008), Contribution to the Flora of Namdapha, Arunachal Pradesh (Chauhan *et al*., 1996), Flora of Assam Vol. I-IV (Kanjilal *et al*., 1934-1940) Flora of Meghalaya I-II (Haridasan and Rao, 1985, 1987) and Flora of China (efloras, 2013,2014) have been consulted.

1. *Acmella paniculata* (Wallich. ex. DC.) R. K. Jansen [Asteraceae] 'Yakhohamang / Yorkhung hamang'

Collection no: Hapoli, 26.6.2009, *Bamin- 20* [Pl. 2A]

Description: Annual herb, widely spreading, stems glabrous, branches divaricate. Leaves opposite, ovate-elliptic, long petioled, distantly serrulate denticulate, sparsely pubescent on the lower surface. Capitula ovoid, orange yellow, involucral bracts biseriate, linear ovate.

Flowering & Fruiting: May-October.

Habitat: Found growing in wild along road sides, home gardens, sides of forest areas.

Distribution: Burma, China, Thailand, Nepal, Taiwan, India (North East India).

Uses: Leafy shoots are consumed raw as vegetable, and is medicinally used for constipation.

2. *Acorus calamus* Linn. [Araceace] 'Kile tolyo'

Collection no: Hong, Hong agiya, 14.3.2009, *Bamin- 05* [Pl. 2B]

Description: A rhizomatous perennial semi-aquatic herb, erect, rootstock creeping rhizomes are branched and aromatic, Leaves elongated, large, ensiform and entire in the margins. Flowers greenish yellow, orbicular, concave, incurred at the tip. Berries few seeded, oblong.

Flowering & Fruiting: April-October.

Habitat: Found in marshy areas and along streams, swamps, near small ponds.

Distribution: Afghanistan, China, Bangladesh, Bhutan, Indonesia, Japan, Korea, Nepal, Pakistan, Russia, Sri Lanka, Thailand, Vietnam, India (Arunachal Pradesh and Tripura).

Uses: The paste of the rhizome is applied on dislocated joints, wounds, cuts. It is also used for bone setting by applying the paste. Also used as medicine to get relief from diarrohea, dysentery and abdominal pain.

3. ***Actinidia callosa*** *Lindl.* [Actinidiaceae] 'Antii tarey'

Collection no: Bulla, Gyachi, 14.3.2010, *Bamin- 09*

Description: Straggling shrub, stem glabrous or white verrucose. Leaves broadly ovate- elliptic. Flowers in axillary umbellate cymes. Fruits ovoid, drooping.

Flowering & Fruiting: August- October.

Habitat: Found in forest edges and edges of bamboo grooves.

Distribution: China, Bhutan, India (Arunachal Pradesh, Manipur, Assam).

Uses: Fruits are edible. They are consumed as juicy fruits.

4. ***Actinidia chinensis*** *Planch.* [Actinidiaceae] 'Harkhu ayi'

Collection no: Hapoli, Agey putu, 16.8.2010, *Bamin- 04*

Description: Large climbing shrub. Leaves alternate, abaxially pale green, adaxially dark green, broadly ovate, glabrous. Flowers orange-yellow. Fruit subglobose to cylindric to obovoid or ellipsoidal, glabrous on maturity.

Flowering & fruiting: December- April.

Habitat: Found in forest edges preferably in shaded places.

Distribution: China, India (Arunachal Pradesh, Manipur, Assam).

Uses: Fruits are edible. They are consumed as jucy fruits.

5. ***Ageratum conyzoides*** Linn. [Asteraceae] 'Borbia tami'

Collection no: Hapoli, 14.3.2009, *Bamin- 10*

Description: Small annual herb about 1 m high, hairy, aromatic with striate branches. Leaves opposite or alternate above, petioled, broadly triangular or ovate, margins crenate-serrate pilose above, heads homogamous, capitulum in terminal corymbs or panicles. Flowers bluish purple, achenes subtriangular, pappus clavate, sometimes serrate below.

Flowering & Fruiting: August-October.

Habitat: Abundantly found along roadsides, waste lands as a weed.

Distribution: Bhutan, China, Nepal, India (found almost everywhere in India).

Uses: The leaf paste or its juice is applied to stop bleeding. It is also applied on swollen joints to relieve pain.

6. *Allium hookeri* Thwaites [Amaryllidaceae] 'Lepi/ Taley'

Collection no: Hapoli, 14.3.2009, *Bamin-06*

Description: Annual tuberous herb, roots elongated, thick and fleshy. Leaves linear, with distinct mid vein. Bulbs clustered, cylindric, tunic membranous, entire. Flowers in umbel. Perianth white or greenish yellow to yellow, lanceolate, apex acuminate, sometimes unequally 2-lobed.

Flowering & Fruiting: May-December.

Distribution: Bhutan, Myanmar, Sri-lanka, Southern China, India (North East India).

Uses: Leaves are eaten as salad and also as condiment and medicines.

Remarks: It is preferred raw with chilli chutney 'Tero Pila' made of pork fat, and chilli, local salt 'Tapyo' or common salt and warm water. Also used as an ingredient in local chutney 'Pikey'.

7. *Allium tuberosum* Rottler ex Spreng [Amaryllidaceae] 'Lepi/ Taley'

Collection no: Hapoli, 15.3.2009, *Bamin-01*

Description: Leaves 4-5, erect, narrow linear flat tall compressed, trigonous above, pedicels longer than the small white or pink stellate flowers, sepals oblong-lanceolate, filaments simple linear, perigynous, style short.

Flowering & fruiting: May-December.

Habitat: Grows in wild in agricultural lands, forest areas or cultivated in home gardens.

Distribution: China, Indonesia, Malaysia, Phillippines, India (Arunachal Pradesh, Manipur).

Uses: Leaves are edible as salad. It is preferred raw with chilli chutney 'Tero Pila'. Also used as an ingredient in local chutney 'Pikey'.

8. *Alnus nepalensis* D. Don [Betulaceae] 'Riime'

Collection no: Hapoli, Ring road, 15.8.2010, *Bamin-76.*

Description: Small or medium sized tree, bark compact, grey, grayish- brown, warty, sparsely yellow pubescent when young, glabrescent. Leaves alternate, elliptic or elliptic lanceolate, entire or somewhat denticulate, glabrous above, slightly pubescent

along the nerve beneath when young, base narrowed or rounded. Flowers in solitary or drooping panickled spikes. Fruits ellipsoid or subcylindric cone like spikes, black brown colour. Nuts with numerous wings.

Flowering & fruiting: June- November.

Habitat: Mostly found in forest and in bamboo grooves.

Distribution: Bhutan, Myanmar, Nepal, Pakistan, India (North and North East India).

Uses: Branches are used as firewood. Stems are highly preferred for house construction.

9. *Amaranthus spinosus* Linn. [Amaranthaceae] 'Pulu tayi hamang'

Collection no: Hapoli roadside, 2.9.2010, *Bamin-53.*

Description: Annual herb, erect, spiny, glabrous, stem and branches with axillary spines. Leaves opposite, ovate, oblong, lanceolate, cuneate at the base. Flowers in axillary clusters, in terminal or simple axillary spikes. Urticles included in perianth.

Flowering & fruiting: April- October.

Habitat: Mostly grow in waste lands in open places and also as weeds in fields.

Distribution: America, China, Malaysia, India (North and North East India).

Uses: Leaves and young shoots are eaten cooked as vegetable and also used as fodder.

10. *Amaranthus tricolor* Linn. [Amaranthaceae] 'Lancha tayi hamang'

Collection no: Bulla, 5.9.2009, *Bamin-122*

Description: Erect herb about 2 m high, young part red or bright pink colour. Leaves ovate, lanceolate, decurrent at base and glabrous. Flowers in clusters, unisexual, perianth green, bracts present. Urticles with perianth, ovate-oblong. Seeds blackish brown.

Flowering & fruiting: April - October.

Habitat: Mostly found in wet places and also as weeds in fields.

Distribution: Native to Tropical Asia and throughout Tropics of India (North and North East India).

Uses: Leaves and young shoots are cooked as vegetable and also used as fodder.

11. *Angiopteris* evecta (G. Forst.) G. F. Hoffm. [Marattiaceae] 'Tiibe/chanyu'

Collection no: Hija, Ruhing, 14.9.2009, *Bamin-27*

Description: Erect terrestrial tree fern, rhizome broad, fleshy, smooth green swollen at base, with minute brown hairs and brown scales; fronds long, bipinnate joint to the

main rachis, widely spreading, petiole serrate or toothed, sori arranged in two rows bipinnate; wide spreading swollen at base; petiole, oblong lanceolate, acuminate, serrate or toothed, veins simple, parallel. Sori arranged in two close rows, sporangia 7-15 in each sorus; spore hyaline, tetrahedral.

Spore formation: June- July.

Habitat: Found in dense forests and slopes.

Distribution: Australia, China, Japan, Malaysia, India (Arunachal Pradesh, Meghalaya, Nagaland).

Uses: Stem, tubers are dried, burnt and used for making for making local salt and filtered liquid ash 'Piyu, Pila'. Stem used for religious purposes.

12. *Anisomeles indica* (Linn.) Kuntze [Lamiaceae] 'Naru tami'

Collection no: Hapoli, 14.8.2009, *Bamin-11*

Description: Under shrub, about 1 m high, with strong scent, stem erect, softly pubescent. Leaves opposite, broadly ovate, softly pubescent on both sides or densely hairy. Flowers pink or pale purplish, in terminal position in verticellaster. The fruit 9-10 mm long, greenish to whitish.

Flowering & Fruiting: August - December.

Habitat: Commonly found along roadsides, forest edges and waste places preferably dry places.

Distribution: China, Bangladesh, Malaysia, Myanmar, Thailand, Phillipines, Vietnam, India (Arunachal Pradesh, Manipur, Maharashtra, West Bengal).

Uses: Whole plant is crushed and applied in muscle cramps.

13. *Artemisia indica* Willd. [Asteraceae] 'Kukulyu /Kuku lyole hamang'

Collection no: Bamin-Michi, 9.4.2010, *Bamin -120* [Pl.2C]

Description: An erect aromatic shrub, 1-3 m high. Leaves opposite, sessile, lobed or deeply pinnatisect with stipule like lobes at base, densely white wooly beneath, glabrous above. Heads ovoid, solitary or fascicled on large terminal paniculate racemes; involucral bracts few, oblong. Achenes oblong ellipsoid, minute.

Flowering & Fruiting: August-November.

Habitat: Found in open areas in forest and slopes of hill.

Distribution: Bhutan, China, Myanmar, Nepal, Sri Lanka, India (Arunachal Pradesh, Assam).

Uses: Leaves are used as pain reliever, the leaves are put behind the ears and its strong smell gives relief from nose blockade, headache etc due to its aroma. The paste of the leaf is applied on the back to get relief from pain. It is also used for getting relief from asthma. It is also used as vegetables.

14. *Aspidopterys indica* (Willd.) W. Theob. [Malphigiaceae] 'Taru payu'

Collection no: Bulla, Dolkho, 3.11.2009, *Bamin -12*

Description: Woody climbers. Leaves ovate-elliptic-ovate to ovate cordate. Flowers in axillary and terminal rusty tomentose panicled, greenish. Fruits are winged.

Flowering & Fruiting: October- December.

Habitat: Found in open forest edges.

Distribution: Myanmar, India (Arunachal Pradesh, Assam, Meghalaya, Eastern Himalaya, Orrisa, Peninsular India).

Uses: Whole plant and stem used as gum. It is crushed or boiled along with water, till the extracts are thickened and sticky. It is then stored and used for hunting. The sticky gum is used for hunting and catching bird.

15. *Balanophora dioica* R. Br. *Ex.* Royle [Balanophoraceae] 'Kidi payu'

Collection no: Hija, Katu Pingo, 29.9.2012, *Bamin-122* [Pl. 2D]

Description: Root parasite (parasitise on tree roots). Rootstocks tuberous, stems covered with imbricate sessile scales. Rhizome brownish and reddish purple, unbranched or several together in a mass, surface with granular warts. Leaves distichous, rarely spirally arranged, imbricate, broadly ovate to ovate-oblong, tip blunt to notched. Flowers closely packed, fleshy and grows on club shaped receptacle; perianth white and turns brownish on maturity and surrounded by linear reddish bracts. Fruits are minute and drupaceous.

Flowering & Fruiting: February - November.

Habitat: It mostly grows under well moisture and humus soil under shady areas on the roots of trees.

Distribution: Bhutan, Myanmar, Nepal, India (North East India).

Uses: The rhizome is soaked in water and crushed till the sticky gum comes out and is used for hunting especially for catching birds, wild rats etc.

16. *Begonia obversa* C. B. Clarke [Begoniaceae] 'Lukhu'

Collection no: Hapoli, Pai gate, 12.4.2010, *Bamin-95*

Description: Small herb with tuberous roots, about 30-50 cm high. Leaves ovate, cordate, acuminate, finely serrated. Flowers unisexual, capsule one winged.

Flowering & Fruiting: April - October.

Habitat: Mostly found in moist areas along the streams and in shady places along forests and roadsides.

Distribution: China, Myanmar, Nepal, India (North East India).

Uses: Leaves are eaten boiled as vegetable and also used as pig fodder.

17. *Begonia roxburghii* (Miq.). A. D. C. [Begoniaceae] 'Byukhu'

Collection no: Hapoli, Pai gate, 12.3.2009, *Bamin-11*

Description: Succulent, erect, perennial herb, glabrous, pinkish, with fibrous roots. Leaves broadly ovate, sinuate, acute to acuminate, glabrous, toothed or serrated. Inflorescence axillary, dichotomously branched short cyme, few flowered, flowers white. Fruits succulent.

Flowering & fruiting: May- September.

Habitat: Mostly found in moist areas and in shady places along forest entrance and slopes.

Distribution: China, Myanmar, Nepal, India (North and North East India).

Uses: Tuber is boiled along with *Rubia manjith* and is used as dye for obtaining colour. Leaves and petioles are also taken as vegetables. Leaves are used as medicine for cough, fever and indigestion.

18. *Berberis wallichiana* DC. [Berberidaceae] 'Tiipe tire/lobye tire'

Collection no: Ring road, 14.4.2010, *Bamin-43* [Pl. 3A]

Description: Thorny shrub, about 2-3 m high with greyish brown bark, yellowish inside. Leaves are broadly obovate or oblong-lanceolate, spinous, serrulate. Flowers many in fascicles, yellow. Berries oblong, ellipsoid, red and it turn blackish blue or deep purple later on ripening.

Flowering & fruiting: October- May.

Habitat: It mostly grows along road side and in open forests.

Distribution: China, Nepal, India (Eastern Himlayan region).

Uses: The bark of the root is said to give relief from pain, when applied on swollen parts. Spines are used for tattooing 'Tiipe' on the chin and forehead by the Apatanis. The thorn of the plant is collected and tied in a bunch. A mixture of starch 'Pila ala' and bacon oil is prepared and applied on the area to be tattooed and the thorn is

pricked on it. The mixer helps in piercing and acts as soothing agent. Fruits give relief from indigestion.

Remarks: Tiipe tire was the most preferred during early days for tattoing on face by the Apatanis.

19. *Calamus acantospathus* Griff. [Arecaceae] 'Tisser'

Collection no: Hill top, 12.6.2009, *Bamin-22* [Pl. 3B]

Description: Perennial climber about 25 m high. Leaves pinnately compound, large, leaflets few, elliptic-lanceolate, scarcely spinescent above, spinulose margins, short spiny or tubercled, petioles and rachis prickly on margins. Flowers in spadices. Fruits obovoid to globose, shortly beaked and brown.

Flowering & Fruiting: March- February.

Habitat: Mostly found in shady places in forests.

Distribution: Bhutan, Myanmar, Nepal, Thailand, Vietnam, India (Arunachal Pradesh, Assam, Sikkim).

Uses: Stem is used as fibre. Used in religious and rituals purposes for making pleated rope'Ali Tarin' usually worn on the leg below knee by man, children and priests. Priests wear it on occasions like Myoko, Murung etc. as accessories and also for making household items like racksack for men 'Lera', baskets used for carrying grains 'Yaghii, Mida yaghi' etc.

20. *Calamus khasianus* Becc. [Arecaceae] 'Tikhe'

Collection no: Hong, 14.4.2008, *Bamin*- 154

Description: Perrenial climber, upto 15-20 m, clustered. Leaf sheaths with hairs, spines pointing downward. Inflorescence bracts tubular. Fruits globose, ellipsoid or ovoid.

Habitat: Grow mostly in forests preferably moist shaddy places.

Distribution: Bangladesh, Bhutan, Myanmar, Nepal, Thailand, Vietnam, India (North East India).

Uses: Stem fibre used for making household items. Mostly used during rituals in preparation of altars. Also used for making nose plugs 'Yaping Hullo'worn by Apatani women.

21. *Cannabis sativa* Linn. [Cannabaceae] 'Bhang'

Collection no: Hija, 13.4.2010, *Bamin-152*

Description: Aromatic herbs, upto 2 m tall, stem ribbed or angled, slightly pubescence. Leaves alternate, lanceolate, serrate, acuminate, sessile, pubescent, stipule in lateral sides. Flower white, minute; male flower axillary panicled cymes; tepals ciliate; stamen exserted; female flower axillary solitary, bracts leafy, glandular, pubescent. Fruit crustaceous nut, compressed.

Flowering & Fruiting: March-May.

Habitat: Found in road sides, open fields.

Distribution: Bhutan, Pakistan, India (North East India and South India).

Uses: Dried leaves are used as toxic drugs.

22. *Cardamine hirsuta* Linn. [Brassicaceae] 'Paddii hamang'

Collection no: Hija, 15.4.2012, *Bamin- 18* [Pl. 3C]

Description: Annual glabrous herb, sub-erect to decumbent. Leaves compound; leaflets orbicular with hairy upper surfaces. Inflorescence racemose or sub-corymbose. Flowers in terminal racemes and white coloured.

Flowering & Fruiting: April-November.

Habitat: Mostly available in marshy areas in forest edges and wet paddy fields, streams and roadsides.

Distribution: China, Burma, Bhutan, Nepal, India (North East India, Uttar Pradesh, West Bengal).

Uses: Leaves are taken as salad and mostly preferred raw along with chilli chutney 'Tero pilla' and local salt 'Tapyo'.

23. *Castanopsis armata* (Roxb.) Spach [Fagaceae] 'Kira'

Collection no: Bulla, Gyachi, 23.7.2012, *Bamin- 194*

Description: Medium size tree, evergreen. Leaves alternate, oblong-lanceolate, glabrous, acute at base, caudate-acuminate. Stipules extra petiolar. Inflorescences usually unisexual, erect, spicate or paniculate. Flowers simple panicled. Fruits globose, spines numerous, arranged in group.

Flowering & Fruiting: March - August.

Habitat: It is mostly found in forest, and also managed in home gardens.

Distribution: Bhutan, Nepal, Myanmar, Thailand, India (Arunachal Pradesh, Assam, Meghalaya).

Uses: Fruits edible, leaves are used during chanting of rituals and religious ceremonies, stem, branches as firewood and house building material, such as pillar 'sirang'.

24. *Castanopsis hystrix* Hook. f. & Thomson *ex* A. DC. [Fagaceae] 'Kiira riihin'

Collection no: Hong, Nyibioagia, 10.9.2009, *Bamin-64*

Description: Trees slender, sparsely to densely puberulent and with yellowish brown small lamellate waxy scale like trichomes. Leaves lanceolate to obovate-elliptic, rarely smaller or larger, papery to thinly leathery, pubescent when young but early glabrescent, at least adaxially along midvein with very lax and thick or tight and thin, reddish brown to yellowish brown, small, lamellate, base sharply acute to rounded; midvein adaxially impressed. Female inflorescence solitary in leaf axil. Nut broadly conical, glabrous.

Flowering & Fruiting: April-October.

Habitat: Found in forest preferably in moist areas, and also in home gardens.

Distribution: Bhutan, Myanmar, Nepal, Thailand, India (Arunachal Pradesh, Assam, Meghalaya, Sikkim).

Uses: Leaves used for decorating the sacred alter and other materials used during rituals and religious ceremonies and also stem, branch is used as firewood and for housing materials such as pillar. It is also used for making sacred pillar 'babo'.

25. *Castanopsis indica* (Roxb. ex. Lindl.) A. DC. [Fagaceae] 'RahuKiira'

Collection no: Hong, Nyibioagia, 10.6.2009, *Bamin-19*

Description: Large evergreen tree, bark silvery grey, warty. Leaves narrowly elliptic oblong or oblong lanceolate, base rounded, acute or acuminate, spinous-serrate, glabrous above, rusty tomentose beneath. Flowers in paniculate spikes, often with spikes. Fruiting spikes long, often branching; cupule globose, usually splitting into 4 segments when mature; bracts spine like, entirely covering cupule, densely hairy. Fruit nuts.

Flowering & Fruiting: June-October.

Habitat: Found in deep subtropical forest in moist areas and in home gardens.

Distribution: Bangladesh, Myanmar, Nepal, Thailand, Vietnam, India (North East India).

Uses: Nuts are edible, leaves used for decorating the sacred alter and other materials used during rituals and religious ceremonies and also stem and branches used as firewood and for housing materials such as pillar 'sirang'.

Remarks: The tree locally known as 'Kiira' is considered to be the most sacred and used in performing every ritual.

26. *Castanopsis tribuloides* (Sm.) A. DC. [Fagaceae] 'Korbing Kira'

Collection no: Bulla, Gyachi, 14.8.2009, *Bamin-24*

Description: Evergreen middle sized tree, light brown in colour. Leaves entire, lanceolate, oblong-lanceolate sometimes serrate towards apex. Flowers in panicles, fascicles or tomentose spikes with short spines. Nuts ovoid, glabrous, solitary.

Flowering & fruiting: April- October.

Habitat: Grows in forest preferably in moist areas and also in home gardens.

Distribution: Bhutan, China, Myanmar, India (North East India).

Uses: As firewood, Nuts like fruits are edible, leaves are used during chanting of rituals and religious ceremonies, stem is used for house building material and firewood.

Remarks: It is the most preferred for religious purposes and house building materials.

27. *Centella asiatica* (Linn.) Urb. [Apiaceae] 'Ngilang hikho'

Collection no: Hija, Dura, 12.4.2010, *Bamin-109*

Description: Prostrate herb, stem long with leaf axil arising from horizontal rootstocks. Leaves are suborbicular or reniform and usually crenate, palmately nerved, long petioled, glabrous, deeply cordate at base. Flowers 3-5 in umbel, sub-sessile, each with a pair of ovate sub-amplexicaule bracts. Fruits are laterally compressed.

Flowering & Fruiting: June- December.

Habitat: Grow along edges of forest, home gardens and roadsides preferably moist areas.

Distribution: Bhutan, China, Indonesia, Japan, Korea, Nepal, India (North East India, Madhya Pradesh, West Bengal).

Uses: The whole plant is eaten and preferred raw as vegetable along with chilli chutney. It is also taken as medicine for gastritis and as blood purifier and also to get relief from abdominal pain. Fresh leaves are taken to improve appetite.

28. *Cephalostachyum mannii* (Gamble) Stapleton [Poaceaea] 'Tajer'

Collection no: Hapoli, Hil top, 2.9.2009, *Bamin-64*

Description: Climbing bamboo of about 12–20 m high with many branching at nodes, tends to bend and double like creeper, culm sheaths sparse stiff, brown appressed bristles. Leaves are lanceolate, hairy beneath. Inflorescence unknown.

Habitat: Home gardens, deep forests.

Distribution: China, India (North East India).

Uses: Mature culm is used for religious and traditional purposes. A piece of its culm is worn in hair as decoration of the head gear 'Abiyo, 'Byokho' by the priest nyibu while performing 'Murung' festival. Culm for binding purposes in roof-making or during other rituals.

29. *Cerasus cerasoides* (Buch.-Ham.ex D. Don) S.Y.Sokolov [Rosaceae] 'Semo'

Collection no: Old Ziro, 25.5.2010, *Bamin-90*

Description: Medium sized tree, smooth bark. Leaves elliptic, oblong-lanceolate, glandular ends. Flowers appear with bare branches or young leaves, pink. Fruits ellipsoid, ovoid, yellow, matures to red.

Flowering & Fruiting: March- August.

Habitat: Found in temperate forests and also cultivated in nearby home gardens and bamboo grooves.

Distribution: Bhutan, Myanmar, Nepal, Thailand, Vietnam, India (Arunachal Pradesh, Sikkim, Himachal Pradesh, Kashmir).

Uses: Small ripe fruits edible or used as ingredient for making chutney.

30. *Chimonocalamus callosus* (Munro) Hsuech & T. P.Yi [Poaceae] 'Tabiyo

Collection no: Hill top, 14.8.2009, *Bamin-17*

Description: Shruby and thorny bamboo; with culms about 7 m tall, nodes with bases of fallen sheaths having brown coloured hairs. Culm sheaths loose and hairy. Leaves cauline. Inflorescence branched panicled ending in leafy branchlet; spiklets flowered with narrow bracts.

Habitat: Found in interior forest areas along with cane species.

Distribution: China, Myanmar, Vietnam, India (Arunachal Pradesh, Assam).

Uses: Young shoots are eaten as vegetable, culm is used as house building materials and as firewood.

31. *Chimonocalamus griffithianus* (Munro) Hsueh & T.P. Yi [Poaceae] 'Riijang'

Collection no: Hapoli, Hill top, 12.4.2010, *Bamin-131*

Description: Thorny bamboo with erect culms, nodes armed with spinules. Culm sheaths longer than internodes, papery, soft hairy, broad at the base, attenuate upwards; blade imperfect and triangular in shape. Leaves linear lanceolate, narrow at the base.

Habitat: Found near streams or springs in the forest.

Distribution: Bhutan, India (Arunachal Pradesh, Meghalaya, Nagaland).

Uses: Young shoots edible as vegetable and the culms are also used as firewood & fences.

32. *Choerospondias axillaris* (Roxb.) B. L. Burtt & A.W. Hill [Anacardiaceae] 'Biiling '

Collection no: Bulla, Gyachi, 14.9.2009, *Bamin-26* [Pl. 3D]

Description: Small to medium sized tree. Leaves alternate, 15-20 cm, compound, 3-7 leaflets, ovate to lanceolate, serrated margin. Flowers white coloured in branch panicled. Fruit oblong and yellow coloured when ripe.

Flowering & Fruiting: February- October.

Habitat: Found in home gardens and dense forests.

Distribution: China, Nepal, Thailand, Vietnam, India (North East India, WestBengal).

Uses: Fruits are edible and has a sweet-sour taste.

Remarks: It is said to be a highly nutritious fruit and it can give lots of commercial potential if it is put into cultivation.

33. *Christella parasitica* (Linn.) [Thelypteridaceae] 'Tari'

Collection no: Hong, Aigira, *Bamin-171*

Description: Creeping, stout ferns, stipes 20-30 cm long; rhizome upto 0.4 cm wide, pale brown, covered with brown, thin, linear lanceolate scales. Young frond circinate, pinnate pinnae soft and hairy, truncate to subtruncate, at base; rachis scaly or hairy, lower surface of the pinnules more or less deeply clothed with acicular and glandular hairs on and between veins, veins upto 8-12 pairs in pinnules; sori medial or submarginal in two rows; indusial bearing both acicular and glandular hairs.

Spore formation: March- September.

Habitat: Found along roadsides, forest edges and forest floors preferably in shaded places.

Distribution: Australia, China, Japan, Malaysia, Nepal, Sri Lanka, Thailand, Vietnam, India (North East and South India).

Uses: Young fronds are crushed and applied on wounds and cuts. It is also used as insectidices.

34. *Cinnamomum bejolghota* (Buch. - Ham.) Sweet. [Lauraceae] 'Yatii/Sangin'

Collection no: Hong, Nyibio, 25.5.2011, *Bamin-121* [Pl. 4A]

Description: Tall tree with dense ovoid crown; bark grey or blackish brown, scented. Branches robust, red-brown when dry. Leaves opposite, aromatic, crowded at the end of branchlets, elliptic or elliptic-lanceolate, thickly leathery, glabrous, trinerved with transverse veins, veinlets reticulate, base sub-rounded or attenuate, margin entire, apex obtuse, acute, or acuminate. Flowers yellow, gray pubescent except apex subglabrous on both surfaces, fragrant. Fruit ellipsoid, green when fresh and turns black on maturity.

Flowering & Fruiting: April-August.

Habitat: Found in dense forests and hill slopes.

Distribution: Bangladesh, Bhutan, China, Laos, Myanmar, Nepal, Thailand, Vietnam, India (Arunachal Pradesh, Assam, Mizoram).

Uses: The leaves are used for making rain- shield 'Yati'.

35. *Cinnamomum verum* J. Presl. [Lauraceae] 'Salley'

Collection no: Bamin, 4.9.2010, *Bamin-135* [Pl.4B]

Description: Evergreen tree, about 10 m tall, bark smooth with strong cinnamomum smell, branches grey. Leaves simple, opposite, ovate or ovate-lanceolate, leathery or subleathery, glabrous on surfaces, triplinerved, midrib and lateral veins elevated on surfaces, transverse veins and veinlets reticulate. Flowers yellow in panicle, with an odour. Fruit ovoid and blackish.

Flowering & Fruiting: June-September.

Habitat: Found in open forests under evergreen trees.

Distribution: Bangladesh, Srilanka, Taiwan, India (Arunachal Pradesh, Assam, Kerala).

Uses: The outer cover of the bark of the tree is peeled, and the inner part of the bark is crapped out, smoked dried and cut into small pieces taken as spice.

36. *Cirsium interpositum* Petr. [Asteraceae] 'Lobyo tire/Tipey tire'

Collection no: Ring road, 21.8.2009, *Bamin-188* [Pl. 4C]

Description: Erect herb, robust, stem, hollow, cottony. Leaves opposite, sessile or base auricled, lobes lanceolate, acute, spinescent above, white appressed, tomentose beneath. Capitula terminal, clustered, glabrous; involucral bracts multiseriate, long, aristate-acuminate. Achenes oblong-ovoid, 4 angled. Florets bisexual, Corolla purple; pappus feathery, unequal in length.

Flowering & Fruiting: May- October.

Habitat: Grows in open forests, road sides.

Distribution: China, Myanmar, India (Arunachal Pradesh, Assam, Manipur).

Uses: The whole plant is dried and burned to ashes and is used for making ingredients for local salt. Spines or thorns used for tattoing.

37. *Cissus repens* Lam. [Vitaceae] 'Taru-beku/ Hulla'

Collection no.: Bulla, 27.9.2009, *Bamin- 68* [Pl.4D]

Description: Herbaceous climber, stem soft, greenish. Leaves simple, stipules brownish, leaf blade cordate-oval, glabrous, apex acute or acuminate. Inflorescence umbeliform. terminal, glabrous. Berry 1-seeded. Seed surface smooth, with sparse ribs.

Flowering & Fruiting: September-December.

Habitat: Found along bamboo forest areas and forest edges.

Distribution: Bangladesh, Bhutan, Malaysia, Nepal, Phillipines, Thailand, Vietnam, India (North East India).

Uses: Fruits are edible.

38. *Clerodendrum glandulosum* Linn. [Lamiaceae] 'Pato hamang'

Collection no: Hapoli, 13.8.2010, *Bamin- 92*

Description: Perrenial shrub about 1-3 m high, stem quadrangular, branches robust, sparsely pubescent, with corky internode. Leaves opposite, broad, oblong-ovate or elliptic oblong, acuminate, coarsely serrated. Inflorescence terminal, compact corymbose panicles 5-25 across. Flower white, calyx pubescent, copular, teeth short; corolla tube white, slender. Druplets bluish green, globose, compressed above.

Flowering & Fruiting: August-December.

Habitat: Grows as wild along the edges of forest, roadsides, shady places amidst bushes and community land near houses.

Distribution: Bangladesh, Bhutan, China, Indonesia, Malaysia, Myanmar, Nepal, Sri Lanka, Vietnam, India (North East India).

Uses: Leaves are taken as vegetable and commonly used as an ingredient for local chutney, as medicine and it is a good remedy for blood pressure.

39. *Clerodendrum serratum* Linn. Moon [Lamiaceae] 'Patohamang'

Collection no: Hapoli, 14.8.2009, *Bamin-32*

Description: Shrubs 1-4 m tall, stems quadrangular, not much branched, glabrous. Branchlets pubescent dark brown to gray-yellow, glabrous tree which is found in wild and also cultivated. Stems quadrangular, branches robust and sparsely pubescent with corky internodes. Inflorescences terminal thyrses, densely yellow-brown pubescent, cymes bracts sessile, ovate to broadly ovate Flowers numerous, bracteates, white coloured, pedicelate. Fruit drupe, subglobose, bluish and turns blackish on drying.

Flowering & Fruiting: August-December.

Habitat: Grows as wild along the edges of forest, roadsides, shady places amidst bushes and community land near houses.

Distribution: China, Malaysia, Sri Lanka, India (North East India, Karnataka, Tamil Nadu).

Uses: Leaves are used as vegetables and as an ingredient for local chutney also used as a remedy for blood pressure.

40. *Coccinia grandis* (Linn.) Voigt. [Cucurbitaceae] 'Jojuru'

Collection no: Hapoli, Agey putu, 18.8.2010, *Bamin- 51*

Description: It is a perennial herbaceous climber with tuberous roots, 3 angled lobed, rough on the surface. Flower white. Fruit long ovoid-oblong, beaked, with white stripes, green-orange-reddish.

Flowering & Fruiting: July- September.

Habitat: Found along roadsides, forest edges, home gardens.

Distribution: China, Malaysia, Thailand, Phillipines, Central America, India (North East India, Bihar, Orrisa, West Bengal).

Uses: Fruits are edible and has a sweet taste.

41. *Colocasia affinis* Schott. [Araceae] 'Yarri/ Ruhing'

Collection no: Hong, Ring road, 13.10.2009, *Bamin -33* [Pl. 5A]

Description: Monoceious and tuberous herb, tubers globose. Leaves ovate or ovate orbicular, glabrous beneath, spathe-tubes cylindric, greenish limb, linear-lanceolate, acuminate. Inflorescences 1–3; peduncle pale green, cylindric. Spathe constricted; tube convolute, green, almost cylindric, yellow, greenish white, or yellowish, oblong-lanceolate. Young berry green.

Habitat: In moist waste places, wild, cultivated.

Flowering & Fruiting: September-December.

Distribution: Bangladesh, Bhutan, China, Myanmar, Nepal, India (Arunachal Pradesh, Assam, Kerala, Gujarat).

Uses: The leaves are used as fodder.

42. *Colocasia esculenta* (Linn.) Schott. [Araceae] 'Inge'

Collection no: Michi, 1.1.2010, *Bamin- 124*

Description: Rhizome vertical to horizontal, monoceious tuberous herbs. Leaves large, ovate or sub triangular, yellowish-greenish or purplish beneath. Spathe-tubes greenish or orange yellow. Small appandage, spadix short. Berry green.

Flowering & Fruiting: May-January.

Habitat: Moist waste places.

Distribution: Bangladesh, Myanmar, Nepal, Pakistan, India (Arunachal Pradesh, Assam, Bihar, Karnataka, Kerala, West Bengal).

Uses: The tuber is edible as vegetable and leaves are cooked as pig fodder.

43. *Crassocephalum crepidioides* (Benth.) S. Moore [Asteraceae] 'Gendahamang'

Collection no: Bulla, 3.10.2009, *Bamin 28*

Description: Erect herb, about 50-60 cm high, glabrous, branched, purplish colour. Leaves oblanceolate-elliptic, acute, tapering at base, irregularly shaped, pubesecnt. Heads in corymb, deep red at tip, involucral bracts oblong, linear, carious margins, achenes minute, blackish. Flowers equal, bisexual, corolla yellow throughout, long, tubular; tube long, very slender, funnel-shaped. Achenes cylindric-linear, ribbed, dark-brown with paler base and apex, thinly pubescent, pappus hairs numerous, thin, silky, minutely toothed, white, caudaceus.

Flowering & Fruiting: October - December.

Habitat: Common in open area among weeds, roadsides in forests.

Distribution: Africa, China, Sri Lanka, India (Arunachal Pradesh, Assam, Meghalaya, Tamil Nadu, Uttrakhand).

Uses: The whole plant and leaves are eaten, either cooked or raw. Dried plants are also used for making piyu, tapyo. Leaves are made into paste to heal cuts and wounds.

44. *Croton roxburghii* Balak. [Euphorbiaceae] 'Pai lamu'

Collection no: Hong, 6.2.2009, *Bamin-37*

Description: Medium size tree, branches with dense scale-glandsgrayish or whitish bark. Leaf blade elliptic, papery, base broadly cuneate to rounded, margins glandular-serrate, apex mucronate. Inflorescence terminal or axillary, many flowered. Flowers yellow, long racemes. Capsule subglobose, ellipsoid.

Flowering & Fruiting: February-June.

Distribution: Bangladesh, Nepal, Sri Lanka, India (Arunachal Pradesh, Assam, Meghalaya).

Uses: Leaves gives relief from stomach disorder.

45. *Cyanthillium cinereum* (Linn.) H. Rob. [Asteraceae] 'Tapyo'

Collection no: Hapoli, 14.4.2010, *Bamin-47*

Description: Annual or perennial herb, pubescent. Leaves petiolated, alternate, elliptic- lanceolate. Heads flowered, terminal corymbs, pinkish to purplish. Involucral bracts, 4 seriate. Pappus white or dull white.

Flowering & Fruiting: August-November.

Habitat: Found along road sides

Distribution: Africa, Arabia, Australia, Indonesia, Japan, Malaysia, Myanmar, Philippines, Sri Lanka, Thailand, Vietnam, India (Throughout).

Uses: Whole plant is dried and burnt down to ashes and used for preparing local salt.

46. *Cyathea gigantea* (Wall. ex. Hook.) Holtt. [Cyatheaceae] 'Tashe'

Collection no: Hija, Dura, 5.10.2009, *Bamin-29* [Pl.5B]

Description: It is a tree fern with massive trunk. Stipe dark black, purplish, scaly at the base with hooked margins. Bipinnate fronds. Sori large forms a Vshape.

Spore formation: July-September.

Habitat: Moist open areas in forest.

Distribution: Bangladesh, China, Myanmar, Nepal, Sri Lanka, Thailand, India (Arunachal Pradesh, Nagaland).

Uses: The pith is used as food and fodder and the leaves also used as food, leaves are also used as a remedy against body ache.

47. *Cyathula prostrata* (Linn.) Blume. [Amaranthaceae] 'Tapyo'

Collection no: Hapoli, 25.8.2009, *Bamin-50*

Description: It is an erect annular herb, branches angular, suberect to ascending. Leaves ovate to rhomboid-obovate, reddish tinged. Flowers in small, drooping clusters on hairy peduncled racemes, pale violet. Seeds orbicular, shiny brown.

Flowering & fruiting: August-February.

Habitat: Shades, secondary forests and in wastelands near roadsides.

Distribution: Africa, Malaysia, Myanmar, Nepal, Thailand, India (North East India).

Uses: Whole plant is dried, burnt and the ash obtained it is used for making local salt of Apatanis.

48. *Cyclosorus glandulosus* (Blume) Ching. [Thelypteridaceae] 'Milo Riji/Milo tarih'

Collection no: Hong, Nyibio, 10.6.2011, *Bamin-168* [Pl.5C]

Description: Rhizome short creeping, sterile fronds, minutely hairy, lamina 30-50 cm long, base truncate, apex abruptly, short acuminate. Fronds approximate to distant; stipes bases not narrowed apices caudate-acuminate Laminae herbaceous, brownish green or yellowish green when dried, with thin acicular hairs throughout on both surfaces, and reddish orange glands throughout abaxially. Sori orbicular, densely hairy. Sporangia bearing reddish orange glands on stalks. Spores with wings

Habitat: Found in shady areas of forest edges, bamboo gardens.

Distribution: Australia, China, Japan, Korea, Malaysia, Nepal, Sri Lanka, Thailand, India (Arunachal Pradesh, Assam)

Uses: Leaves of this fern is used during rituals and festivals.

49. *Dendrocalamus hamiltonii* Nees & Arn. ex Munro [Poaceae] 'Yayii byapu'

Collection no: Hill top, 13.10.2009, *Bamin -31*

Description: It is a large bamboo of about with drooping culm. Culms are large Internodes are thin walled and grayish-white coloured with dense appressed pubescence and turns to dull green on maturity. The culm sheaths are long and glabrous. Leaves variable, small branches, rounded at the base into short thick petiole, broadly lanceolate, scabrous, twisted pointed, smooth above and rough beneath, serrated on the margins.

Flowering & Fruiting: January - December.

Habitat: Mostly bought from the wild state from neighboring areas and cultivated in the study area.

Distribution: China, Bhutan, Nepal, India (Arunachal Pradesh, Assam).

Uses: Matured culm is used for house building, household items like mugs, spoons, baskets, containers etc. (made from the stems, which are usually bent), shoots are edible and highly preferred because of its taste.

50. *Dendrophthoe falcata* (Linn. f.) Ettingsh. [Loranthaceae] 'Sanii Payu'

Collection no: Hija, 26.9.2010, *Bamin- 139* [Pl. 5D]

Description: Parasitic shrub, grayish bark. Leaves opposite, elliptic, ovate-elliptic, glabrous, thick coriaceous. Flowers in axillary racemes, orange-red. Fruits ovoid, oblong, black.

Flowering & fruiting: April-September.

Habitat: Found in forest edges and along roadsides.

Distribution: Africa, Australia, Throughout India (Arunachal Pradesh, Assam, Meghalaya).

Uses: Seeds are crushed or boiled and gum is obtained.

51. *Dendrocnide sinuata* (Blume) Chewin Gard. [Urticaceae] 'Hati pata'

Collection no: Dolokho, Bulla, 12.4.2010, *Bamin-91*

Description: Herbaceous shrubs, upto 3 m tall, young parts covered with stinging hairs. Leaves alternate, entire, ovate or elliptic, often crenulate towards apex, acute or acumnate, covered with stinging hairs, penninerved; cordate or rounded at base, petiole stout, urticle inflated, white.

Flowering & Fruiting: March-September.

Habitat: Found in swampy or moist places in forest edges.

Distribution: Malaysia, Myanmar, Sri Lanka, Thailand, India (North East India).

Uses: Root and leaf extract is used for curing fever and also applied to cure swelling.

52. *Dicranopteris linearis* (Burm. f.) Underw. [Gleicheniaceae] 'Takho/ Takho Tari'

Collection no: Bulla, Ring road, 3.11.2009, *Bamin-36*

Description: Creeping rhizome. Stipes long, glabrous. Rachis clothed with brown branched hairs, glabrescent, obtuse brown glands along veins. Pale yellow brown sporangia.

Spore formation: October - December.

Habitat: Along shady moist road sides.

Distribution: Australia, Indonesia, Japan, Malaysia, Nepal, Sri Lanka, India (Arunachal Pradesh, Kerala).

Uses: Whole plant is used for making spring action traps for rodents, fences for altars or shrines during certain religious rituals purposes.

53. *Dioscorea bulbifera* Linn. [Dioscoreaceae] 'Inge/Hulla'

Collection no: Michi, 18.8.2009, *Bamin-25*

Description: Climber about 30 m long, globose tuber, pyriform tubers, purplish-black coloured, flesh white; bulbils axillary, numerous, irregular in shape, brown, warted. Leaves simple, broadly cordate, acuminate. Flowers white, capsules long stipe, semi-elliptic, base rounded.

Flowering & Fruiting: January- December.

Habitat: Mostly found in shady places.

Distribution: Australia, Thailand, India (North East India, West Bengal, Tamil Nadu).

Uses: Tubers are eaten as vegetable, good for indigestion.

54. *Dioscorea hamiltonii* Hook. f. [Dioscoreaceae] 'Engin'

Collection no: Michi, 13.10.2009, *Bamin-31*

Description: Climbing herb; slender branches, slightly winged, smooth, twining right. Leaves ovate-lanceolate, opposite, cordate at base. Capsules oblong, coppery-brown, obtuse base.

Flowering & Fruiting: January - December.

Habitat: Mostly found in shady places.

Distribution: Bhutan, China, Myanmar, Nepal, Thailand, India (North East India).

Uses: Tubers and bulbils are cooked and eaten and is said to be good for indigestion. The whole plant is also used as fodder for pigs.

55. *Diplazium esculentum* (Retz.) Sw. [Athyriaceae] 'Hiika'

Collection no: Hong, Nyibio, 14.3.2009, *Bamin-08*

Description: Terrestrial fern, rhizome erect, dark brown; broad scale, stipe erect, tufted, base sparsely scaly; frond large, young fronds are green, curly, lamina bi-pinnate, pinnae petiolate; pennules numerous, sessile, acuminate, truncate or broadly cuneate at base, margin lobed; sori linear and continuous along the veins, brownish; sporangia shortly stalked.

Spore formation: October - December.

Habitat: Commonly found in moist areas of roadsides, wasteland, forest fringes and forest slopes.

Distribution: Bangladesh, China, India (North East India, West Bengal, Western Ghats).

Uses: The fronds are edible. It is boiled along with salt and water or boiled with meat. When people go to jungle they collect it from the wild and use it to plug the bamboo in which they cook the meat.

56. *Duchesnea indica* (Andrew) Focke. [Rosaceae] 'Subu Tute jilyung'

Collection no: Hong, Nyibio, 14.4.2009, *Bamin- 45* [Pl. 6A]

Description: Common perennial herb, pubescent. Leaves 3 foliate, leaflets obovate. Flowers yellow, solitary or 2-3 flowered racemes. Fruit acheness on a fleshy red receptacle, ellipsoid.

Flowering & Fruiting: April-March.

Habitat: Roadsides, wastelands, forest fringes.

Distribution: Africa, Afghanistan, Bhutan, China, Indonesia, Japan, Korea, Pakistan, India (Arunachal Pradesh, Assam, Sikkim, Punjab, Bengal).

Uses: Fruit are edible, sweet and juicy.

57. *Elatostema platyphyllum* Wedd. [Urticaceae] 'Hiipe hamang'

Collection no: Bamin, 3.11.2010, *Bamin- 55*

Description: Undershrub, about 50 cm high, glabrous, stems erect, branched. Leaves alternate, obliquely, elliptic- lanceolate, serrulate. leaf blade obliquely elliptic or narrowly elliptic margin denticulate, apex acuminate or caudate-acuminate Flower greenish white slightly pubescent.

Flowering & Fruiting: August-November.

Habitat: Grows in shady places mostly near bamboo grooves and forest entrance.

Distribution: Bhutan, China, Nepal, India (Eastern Himalaya).

Uses: Young leaves are edible as vegetable.

58. *Elaeagnus caudata* *Schlcht*. ex Momiy. [Eleagnaceae] 'Hari ayi'

Collection no: Bulla, Sigiya, 3.11.2009, *Bamin- 53*

Description: Straggling shrub, spiny with silvery branches. Leaves alternate, petiolate, blade margin usually entire, ovate-oblong. Flowers yellow & fragrant,

bisexual, clustered on short axillary shoots, sometimes solitary. Fruit ellipsoid, red-yellow.

Flowering & fruiting: November-March.

Habitat: Mostly grow in secondary forests.

Distribution: China, Nepal, India (Eastern Himalaya).

Uses: Fruits are edible.

59. *Eremocaulon capitatum* (Trinius) Londono [Poaceae] 'Yabing'

Collection no: Hija, 12.4.2009, *Bamin -38*

Description: Semiscandent (woody climber) bamboo, about 4-10 m high, culm yellow, internodes about 1 m long. Leaves pale-green, whitish beneath, ovate-lanceolate, rounded, sheaths glabrous with long caduceus hairs. Inflorescence dense, globular, terminal or axillary heads; sterile spikelets keeled on back, fertile spikelets with 1-3 sterile florets at base.

Flowering & Fruiting: Not seen.

Habitat: Commonly found in deep forest in highly shaded area.

Distribution: China, Phillippines, India (North East India).

Uses: Young shoots are edible as vegetable, as medicine. The liquid inside the young tender shoots is taken during famines to protect from diarrhoea, dysentery or stomach trouble. It is also dipped in drinking water to purify mature culms are used for filtering water and are a good water purifier. Culm used for cutting the umbilical cord of a new born baby when delivered at home during olden days. Used in rituals and religious purposes.

60. *Eupatorium odoratum* (Linn.) [Asteraceae] 'Borbe tami'

Collection no: Hija, Ruhing, 19.2.2011, *Bamin-150*

Description: Fast growing shrub, about 1-2 m tall, stem hairy. Leaves opposite, ovate to ovate- elliptic, serrated, have

pungent smell when it is crushed. Flowers white- purplish pink. Seeds minute, hairy in head.

Flowering & Fruiting: March-September.

Habitat: Commonly found along road sides and forest entrances.

Distribution: Throughout the tropical region of the world.

Uses: Leaves are crushed and applied on cuts and wounds.

61. *Eurya aciminata* DC. [Theaceae] 'Sankhii/nausankhii'

Collection no: Bulla, Pisani, 15.4.2009, *Bamin-104*

Description: Large shrub, much branched, young branches pubescent. Leaves alternate, elliptic-oblong to elliptic-lanceolat, acuminate or acute apex, crenate, glabrous. Flowers axillary, yellowish. Berries globose, bluish-black.

Flowering & Fruiting: March-August.

Habitat: Commonly grow in the roadside in the forest area.

Distribution: China, Bhutan, Nepal, Thailand, India (North East India).

Uses*:* Whole plant is used as fencing material, leaves used as dye.

62. *Exbucklandia populnea* (R. Br. ex Griff.) R. W. Br. [Lauraceae] 'DoloYasang/ Tapo'

Collection no: Hong, 9.4.2010, *Bamin -140* [Pl.6B]

Description: Middle size tree, 15-20 m tall, branch pubescent, bark black. Leaves palmately 3 lobed when young, broadly ovate-rounded, base cordate, acute, acuminate, margin entire, abaxially glabrous, adaxially drying dark green, shiny; palmately veined, petiole longer in young leaves, glabrous; stipule orbicular. Flower bisexual, spathulate, head 10-20 flowered, peduncle pubescent; petals usually absent; ovary yellow-brown pubescent.

Flowering & Fruiting: May- September.

Habitat: Grows in hill slopes in the forest.

Distribution: Bhutan, China, Myanmar, India (North East India, West Bengal).

Uses: The stem is used as house building material. Also used for making the traditional platform 'Lapang' and tradional pillar 'Babo' used during Myoko festival to symbolize the presence of male member in the family. Childrens uses the young pods as spoons.

63. *Ficus auriculata* Lour. [Moraceae] 'Taro ahii'

Collection no: Bulla, Gyachi, 3.11.2009 , *Bamin -34* [Pl. 6C]

Description: A deciduous woody trees, middle sized, crown elongated and wide with rough grayish brown bark. Leaves alternate, broad, ovate, elliptic, oblong base cordate, obtuse, entire margin; petiole thick, stipules reddish purple, triangular-ovate, lanceolate. Fruit pear-shaped, present on leafless branchlets, pubescent when young, dark red or purple at maturity.

Flowering & Fruiting: March-August.

Habitat: Deep forest slopes.

Distribution: Bhutan, China, Myanmar, Nepal, Pakistan, Thailand, Vietnam, India (North East India, Bihar, Orissa).

Uses: The fruit is edible and very much preferred.

64. *Ficus hookeriana* Corner [Moraceae] 'Koa ahii'

Collection no.: Bulla, Gyachi, 14.8.2010, *Bamin- 138*

Description: Trees upto 20m tall, epiphytic. Leaves spirally arrange lamina elliptic to broadly ovate- elliptic, glabrous margin, entire, coraceous.Veins distinct underneath. Stipule large, ovate, membranous. Fruits axillary on leafy branchlets, paired, obovoid-ellipsoid to cylindric.

Flowering & Fruiting: May-December.

Habitat: Found in forest and open areas.

Distribution: Bhutan, Nepal, India (Arunachal Pradesh, Sikkim).

Uses: Stem and branches are used as firewood.

65. *Ficus sarmentosa* Buch -Ham. ex. J. E. Sm. [Moraceae] 'Sireh Myarung'

Collection no: Hong, 23.4.2010, *Bamin- 145* [Pl. 6D]

Description: A large, woody creeper or root climber, with ashy grey to brown bark. Young twigs brownish-pubescent when growing in damp shady places otherwise almost glabrous. Leaves alternate, ovate-oblong to ovate-lanceolate or elliptic, margins entire, apex acute or acuminate. Receptacle usually solitary rarely paired, axillary, sessile to shortly peduncled, globose to ovoid or obovoid. Flowers pedicellate, dispersed among the gall flowers.

Flowering & Fruiting: February-May.

Habitat: Mostly grow in forest edges, bamboo grooves.

Distribution: Bangladesh, Bhutan, China, Japan, Korea, Myanmar, Nepal, Pakistan, Taiwan, India (North East India, Punjab, Himachal Pradesh, Jammu & Kashmir, Uttar Pradesh, West Bengal).

Uses: Young fruits are edible.

66. *Fragaria vesca* Linn. [Rosaceae] 'Kidi Nyimung'

Collection no: Hong, Nyibio, 12.4.2011, *Bamin-166*

Description: Herbs perennial, 5–30 cm tall. Stems together with petioles, rarely glabrescent. Leaf blade 3-foliolate, rarely pinnately 5-foliolate; leaflets sessile or

central one shortly petiolulate, abaxially greenish, adaxially green, obovate, elliptic or broadly ovate, abaxially pubescent, adaxially sparsely pubescent, base cuneate, margin obtusely or acutely incised serrate, apex obtuse. Inflorescence corymbiform, 2–5 flowered, with a greenish, subulate or petiolate, leaflet like bract. Fruits globose.

Flowering & Fruting: February-May.

Habitat: Found in shady damp places in deep forest slopes and roadsides.

Distribution: Bhutan, Europe, Japan, Korea, Northern Asia, North America, India (North East India).

Uses: Small red wild fruits are edible.

67. *Gnaphalium affine* D.Don. [Asteraceae] 'Miiyang'

Collection no: Hapoli, Agey putu, 14.4.2010, *Bamin- 42* [Pl. 7A]

Description: Erect annual herb of about 60 cm tall, stems densely white lanate tomentose. Leaves spathulate, opposite, oblong, narrowed, sessile, decurrent, margin entire, apex rounded, mucronulate. Flowers in terminal condensed heads, corolla pinkish red. Pappus yellow.

Flowering & Fruiting: April-November.

Habitat: Found abundantly near roadsides, waste places, forest floors.

Distribution: Afganistan, Bhutan, Indonesia, Japan, Korea, Myanmar, Nepal, Pakistan, Phillippines, Vietnam, India (North and North East India).

Uses: The dried leaves used for making quick fire. Commonly used in forest fire during forest activities.

68. *Gonostegia hirta* (Blume ex.Hassk.) Miq. [Urticaceae] 'Hiipe Hamang/ tabu chikar'

Collection no: Hija, Dura, 24.8.2009, *Bamin-118*

Description: Herbs or undershrubs often prostrate. Stem pubescent and quadrangular. Leaves opposite, lanceolate, acuminate. Adaxial surface rugrose, pubescent abaxial surface, shiny, base rounded. Flowers axillary, sessile with grey hooked hair. Achenes ellipsoid, dull black.

Flowering & Fruiting: July-September.

Habitat: Found in moist areas in the forests and waste lands.

Distribution: China, Australia, India (North East India, Jammu & Kashmir).

Uses: Leaves used as vegetable, fodder.

69. *Gynostemma pentaphyllum* (Thunb.) Makino. [Cucurbitaceae] 'Rikko'

Collection no: Hapoli, 6 kilo, 12.8.2009, *Bamin-21* [Pl. 7B]

Description: Slender climber with simple tendrils about 25 m long, branchlet glabrous. Leaves alternate, palmately trifoliate; leaflets ovate-lanceolate, crenate-serrated. Flowers minute in long axillary panicles, greenish or whitish. Fruit globose, berry greenish.

Habitat: Found in shady and wet places in forest areas.

Flowering & Fruiting: July-August.

Distribution: China, Bangladesh, Bhutan, Japan, Myanmar, Nepal, India (North East India).

Uses: Smoke or Sun dried stem are taken against cold, cough, stomachache and throat pain. The dried stem or root is powdered and mixed with local salt or common salt and taken with water or starch 'Pila ala' and taken orally.

Remarks: It is said to be very effective in treating cough and cold and is still being used by many villagers.

70. *Gynura bicolor* (Roxb.ex Willd.) DC. [Asteraceae] 'Halyanghamang/genda'

Collection no: Bamin, 9.4.2010, *Bamin-132*

Description: Succulent herb, stem erect, about 50-100 cm tall. Leaves spirally arranged, sessile, elliptic-lanceolate. Flowers in terminal heads; heads many, orange-yellow, pappus white.

Flowering & Fruiting: August-April.

Habitat: Found in moist shady places in road sides.

Distribution: China, Malaysia, Myanmar, India (North East India, Western Ghats, Uttar Pradesh).

Uses: Leaves mostly preffered as raw vegetables. The leaf juice or raw leaves is taken orally to treat against intestinal worms.

71. *Houttuynia cordata* Thunb. Kongl. [Saururaceae] 'Sia hamang'

Collection no: Hong, Nyibio, 2.9.2009, *Bamin- 52* [Pl. 7C]

Description: Aromatic perrenial herb, prostrate, alternate, root stock creeping. Leaves alternate, ovate, cordate, acuminate and pubescent on the nerve of young leaf. Flower prostrate, dense minute, white, terminal or axillary, in globose-arranged fruit like structure. Seeds globose, testa membranous

Flowering & Fruiting: April - October.

Habitat: Mostly found near roadsides, shady places in forest and fields.

Distribution: Bhutan, China, Japan, Myanmar, Nepal, Thailand, Indonesia, India (North East India).

Uses: The leafy shoots are used as vegetables either raw as chutney or cooked. It is mostly preferred raw and is said to provide good sleep and freshness of mind.

72. *Hydrocotyle javanica* Thunb. [Apiaceae] 'Hibiyo'

Collection no: Bulla, Subu lemba, 14.3.2009, *Bamin*- 07

Description: Prostrate herb, stem densely pubescent. Leaves alternate, orbicular or reniform, crenate 5-7 lobed, thin- papery. Flowers many in umbels, sessile in capitates clusters, petals greenish. Fruit pale brown- deep purple.

Flowering & Fruiting: July- October.

Habitat: Found in moist shady places along forest edges and bamboo gardens.

Distribution: China, Japan, Indonesia, Nepal, India (Arunachal Pradesh, Karnataka, Kerala, Maharashtra, Tamil Nadu, Eastern Himalayan region).

Uses: Leaves are taken as vegetable and as medicine to get relief from indigestion.

73. *Hyptis suaveolens* (Linn.) Poit. [Lamiaceae] 'Narutami'

Collection no: Hija, 5.4.2010, *Bamin-41*

Description: Annual herb, robust, branched aromatic, hairy. Leaves opposite, ovate to broadly ovate, cordate at base, hairy. Flowers dark purple, with spiny lobes, cymes 2-5 flowered, green calyx. Fruit nutlets, flattened.

Flowering & Fruiting: March- September.

Habitat: Mostly found along rivers, streams, along roads and agricultural fields.

Distribution: Native of Tropical America and neutralized in almost all the tropical or subtropical countries, India (North East India, Northern India).

Uses: The leaves are crushed and applied on cuts and wounds to stop bleeding.

74. *Impatiens racemosa* DC. [Balsaminaceae] 'Aki tayi'

Collection no: Michi, 18.8.2010, *Bamin-49*

Description: Annual herb, about 2 m high. Leaves elliptic-ovate or elliptic-lanceolate, glabrous. Inflorescence axillary or sub terminal, racemose, 4-10 flowered. Flowers small, yellow with 6-10 racemes. Capsule linear or narrowly clavate. Seeds many, brown, oblong.

Flowering & Fruiting: June-October.

Habitat: Found in forest areas in moist, shady places.

Distribution: Bhutan, Myanmar, Nepal, India (Arunachal Pradesh, Meghalaya, Sikkim, North India, West Bengal).

Uses: Leaves taken as vegetable.

75. *Juncus effusus* Linn. [Juncaceae] 'Mima'

Collection no: Ring road, 21.8.2009, *Bamin-62* [Pl. 7D]

Description: Perennial tufted herb with rounded stems, rhizome shortly creeping, thick. Stems terete, striate; pith continuous. Leaves alternate, scaly at base. Inflorescenes pseudolateral, densely to many flowered. Flowers solitary, subsessile, pseudoterminal, pale green, yellowish. Capsule oblong, reticulate. Seeds ovoid to oblong.

Flowering & Fruiting: March- September.

Habitat: In swampy and moist places along ponds.

Distribution: Bhutan, Indonesia, Japan, Korea, Malaysia, Nepal, Srilanka, Thailand, Vietnam, India (Arunachal Pradesh, Sikkim).

Uses: Leaves are used for tying vegetables, meat etc.

76. *Kavalama urens* (Roxb.) Raf. [Sterculiaceae] 'Niiji yanii'

Collection no: Bulla, Subu lemba, 14.3.2008, *Bamin-13* [Pl. 8A]

Description: Large deciduous tree upto 25 m high, stellately hairy, bark mucilaginous and rich in fibers. Leaves alternate, stipulate, cordate, 3-5 lobed leaves, rarely palmately compound entire, serrate, or parted. Inflorescence axillary or rarely terminal, paniculate. Flower yellow. Fruit capsule or follicle, ovoid to oblong, pubescent, woody, dehiscent.

Flowering & Fruiting: February-July.

Distribution: China, Malaysia, Nepal, India (Arunachal Pradesh, Sikkim).

Uses: The leaves of this plant is widely used for storing and wrapping different items like meat 'Yo', rice powder mixed with ginger 'Yatang' etc offered to God 'Uii' during rituals. It is used for covering local wine 'O' after preparation, for fermentation.

Remarks: It is the preferred leaf that is used during rituals and festivals for storing local beer or the food that is to be served to the 'Uii'.

77. *Lasianthus japonicus* Miq, [Rubiaceae] 'Santu payu'

Collection no: Hija, Kidi Santu, 18.4.2009, *Bamin-46*

Description: Shrub, about 3-4 m high, branches glabrous or subglabrous to sparsely strigose on young branches. Leaves opposite, decussate, lanceolate, long caudate-acuminate, glabrous, stipulate. Flowers in axillary, white or bluish white. Fruits globose, glabrous, blue violet on ripening.

Flowering & Fruiting: August - January.

Habitat: Found along roadsides and in shaded areas of forests.

Distribution: China, South Japan, India (Arunachal Pradesh, Assam, Sikkim).

Uses: The extract of fruit and stems is used as gum for bird hunting. The fruits are boiled in water and continuously stirred till it is thickened.

Remarks: It is most preferred for hunting bird.

78. *Ligustrum ovalifolium* Hassk. [Oleaceae] 'Sankhan melyan'

Collection no: Michi, 11.4.2010, *Bamin-115*

Description: Semi evergreen shrub or small tree, fast growing. Leaves opposite, simple, petiolate, thick and fleshy green, leaf blade entire. Inflorescence terminal panicles of cymes. Flowers bisexual, sessile or pedicellate, small white, and fragrant and borne in panicles. Fruits berrylike drupe with membranous or papery endocarp, rarely drupaceous purple-black.

Flowering & Fruiting: August-November.

Habitat: Found along roadsides, home gardens and nearby forest areas.

Distribution: China, Japan, South Korea, India (North East India).

Uses: Whole plant and stems are used during rituals and mostly for fences around the houses and bamboo grooves.

79. *Litsea cubeba* (Lour.) Pers. [Lauraceae] 'Santero'

Collection no: 6 kilo, 21.9.2009, *Bamin-57* [Pl. 8B]

Description: Deciduous aromatic tree, 8-10 m tall, bark greenish brown colour, young shoots silky, branchlets glabrous or pubescent. Leaves alternate, lanceolate tapered at tip, entire, midrib often purplish below. Flower buds usually arise on the axils of leaves, umbels solitary or clustered, 4-6 flowered. Flowers pale yellow, filaments hairy below middle. Fruit ovoid, ellipsoid, subglobose, yellowish green scented and flavoured, black at maturity.

Flowering & Fruiting: August- November.

Habitat: Found in secondary forests, also cultivated.

Distribution: Bhutan, China, Myanmar, Nepal, Indonesia, India (Arunachal Pradesh, Mizoram).

Uses: Fruits are eaten fresh against cold and cough, helps to give good sleep. Used as condiment in boiled vegetables or local chutney. Seeds are chewed incase of thread worms.

80. *Loropetalum chinense* (R. Br.) Oliv. [Hamamelidaceae] 'Marri/Marri ripu'

Collection no: Michi, 9.6.2011, *Bamin-169* [Pl. 8C]

Description: Shrubs or small trees, 1–3 m tall, much branched; branchlets stellately pubescent. Leaf blade ovate, elliptic or, rarely, obovate, discolorous, abaxially densely stellately pubescent, adaxially sparsely pubescent or stellately pubescent when young, glabrescent, base asymmetrical, rounded or cuneate, margin entire, apex acute or shortly acuminate. Inflorescence a short raceme or nearly capitate, terminal, mostly on short lateral branches. Flowers shortly pedicellate, open before leaves appear. Floral cup cupular, stellately pubescent, white, pale yellow or red.

Flowering & Fruiting: March- September.

Habitat: Found in slightly moist places near bamboo grooves and forest fringes.

Distribution: China, Japan, India (North East India).

Uses: Leafy branches are used in religious ceremonies. The leaf of this plant is put in the corner of the granary 'Nesu' on the morning of 'Aji eha' (performed after 15 days at the end part of Myoko) to keep away from evil spirits or to avoid returning of Myoko god. This ritual is performed only by those who sacrifices pig during the month long festival.

81. *Lyonia ovalifolia* (Wall.) Drude [Ericaceae] 'Sarlang'

Collection no: Ring road, 21.8.2009, *Bamin-142*

Description: A small tree, deciduous or evergreen, 1–4 m tall. Twigs glabrous or pubescense . Buds narrowly ovoid, glabrous or pubescent. Leaf blade ovate, narrowly to broadly elliptic, lanceolate, or suborbicular, papery to thinly leathery, both surfaces with white or brown hairs, rarely abaxially densely white villous on midvein or subglabrous, veins prominently raised to slightly depressed or nearly obscure, base obtuse, cuneate, or sometimes cordate, apex acuminate. Flowers white. Fruits globose, glabrous.

Flowering & Fruiting: March- November.

Habitat: Found in forests edges and bamboo grooves.

Distribution: Bangladesh, Bhutan, Cambodia, Japan, Laos, Malaysia, Myanmar, Nepal, Pakistan, Sikkim, Thailand, Vietnam, India (Arunachal Pradesh, Sikkim).

Uses: Stem is used for housebuilding.

82. *Machilus villosa* (Roxb.) Hook. f [Lauraceae] 'Sampe'

Collection no: Bulla, Kalung saro, 9.6.2011, *Bamin-167*

Description: Medium to large size tree. Leaves elliptic, elliptic-lanceolate, leathery, pubescent, purple-browinsh below, veinlets abaxially visible. Flowers yellow, perianth. Fruits globose.

Flowering & Fruiting: January-May.

Habitat: Found in open forests or hill slopes, also found in nearby forests and home gardens.

Distribution: Bangladesh, Bhutan, Myanmar, Nepal, India (Arunachal Pradesh, Sikkim).

Uses: Stem of the tree is used as firewood during festivals like Myoko.

83. *Magnolia champaca* (Linn.) Baill. ex Pierre [Magnoliaceae] 'Salyo'

Collection no: Bulla, Gyachi 4.11.2010, *Bamin -62*

Description: Tall evergreen tree with ash-grey wood, young twigs, ascending and forming a narrow umbelliform crown. Leaves alternate, lanceolate, ovate-lanceolate, nerve lateral. Flowers large showy, solitary, pale or orange yellow, faintly scented, drooping fleshy, gradually narrower towards the centre, yellow. Fruit cone like drooping, seeds 2 -4 per carpel, ripe carpel woody.

Flowering & Fruiting: May-November.

Habitat: Found in open forests.

Distribution: China, Malaysia, India (North East India, Kerala, Tamil Nadu).

Uses: The fruit are edible and is cooked for local delicacies. It improves appetite and liver disorder. The stems are used for building houses and as firewood.

Remarks: Because of aroma and taste it is highly preferred. And is one of the highly preffered firewood and also as timber.

84. *Magnolia oblonga* (Wall.ex Hook.f. & Thomson) Figlar [Magnoliaceae] 'Salyo'

Collection no: Bulla, Gyachi 22.9.2009, *Bamin -67*

Description: Medium size tree, bark grey, warty, wrinkle outside, aromatic. Leaves alternate, oblanceolate, ovate, base acute, acuminate, glabrous, pale and glacaus

beneath. Flower large showy, white-yellowish, scarcely scented, petals oblanceolate or spathulate. Fruit sub globose, long, sessile, woody, beaked, warty, tomentose surface, 1- 5 seeded, shiny, orange.

Flowering & Fruiting: June-October.

Habitat: Found in open forests.

Distribution: China, Bangladesh, Myanmar, India (North East India).

Uses: The fruit are edible and is cooked for local delicacy called 'Pikey'. It improves appetite and liver disorder. Stem and branches used for building houses and also as firewood.

Remarks: The tree is highly preferred species as timber, and so throughout the year it is cut down for timber and firewood purposes.

85. *Mahonia napaulensis* DC. [Berberidaceae] 'Taaming"

Collection no: Bamin, Tiling agiya, 14.2.2010, *Bamin-39* [Pl. 8D]

Description: Shrubs or small tree. Leaves compound, ovate or lanceolate, base broadly cunate, rounded or subcordate spiny. Inflorescence 3-18-fascicled racemes bracts of inflorescence oblong to ovate or ovate-lanceolate. Flowers yellowish, sepals triangular-ovate or ovate, petals elliptic to oblong-elliptic. Fruits bluish black.

Flowering & Fruiting: November-January.

Habitat: Found in thick forest margins and home gardens.

Distribution: Bhutan, Myanmar, Nepal, Australia, Indonesia, Sri Lanka, India (Arunachal Pradesh, Assam, Mizoram, Sikkim, Himachal Pradesh).

Uses: Ripe fruits are edible. Use in religious purposes. The bark of the tree along with its leaves is kept around the corner of the house to keep evil spirits away during bad health conditions. Bark is used as dye for obtaining deep yellow colour 'Pyaming'.

86. *Manihot esculenta* Crantz. [Dioscoreaceae] 'Sann engin'

Collection no: Michi, 4.11.2010, *Bamin-60*,

Description: Erect shrubs; root tuberous, elongated. Leaves peltate or sub-peltate, palmately lobed, lobes oblong-obovate to oblanceolate to narrowly elliptic, pubescent beneath, apex acuminate, entire. Stipules triangular-lanceolate. Flowers in terminal or axillary raceme, yellow. Capsule ellipsoid, scabrous. Seeds slightly triangular, testa crustaceous, smooth, with spot stripes.

Flowering & Fruiting: September -November.

Habitat: Found along wastelands and hill slopes, naturalized in forests.

Distribution: Brazil, Phillippines, South America, Thailand, India (Arunachal Pradesh, Assam, Meghalaya).

Uses: Tubers are taken as vegetable.

87. *Mikania micrantha* Kunth [Asteraceae] 'Riring /Maantami'

Collection no: Hapoli, 21.8.2009, *Bamin-55*

Description: Extensive twiner or shrub, young part pubescent. Leaves triangular, opposite, petiole elongated, ovate, acute, base rounded cordate, crenate, villous beneath. Flowers in terminal or axillary corymbose head, white or creamy white; bracts 4; corolla regular, tubular; limb campanulate, 5- fid, achenes glabrous, truncate, glandular, pappus hairs numerous.

Flowering & Fruiting: July-September.

Habitat: Abundantly found along road side, forest.

Distribution: China, Central and South America, Mexico, India (Arunachal Pradesh, Assam, Manipur, Meghalaya).

Uses: The juice of leaves and the stem are applied on rashes, cuts, wounds or other skin related problems like itching, skin allergy etc. The leaves are also heated on fire and applied on the eyes to get relief from eye infection.

88. *Molineria capitulata* (Lour.) Herb. [Hypoxidaceae] 'Loli'

Collection no: Hija, 17.9.2009, *Bamin-63* [Pl. 9A]

Description: Tall herb, upto 2 m high, tuberous rootstocks. Leaves are long petioled, lanceolate, stout or slender, flattened, with yellow-green spots on it. Flowers yellow. Berries white. Seeds black colour.

Flowering & Fruiting: October - December.

Habitat: Found in shady and moist places.

Distribution: Australia, Bhutan, China, Indonesia, Malaysia, Nepal, Sri-Lanka, India. (North East India).

Uses: Leaves are used for religious purposes such as tying animals that are to be sacrificed during rituals like 'Mida', 'Murung', 'Myoko' or any rituals at home. It is also used during rituals performed for easier and safe delivery of baby. Fresh leaves are tied around the lower abdomen during pregnancy to get relief from backpain and for easy delivery.

89. *Morus alba* Linn. [Moraceae] 'Gende'

Collection no: Hong, Ring road, 15.8.2010, *Bamin-75* [Pl. 9B]

Description: A medium size deciduous tree, bark rough, whitish with milky latex. Leaves alternate, ovate, entire, apex acuminate. Flowers in catkin, yellowish green, axillary, solitary, minutely white puberulous to tomentellous. Fruits reddish to black, spherical.

Flowering & Fruiting: August-December.

Habitat: Found in forest and home gardens.

Distribution: Afghanistan, Bhutan, China, Japan, Nepal, India (Arunachal Pradesh, Meghalaya).

Uses: Fruits have a sweet sour taste and are edible.

90. *Musa x paradisiaca* Linn. [Musaceae] 'Kol, Kulu'

Collection no: Hong, Ring road, 2.9.2010, *Bamin-59*

Description: Psudostem upto 10 m high; leafblade long; firm pulp; inflorescence erect or decurved spike, female at lower, male at upper, bracts large, spathaceous ovate or orbicular; calyx slit down one side to the base, 3- lobes; bracts of male flower persistent; corolla lobes as long as calyx, wrapped round the stamen and style. Fruits fleshy, sweet when ripe, sticky, indehiscent; seed sterile or absent.

Flowering & Fruiting: August- December.

Habitat: Found in forests edges.

Distribution: China, Indonesia, Malaysia, Myanmar, Nepal, Thailand, India (Arunachal Pradesh, Sikkim).

Uses: Pseudostems or stumps are dried and burned to ash and this is then used for making the local salt. Inflorescence taken as vegetable.

91. *Myrica esculenta* Buch.-Ham. ex D.Don [Myricaceae] 'Baching'

Collection no: Bulla, 25.5.2011, *Bamin-120* [Pl. 9C]

Description: An evergreen tree about 5-20m in height, barks dark or blackish brown and horizontally wrinkled. Leaves are oblong-oblanceolate, acute, narrow at the base, entire or serrated. Fruits ovoid-oblong, green colour and turns red on ripening, sour in taste.

Flowering & Fruiting: March-June.

Habitat: Forests, home gardens, bamboo grooves.

Distribution: Bhutan, China, Myanmar, Thailand, India (Nort East India, Uttar Pradesh, Gujarat).

Uses: The fruit has sweet- sour taste and is edible and also used for making pickles.

92. *Nicotiana tabacum* Linn. [Solanaceae] 'Muku'

Collection no: Hapoli, Sibey, 10.4.2010, *Bamin-156*

Description: A glandular, pubescent herb. Leaves oblong-lanceolate. Flowers pink, paniculate raceme. Seeds brown.

Flowering & Fruiting: January- July.

Habitat: Home gardens, naturalized in forest areas.

Distribution: China, Tropical and Sub-tropical America, India (Arunachal Pradesh, Assam).

Uses: Leaves used as tobacco. Leaves are also used for getting relief from swelling joints.

93. *Oenanthe javanica* (Blume) DC. [Apiaceae] 'Hiigu'

Collection no: Hapoli, Agey-Putu, 22.9.2009, *Bamin-69* [9D]

Description: Perennial, aromatic herb, about 30-40 cm high, fibrous roots. Leaves pinnate, lanceolate, serrate, ultimate segments linear. Flowers terminal or opposite compound umbels and white in colour. Fruit sub-globose or ovoid.

Flowering & Fruiting: July-October.

Habitat: Mostly found in marshy places along forest edges and near streams.

Distribution: China, Indonesia, Japan, Korea, Malaysia, Nepal, Pakistan, Thailand, India (North East India, Kashmir, West Bengal).

Uses: Leaves are used as medicine. It is eaten raw to get relief from indigestion. Also taken as vegetable and preferred with chilli chutney.

94. *Oxalis corniculata* Linn. [Oxalidaceae] 'OKhuihamang'

Collection no: Hapoli, Agey putu, 4.9.2012, *Bamin-173*

Description: Erect perennial herb, stem weak, pubescent, roots at the nodes. Leaves palmately trifoliate, leaflets ovate, slightly pubescent. Flowers yellow, sub-umbellate, Capsules cylindric, triangular. Seed numerous.

Flowering & Fruiting: May-July.

Habitat: Found along edges of forest on damp areas, along wet fields, rivers, roadsides.

Distribution: Bhutan, Japan, Korea, Malaysia, Myanmar, Nepal, Pakistan, Thailand throughout India (North East India).

Uses: The whole plant is taken as vegetable and also helps in improving digestion.

Remarks: It is not taken along with local beer as it might lead to sourness. Hence, the name suggests 'O'- local beer, 'Khui'-sour).

95. *Paederia foetida* Linn. [Rubiaceae] 'Paritaru/gandhali'

Collection no: Hija lemba, 21.6.2010, *Bamin-74*

Description: Scandent climber or rambling on ground, stem grey, soft and ribbed, hairy. Leaves opposite, oblong-ovate or lanceolate, shortly acuminate, entire, membranous, glabrous. Flowers greyish purple, with reddish purple mouth, in axillary and terminal cymose panicles. Corolla funnel shaped, tube glandular hairy within, grayish, tomentose. Fruit ellipsoid, reddish, compressed.

Flowering & Fruiting: May–October.

Habitat: Mostly found along road sides and in marshy places.

Distribution: Bangladesh, Bhutan, Cambodia, China, Indonesia, Japan, Malaysia, Nepal, Vietnam, India (North East India, Bihar, Orrisa).

Uses: The leaves extract are taken during stomachache, gastritis and is preferred against swelling stomach.

96. *Pericampylus glaucus* (Lam.) Merr. [Menispermaceae] 'Rukki taru'

Collection no: Bulla, Dolokho, 3.11.2010, *Bamin-61*

Description: It is a woody climber. Stems glabrescent. Leaves traingular ovate-oblong, glabrous, leaf base heart-shaped or truncate, apex rounded or obtuse. Inflorescence arises from axil. Flowers small, pale green. Drupes red-purple.

Flowering & fruiting: April-October.

Habitat: Along forest margins and slopes.

Distribution: Bhutan, China, Indonesia, Malaysia, Nepal, Thailand, India (North East India, Uttar Pradesh, West Bengal).

Uses: The stem is used as fiber for house building. It has high durability.

97. *Perilla frutescens* (Linn.) Britton [Lamiaceae] 'Tining'

Collection no: Ring road, 21.8.2010, *Bamin-79*

Description: An aromatic herb upto1 m tall, stem angular, hairy. Leaves broadly ovate, serrated. Flowers terminal, axillary racemes, white. Nuts pale brown, globose.

Flowering & Fruiting: October-January.

Habitat: Along edges of forests and cultivated in home gardens.

Distribution: Bhutan, China, Japan, Nepal, India (Arunachal Pradesh, Assam, Kashmir, Western Himalays).

Uses: Seeds are grounded and used as condiment in preparation of rice cakes.

98. *Persicaria barbata* H. Hara. [Polygonaceae] 'Rerupi/Luli'

Collection no.: Hapoli, 13.8.2010, *Bamin-88*

Description: Perrenial herb upto 30-40 cm high stems erect, glabrous ascending or erect. Leaves opposite, lanceolate to linear lanceolate, long bearded, appressed setulose on both surfaces. Inflorescence terminal, spicate. Flowers in slender paniculate racemes, white or greenish white.

Flowering & Fruiting: January-December.

Habitat: Found along roadsides and waste areas mostly in damp areas.

Distribution: Bhutan, Indonesia, Malaysia, Nepal, Sri Lanka, Thailand, Vietnam, India (North East India, Kerala, Western Ghats).

Uses: Leaves used as fodder. The leaves or whole plant is crushed and is used for catching fish. Also used for making local salt.

99. *Persicaria hydropiper* (Linn.) Spach. [Polygonaceae] 'Roring'

Collection no: Hong lemba, 15.8.2010, *Bamin-103*

Description: Annual herb, root tufted or creeping, pink, stem much branched, stout, leafy, upto 20-80 cm tall, glabrous, nodes swollen. Leaves opposite, lanceolate or oblong lanceolate, ciliate, covered with impressed glands, stipules glabrous, scattered erect, apressed hairs. Inflorescence raceme flexuous, leafy at base, filliform, decurved, interrupted, trigonous, opaque granulate; bract of perianth pinkish, grandular. Flowers white- greenish, paniculate racemes.

Flowering & Fruiting: January-December.

Habitat: Mostly found near streams, roadsides, moist areas.

Distribution: Bangladesh, Bhutan, China, Indonesia, Japan, India (Arunachal Pradesh, Sikkim, Jammu & Kashmir, Orissa, West Bengal).

Uses: Leaves are crushed and the paste is used as fish poison.

100. *Phoebe goalparensis* Hutch. [Lauraceae] 'Samper'

Collection no: Hong, 14.8.2010, *Bamin-128* [Pl. 10A]

Description: Tall tree, about 30m height, bark grayish green and reticulately furrowed. Leaves alternate, obovate, ovate, lanceolate, chartaceous, base narrowed or acute, somewhat obtusely acuminate; petiole puberulous on nerves beneath, glabrous above. Flowers in lax, puberulous panicles, perianth villous beneath inside. Fruit drupe, ellipsoid, ovoid, or globose, turns blackish when ripe, persistent and enlarged perianth lobes surrounded at base.

Flowering & Fruiting: March- May.

Distribution: Endemic to India (Arunachal Pradesh,Assam, Meghalaya).

Habitat: Found in open and sloppy areas in primary forests.

Uses: Fruits are taken as vegetable. It is also used for making local chutney 'Pikey' and is considered good for stomach, cold and cough.

101. *Phragmites karka* (Retz.) Trin. ex. Steud. [Poaceae] 'Pepu'

Collection no: Hija, Dani lemba, 19.8.2010, *Bamin-111* [Pl. 10B]

Description: Large perennial grass or weed with creeping rhizome. Leaves linear to broadly lanceolate, short ligule with stiff hairs. Flowers in long spike

Flowering & Fruiting: September - April.

Habitat: Mostly found in moist places near forest entrance, homegardens.

Distribution: Australia, Burma, China, Japan, Malaysia, India (Arunachal Pradesh, Assam).

Uses: The whole plant is used for making local mat 'Pepu' and also the burnt ash of this plant is used for making local salt.

102. *Phyllostachys bambusoides* Gamble [Poaceae] 'Bije'

Collection no: Bamin, 13.4.2010, *Bamin-30* [Pl. 10C]

Description: It is a monopodial bamboo. The internodes are covered with short sparse. It is black-brown in colour on maturity and green coloured when young, alternate branching with side branch, less at the lower portion than in the apex. Rhizome long necked and solid. Shoots are reddish-brown to green with purplish brown or black spots. Leaves medium sized, with prominent mid rib with few white hairs.

Flowering & Fruitng: May-August.

Distribution: China, Japan, India (Arunachal Pradesh, Meghalaya, Nagaland).

Uses: Young shoots are taken as vegetable. Culm is used for house building and fencing materials and in carving various household and handicraft items.

Remarks: It is the most preferred bamboo species of Apatanis called as 'Bije' and is used in every occasion and for every purpose like rituals, handicrafts, household items, etc.

103. *Physalis angulata* Linn. [Solanaceae] 'Apu byayung'

Collection no: Bamin, Roto lemba, 9.4.2012, *Bamin-177* [Pl. 10D]

Description: Annual herbs, roots fibrous, stems prostrate or erect, pubescent with hairs Leaves arranged spirally, simple, ovate-lanceolate, pubescent along veins, base cuneate, often oblique, margin entire, sinuate, or with a few coarse teeth, apex acuminate. Flowers solitary, yellow. Fruiting calyx green, subglobose or ovoid, fruits globose.

Flowering & Fruiting: June- September.

Habitat: Mostly found along road sides or wastelands preferably in shady, moist areas.

Distribution: China, Indonesia, India (Arunachal Pradesh, Assam, Tripura, West Bengal, Uttar Pradesh).

Uses: Young leaves and ripe fruits taken as vegetable and is a remedy for indigestion and other stomach problems.

104. *Physalis minima* Linn. [Solanaceae] 'Apu byayung'

Collection no: Bamin, Roto lemba, 9.4.2012, *Bamin*- 175

Description: Annual herb. Leaves soft and glabrous. Flowers yellow, solitary. Fruit berry covered with green papery calyx on the outside.

Flowering & Fruiting: June- September.

Habitat: Mostly found in shady, moist areas along road sides, river banks or wastelands.

Distribution: Australia, Brazil, China, Indonesia, India (Arunachal Pradesh, Assam, Tripura, West Bengal, Uttar Pradesh)

Uses: Young leaves and fruits taken as vegetable and is a remedy for indigestion and other stomach problems.

105. *Pinus wallichiana* A.B. Jackson [Pinaceae] 'Piisa saati/Telghos'

Collection no: Hapoli, Agey, 14.8.2010, *Bamin-108* [Pl. 11A]

Description: Tall symmetrical pyramidal tree upto 50 m, with smooth, slate-grey bark which becomes rough and shallowly fissured on mature trees. Leaves 15-20 cm

long. Cones in clusters of 2-3. Wood highly resinous. Distinguished by its clusters of long cylindrical pendulous cones, and its slender drooping grey or blue-green needle like leaves borne on short shoots in clusters of 5.

Flowering & Fruiting: March- July.

Habitat: Pine forests and homegardens.

Distribution: Eastern Afghanistan, Northern Pakistan, China, India (Arunachal Pradesh).

Uses: The pine sap or resin is collected from the tree by cutting a small part of stem and is applied in crack heels and also in wounds sometimes. It is said to give relief and is mostly applied at night before sleep. The small young tree barks, cones, leaves are used for burning fire.

Remarks: Bark and resins are highly preffered by the Apatnis for for starting fire and also as firewood.

106. *Piper hamiltonii* C. DC, [Piperaceae] 'Riidii'

Collection no: Hong, Ring road, 12.4.2010, *Bamin-129*

Description: Small climber, dioeceous, stem glabrous, slightly swollen. Leaves alternate, ovate-orbicular, acuminate at apex. Flowers densely arranged in spike, minute. Fruits in pendant spike, ovoid, loosely aggregated, black when ripe.

Habitat: Fund in shadey forest areas.

Flowering & Fruiting: June- December.

Distribution: Bhutan, Bangladesh, China, Myanmar, NepalIndia (North East India, South Western Ghats, Kerala, Tamil Nadu).

Uses: Vegetable, fruits chewed to get relief from cough and cold.

107. *Piper pedicellatum* C. DC. [Piperaceae] 'Raru/rari'

Collection no: Hong, Ring road, 12.4.2010, *Bamin-110*

Description: Erect shrub, about 1 m high, woody, stout, glabrous, nodes swollen. Leaves alternate, stipulate, ovate to ovate elliptic, acuminate, pale green. Flowers densely arranged in erect spike, rachis pubescent. Fruits cylindric, swollen spike.

Habitat: Found in shady forest areas.

Flowering & Fruiting: January - October.

Distribution: Bhutan, Bangladesh, China, India (Arunachal Pradesh, Assam, Sikkim).

Uses: Leaves are taken as vegetable.

108. *Plantago erosa* Wall. [Plantaginaceae] 'Mepi'

Collection no: Hapoli, 4.9.2009, *Bamin-125*

Description: Annual herb, about 1-4 cm high, stem short or absent, rootstock erect, stout. Leaves radical, petiolate, ovate, oblong, to ovate, acute to subacute, sinuate-toothed, spike long, hairy. Flowers regular, sessile, white coloured. Seeds minute, black.

Flowering & Fruiting: July-November.

Habitat: It is found in shady forest edges or along wastelands and roadsides.

Distribution: Bangladesh, Bhutan, China, India, Nepal, Sri Lanka, India (North East India).

Uses: Leaves are either consumed raw or cooked as vegetable. It is good for constipation and indigestion. Also used as fodder.

109. *Plectocomia himalayana* Griff. [Arecaceae] 'Tarpi'

Collection no: Michi lemba, 12.4.2010, *Bamin-89*

Description: A climbing shrub, Stems clustered. Leaf sheaths green, densely covered initially with whitish brown tomentum, needlelike spines, rachis lanceolate, filiform apex, without prominent mid- and submarginal veins, minutely spiny along margins, irregularly arranged in clusters. Inflorescences several per stem branched rectangular bracts fruit scales fringed, without bristly, erect apices. Fruits depressed globose.,

Habitat: Found in Shady and sloppy area inside deep forests and bamboo grooves.

Distribution: Bhutan, China, Nepal, Thailand, India (Arunachal Pradesh, Assam, Sikkim, West Bengal).

Uses: Stem used as fiber for making household items and building material.

110. *Pogostemon yatabeanus* (Makino) Press [Lamiaceae] 'Higu hiha'

Collection no: Sibey, 2.11.2012, *Bamin-186* [Pl. 11B]

Description: Erect herbs, villous or shaggy, stems solid. Leaves opposite, oblong, elliptic-oblong, rarely linear to falcate, serrate, hairy. Flowers simple, dense, uninterrupted racemes, purple. Nutlets ovoid to globose, flattened, smooth.

Flowering & Fruiting: August-October.

Habitat: Found in marshy, swampy areas along road sides.

Distribution: China, Japan, Korea, India (Arunachal Pradesh, Mizoram).

Uses: The whole plant is dried and burned down for preparing local salt 'Tapyo'The ash from the plant is used for making local delicacies.

Remarks: It is considered to be one of the most preferred plants used for making local salt 'Tapyo' especially by the villagers of Bamin. It is very rarely found now.

111. ***Portulaca oleracea*** Linn. [Portulacaceae] 'Lai hamang'

Collection no: Hapoli, 3.4.2009, *Bamin- 9*

Description: Erect succulent herb; stem fleshy, purple. Leaves alternate or sub opposite, spathulate, oblong, obtuse. Flower arranged in capituli with 2 involucral leaves, surrounded by hairs, solitary or in cluster, yellow. Fruit capsule. Seeds minute, reniform, glabrous, black.

Flowering & Fruiting: April-June.

Habitat: Grows along the edges of open fields, mostly in moist areas and along roadsides. Mostly cultivated.

Distribution: Africa, Asia, Australia, India (North East India, South India).

Uses: Whole plant taken as vegetable.

112. ***Primula denticulata*** Sm. [Primulaceae] 'Bagang rinyo'

Collection no: Hija, Dura, 19.2.2012, *Bamin-102*

Description: Herbs perennial. Basal bud scales fleshy and ovate, apex acute, margin entire, efarinose. Leaves in a rosette up to 30 cm long(including petiole); petiole broadly winged, leaf blade oblong to oblanceolate, enlarged to 25 cm or longer at fruiting, abaxially pubescent white hairs along veins or sub-glabrous, margin denticulate, apex rounded to obtuse, lateral veins 10–20 pairs, opposite or alternate, prominent in beneath surface. Scapes 1–3, Flowers heterostylous. Calyx green and slightly scattered with purple colour at base, narrowly campanulate up to 1cm, parted to middle, apex obtuse, ; Corolla purple to pinkish purple, rarely white, with a yellow eye,

Flowering & Fruiting: February- May.

Habitat: Found along hill slopes.

Distribution: Afghanistan, Bhutan, China, Myanmar, Nepal, Pakistan, India (Arunachal Pradesh, Sikkim, Jammu & Kashmir, Himachal Pradesh, Meghalaya and Manipur).

Uses: As an ornamental flower.

113. ***Prunus persica*** (Linn.) Batsch. [Rosaceae] 'Takung ahii'

Collection no: Michi, 18.4.2010, *Bamin- 98*

Description: A shrub or medium sized tree. Leaves linear-lanceolate, broadly oblanceolate, sharply acuminate, serrate to serrulate, glabrous at length, glandular at upper portions, stipules frimbicate. Flowers fascicles, pink to white, axillary, solitary or fascicled. Drupes 3-5 cm long, elliptic ovoid, succulent, rugose, irregularly furrowed and pitted.

Flowering & Fruiting: February- May.

Habitat: Found in outskirts of villages and cultivated.

Distribution: China, Japan, India (Arunachal Pradesh, Assam, Manipur, Meghalaya).

Uses: Fruits are edible. Whole plant used for religious purposes.

Remarks: Whole plant is used as the main alter 'Yugyang 'where important rituals and chanting are done during festivals like Myoko.

114. ***Pyrus calleryana*** Decne. [Rosaceae] 'Piita ahii'

Collection no: Bulla, Pisani, 27.8.2011, *Bamin-81*

Description: A tall tree, branchlets reddish brown when young, grayish brown when old, terete, glabrous when old. Stipules caducous, linear-lanceolate, glabrous, margin entire, apex acuminate. Leaf blade broadly ovate, rarely narrowly elliptic, glabrous, base rounded or broadly cuneate, margin obtusely serrate, apex acuminate, rarely acute. Raceme umbel-like, peduncle glabrous; bracts caducous, linear-lanceolate, membranous, adaxially tomentose, margin initially glandular serrate, apex acuminate. Flowers in hypanthium, cupular, glabrous. Petals white, ovate, base shortly clawed, apex rounded. Pome blackish brown with pale dots, globose, sepals caducous; fruiting pedicel glabrous.

Flowering & Fruiting: March- November.

Habitat: Found in outskirts of villages and nearby forests.

Distribution: Burma, Bhutan, China, Japan, Vietnam, India (Arunachal Pradesh, Meghalaya).

Uses: Fruits are edible.

115. ***Pyrus pashia*** Buch. Ham.ex D.Don, [Rosaceae] 'Pecha'

Collection no: Hong, 28.8.2011, *Bamin-94*

Description: Trees upto 15 m high, deciduous, bark grey, rough, white tomentose; branch purplish brown or dark brown when old. Leaves ovate-elliptic or lanceolate, acuminate, serrulate. Flowers in axillary or terminal umbels or fascicles, white or pinkish. Fruits globose, black when ripe.

Flowering & Fruiting: March-October.

Habitat: Found in in open forests, home gardens and outskirts of village.

Distribution: Afghanistan, China, Pakistan, Vietnam, India (North East India, Kashmir).

Uses: Fruits are eaten either fresh or roasted and is one of the most conmmonly preffered fruits.

116. *Quercus griffithii* J. D. Hook. F. & Thomson *ex* Miq. [Fagaceae] 'Sankhe /santii'

Collection no: Bulla, Kalung saro, 21.8.2010, *Bamin-78*

Description: Tree about 10-15 m high, branches soft, rusty, tomentose. Leaves alternate, elliptic-ovate, lanceolate, serrate, densely tomentose. Flowers in spikes, yellow. Fruits or nuts ovate, acute scales.

Flowering & Fruiting: April- July.

Habitat: Along edges of forests and in deep forests.

Distribution: Bhutan, China, Myanmar, India (North East India).

Uses: Nuts are cooked and eaten. Stem is used as house building material.

117. *Quercus lamellosa* Sm. [Fagaceae] 'Santii Sanii/Santi tiru'

Collection no: Bulla, Ring road,14.8.2010, *Bamin- 141*

Description: Large evergreen tree. Leaves oblong or elliptic, acute- acuminate, remotely sharp and sharply serrated towards apex, glabrous above, glaucous beneath except the nerves. Flowers solitary or in axillary spikes. Nuts subglobose, velvety .

Flowering & Fruiting: June-November.

Habitat: Along edges of forests and in deep forests.

Distribution: China, Nepal, Thailand, India (Arunachal Pradesh, Assam).

Uses: Branches, stem used as firewood.

118. *Quercus semecarpifolia* Sm. [Fagaceae] 'Saii/Kira'

Collection no: Bulla, Kalung saro, 21.8.2010, *Bamin- 82*

Habitat: Along edges of forests and in deep forests

Description: Trees about 30 m tall, evergreen. Branchlets with prominent stellate hairs, glabrescent, lenticellate; lenticels narrowly rounded. Petiole brown tomentose and with stellate hairs, glabrescent; leaf blade elliptic to narrowly, abaxially with

brown stellate hairs and scurfy powder, adaxially glabrescent or sparsely with stellate hairs,

margin entire or with spiniform teeth, apex obtuse. Infructescence with 1 or 2 cupules, glabrous.

Flowering & Fruiting: April- October.

Distribution: Bangladesh, China,India (Arunachal Pradesh, Assam, Meghalaya).

Uses: Nuts are edible.

119. *Rhododendron arboreum* Sm. [Ericaceae] 'Senyi apu/ Senyi muru'

Collection no: Hija, Kidi Santu, 19.2.2010, *Bamin-84*

Description: Tree or large shrubs of about 7 m tall with a great girth, bark thick, rough. Leaves broadly lanceolate, rugose on both surfaces, rusty beneath. Inflorescence many flowered and dense. Flowers red, rarely with white dots on it, pedicels short, corolla lobes emarginate. Capsules cylindic, and curved.

Flowering & Fruiting: March-July.

Habitat: On rocky slopes and deep forests.

Distribution: Bhutan, China, Myanmar, Nepal, Sri Lanka, Thailand, India (Arunachal Pradesh, Sikkim, Kashmir).

Uses: Used as ornamental plant.

120. *Rhus chinensis* Mill. [Anacardiaceae] 'Taamo'

Collection no: Ring road, 21.8.2010, *Bamin-80*

Description: Small deciduous tree, branches spreading, bark ash-grey, dull greyish white inside, warty. Leaves opposite, elliptic-ovate or oblong lanceolate, acuminate, margin dentate, pubescent, base rounded. Flower in terminal panicle, dense, white or pale green. Drupe tomentose, compressed, pink on ripening.

Flowering & Fruiting: March-October.

Habitat: Found in forests, home gardens, bamboo gardens.

Distribution: Bhutan, Indonesia, Japan, Korea, Singapore, Thailand, Vietnam, India (North East India).

Uses: Fruits are edible and preferred raw and also used for medicine during stomach disorder.

121. *Rubia manjith* Roxb. ex. Flehm [Rubiaceae] 'Tiiming'

Collection no: Pai gate, 14.9.2010, *Bamin-137*

Description: It is a climbing herb, with perennial root stocks, roots long, golden yellow, cylindric, flexuose with thin red bark. Stems long, rough and becomes slightly woody at the base, bark white and quadrangular. Leaves ovate- lanceolate, rounded or subcordate at the base, long acuminate at the apex, nerves 3-5 palmate, petioles 4-8 cm, Panicles branched. Flowers are in terminal panicles of cymes. Berries globose, smooth, shining, becomes purplish black on ripe.

Flowering & Fruiting: March-December.

Habitat: Along road sides, steep slopes and climbing on hedges.

Distribution: Bhutan, China, Nepal, India (North East India).

Uses: The stem is used for obtaining red colour, used for dying yarn or clothes. The stem is cut into small pieces or is directly boiled in water till the red colour appears. The dried shoots are also powdered and taken with water in case of cold.

122. *Rubus ellipticus* Sm. [Rosaceae] 'Jilung/henchi/nyimpung jilyung'

Collection no: Hong, ring road, 9.6.2010, *Bamin-71* [Pl. 11C]

Description: Straggling shrub with stout prickles, prickles hooked or slightly curved at the tip. Branches with reddish bristles. Leaves pinnately 3-foliolate, stipules long, leaflets long, broadly obovate, elliptic, closely serrate, dark- green and glabrous above, pale and tomentose beneath. Flowers small, white colour. Fruits globose, orange-yellow colour, clustered, drupes succulent.

Flowering & Fruiting: May-September.

Habitat: Found along forest edges, stream sides and roadsides.

Distribution: Bhutan, China, Myanmar, Nepal, Thailand, India (Arunachal Pradesh, Assam, Manipur, Mizoram).

Uses: Fruits are sweet and sour in taste and edible.

123. *Rubus niveus* Thunb. [Rosaceae] 'Henchi/nikhe'

Collection no: Hong, Ring road, 9.6.2010, Bamin-*70*

Description: Scandent prickly shrubs 3-5 m tall with reddish branchlets, white bloom, scattered hooked prickles. Leaves 5-11 foliate with channeled leaf stalks and small linear stipules, leaflets ovate-lanceolate, sub-sessile or sessile, margins sharply dentate, sub-glabrous above, white tomentose beneath. Flowers pink in axillary or terminal clusters. Flowers stalks woolly haired. Fruits red, becomes black on ripening, ovoid or globose.

Flowering & Fruiting: May- September.

Habitat: Found in open places along roadsides.

Distribution: China, Malaysia, Phillippines, Sri Lanka, India (North East India).

Uses: Fruits are edible.

124. *Rubus rosaefolius* Sm. [Rosaceae] 'Hitungbulung/jilying'

Collection no: Hong, Ring road, 9.6.2010, Bamin-*72*

Description: Straggling or scandent shrub with spreading branches, 2-4 m high; hairs dense, intermixed with prickles scattered. Leaves pinnately 5-9 foliate, leaflets ovate or ovate-oblong, acuminate, margins doubly serrate, rounded base, both surfaces with sessile glistening glands. Flowers large in axillary, white, solitary or 1-5 flowered, calyx caudate acuminate, pubescent, glandular. Fruits sub-globose, scarlet or orange-yellow on ripening.

Flowering & Fruiting: February - July.

Habitat: Found along moist and shaded forest edges.

Distribution: Brazil, China, Thailand, India (North East India).

Uses: Fruits are sour and edible.

125. *Rumex nepalensis* Spr. [Polygonaceae] 'Tajang liho'

Collection no: Hapoli, Siro, *Bamin-189.*

Description: Perennial herbs, erect stems, branched, glabrous, branches form open panicle. Basal leaves 1-2 times as long as broad with cordate base, acute tip, flat; cauline leaves gradually shorter petioled, diminishing in size, proportionally longer and more acute; leaves papillose beneath along the nerves. Inflorescene in whorls, many-flowered. Nut long, dark brown.

Flowering & Fruiting: April-June.

Habitat: Found in moist and damp places in open wastelands.

Distribution: Bhutan, China, Indonesia, Myanmar, Nepal, Pakistan, India (North East India).

Uses: Young leaves taken as vegetable and is a remedy for indigestion and other stomach problems. Leaves also used as fodder.

126. *Saccharum arundinaceum* Retz. [Poaceae] 'Peji Paelo'

Collection no: Michi 11.6.2014, *Bamin-127*

Description: Perennial, forming large clumps. Culms robust, glabrous. Leaf sheaths glabrous or pubescent, ciliate at mouth and margins; leaf blades abaxial surface

glabrous, adaxial surface velvety with long soft hairs on broad lower midvein, margins serrate, base narrow, apex long attenuate. Inforescence long panicled, much branched, axis glabrous.

Flowering & Fruiting: August - December.

Habitat: Found in open areas, hedges, bamboo grooves.

Distribution: Bhutan, Indonesia, Malaysia, Myanmar, Sri Lanka, Thailand, Vietnam, India (North East India).

Uses: Leaves for tying the animals that are to be sacrificed during rituals and chanting religious ceremonies and festivals especially during 'Dree' festival.

127. *Saccharum spontaneum* Linn. [Poaceae] 'Paelo'

Collection no: Hija, 18.7.2010, *Bamin- 105*

Description: Perennial, with long rhizomes. Culms noded, often hollow in center, nodes bearded, softly pilose below inflorescence. Leaf sheaths pilose at mouth and margin, sometimes tuberculate-pilose throughout; leaf blades glaucous, glabrous, margins serrate, tapering to midrib at base, apex long attentuate; ligule brown, 2–8 mm. Panicle axis silky pilose; racemes 4–17 cm.

Habitat: Mountain slopes, open areas.

Distribution: Bhutan, Indonesia, Japan, Malaysia, Pakistan, Thailand, Sri Lanka, Vietnam, India (Arunachal Pradesh, Assam).

Uses: Stem is used for house building as thatch.

128. *Sageretia filiformis (*Roth ex. Schult.) G. Don. [Rhamnaceae] 'Moreh Miiji'

Collection no: Bulla, Ring Road, 20.8.2009, *Bamin-126*

Description: A shrub or small tree with spiny slender glabrescent branches. Leaves ovate lanceolate, acute or acuminate, serrate, younger leaves densely woolly, with a rounded or subcordate base, 5-8 pairs of prominent lateral nerves. Petiole long. Inflorescence a branched raceme. Flowers sessile, greenish yellow. Disc deeply cup shaped. Fruit long, obovoid, edible. Fruits black.

Flowering & fruiting: March-June.

Habitat: Found along forest edges and roadsides.

Distribution: North America, Nepal, India (Arunachal Pradesh, North West India).

Uses: Stem used as firewood, bark and stem used to get relief from fungal infection like corn.

129. *Schefflera elliptica* (Blume) Horms. [Araliaceae] 'Sanko'

Collection no: Hija Dura, 17.2.2012, Hong, Nyibio, 12.4.2014, *Bamin-146*

Description: Scandent Shrub, climbers or epiphytic. Leaves digitately 5-7 foliate; leaflets elliptic-oblong, oblanceolate, acute-acuminate at apex, entire along margins, highly branched. Flowers terminal, panicled, umbels or racemes, pale green or yellowish green. Fruits globose, crowned by a conical disk, scented.

Flowering & Fruiting: February-October.

Habitat: Found in forests.

Distribution: Myanmar, Malaya, Pakistan, Tropical Australia. Thailand, Vietnam, India (Arunachal Pradesh, Assam, Manipur, Mizoram).

Uses: Fruits are edible and used for making chutney or eaten raw. Tender stems are also edible.

130. *Solanum kurzii* *Brace ex* Prain [Solanaceae] 'Byako'

Collection no: Hapoli, 5.4.2010, *Bamin-113*

Description: A perennial herb. Leaves ovate, densely hairy. Flowers in subterminal racemose cymes and white coloured. Berries globose, glabrous and yellow-red on ripening.

Flowering & Fruiting: January-December.

Habitat: Found along road side and along forest areas throughout the study area.

Distribution: Tropical and Subtropical regions in America, China, Myanmar India (North East India).

Uses: Fruit are taken as vegetable. Eaten with a little salt in case of stomachache and is good for expelling worms.

131. *Solanum myriacanthum* Dunal [Solanaceae] 'Siit byako'

Collection no: Hapoli, 14.4.2010, *Bamin-44*

Description: Shrub of about 5 m tall. Stems are stout and compressed hooked prickles, woody at the base, glandular hairy. Leaves solitary or paired, simple or pinnately compound, mostly petiolate; leaf blade entire, dentate, lobed, or parted. Inflorescences axillary, extra-axillary, or leaf opposed, mostly racemose. Flowers white in lateral cyme. Berries globose and yellow coloured with persistent calyx.

Flowering & Fruiting: November-January.

Habitat: Found along road side and forest areas throughout the study area.

Distribution: China, India (North East India).

Uses: The seeds used as medicine against toothache.

132. *Solanum nigrum* Linn. [Solanaceae] 'Hirohamang'

Collection no: Hapoli, 5.4.2010, *Bamin-40*

Description: Annular herb, upto 1 m. leaves, alternate, ovate-lanceolate or ovate oblong, entire, sinuate, toothed. Flowers in sub-umbellate cymes, pedicellate, white. Berries globose, reddish yellow and turns to black on ripening, calyx persistent. Seeds yellow, discoid, minutely pitted.

Flowering & Fruiting: March-November.

Habitat: Found in waste lands, as weed in open and moist places along roadsides.

Distribution: America, Australia, China, India (North East India, Orissa, Gujarat).

Uses: Leaves are either cooked or eaten raw as vegetable. It is preferred during indigestion and also acts as liver tonic. It is also preferred during loose motion. The berries are also edible as raw or cooked.

133. *Solanum torvum* *Swartz*, Prodr.47.1788 [Solanaceae] 'Byako'

Collection no: Hapoli, 27.9.2010, *Bamin- 100*

Description: Small shrubs, sparsely stellate pubescent, pricky. Leaves ovate, serrated, shortly acuminate, stellate pubescent. Inflorescence extra-axillary, racemose, few flowered Flowers white colured. Fruit globose yellow.

Flowering & Fruiting: April - August.

Habitat: Found along road sides, wasteland in shady areas.

Distribution: China, Malaysia, Phillipines, India (North East India, Gujarat, Maharashtra, West Bengal).

Uses: Fruit is taken as vegetable and as medicine to get relief from cough and stomach problems.

134. *Sonchus brachyotus* DC. [Asteraceae] 'Pakuhadu hamang/kochi hamang'

Collection no: Bamin, 2.4.2010, *Bamin-85*

Description: An annual herb with milky stem. Stem usually unbranched and glabrous. Lower leaves are narrowly elliptic-oblanceolate, dentate margin, smaller upper leaves. Inflorescence capitula, many, white tomentsoe with long peduncle.

Flowering & Fruiting: January- December.

Habitat: Commonly found in roadsides and open areas.

Distribution: Africa, Bhutan, Malaysia, Nepal, Thailand, Vietnam, India (Throughout India).

Uses: The leaves are edible. Boiled leaves are taken against stomach ache and gastritis.

135. *Strobilanthes helictus* T. Anderson [Acanthaceae] 'Tagging'

Collection no : Bulla , 21.8.2010, *Bamin*- 83

Description: Herbs or under shrubs upto 3 m high, young branches pubescent. Leaves lanceolate or elliptic, acuminate at both ends, glabrous. Flowers elongate, twisted, glabrous or hairy spikes, creamy white.

Flowering & Fruiting: August - December.

Habitat: Found along forest edges and roadsides preferably shady area..

Distribution: Bhutan, China, Myanmar, Nepal, India (Arunachal Pradesh).

Uses: Young leaves are taken as vegetables and is good for indigestion.

136. *Symplocos paniculata* (Thunb.) Miq. [Symplocaceae] 'Sankhi'

Collection no: Hija, 28.5.2010, *Bamin-117*

Description: Shrubs or small deciduous.tree. Young branchlets glabrous or pilose; old branchlets glabrous. Leaf blade ovate, elliptic-obovate, or broadly obovate, usually slightly rhomboid, membranous to thinly papery, abaxially glabrous or pubescent, adaxially glabrous or appressed hairy, base broadly cuneate to subcordate, margin sharply glandular dentate, apex acuminate to acute, lateral veins 4-10 pairs. Drupes bluish, globose.

Flowering & Fruiting: March-September.

Habitat: Found in forest slopes.

Distribution: Bhutan, Japan, Korea, Myanmar, Vietnam, India (Arunachal Pradesh)

Uses: As dye. The leaves are boiled along with *Rubia manjith* in water or starch till the yellow-brownish colour appears and clothes are then dipped in it for dying.

137. *Trichosanthes tricuspidata* Lour. [Cucurbitaceae] 'Bullungkoa'

Collection no: Bulla, 3.11.2010, *Bamin-133*

Description: Large climber with robust, woody stem. Leaves palmate, 3-7 lobed. Fruit globose, red when ripe or orange red coloured with 10 orange streaks, seeds many. Flowers with imbricate corolla.

Flowering & Fruiting: July- November.

Habitat: Found in shady and wastelands, open fields, roadsides.

Distribution: Malaysia, Nepal, Thailand, Vietnam, India (Arunachal Pradesh).

Uses: Stem and root used as medicine in cuts and wounds. Wild fruits are used as poison.

138. *Thysanolaena maxima* (Roxb.) O. Kuntze [Poaceae] 'Ipinani'

Collection no: Hapoli, Paigate, 14.9.2011, *Bamin-170*

Description: Perennial grass. Leaf sheaths smooth; leaf blades broadly lanceolate-oblong, leathery. Panicle long, branches mostly staright, erect. Spikelets lanceolate, ovate, sub-acute, sterile lemma glabrous.

Flowering & Fruiting: August- December.

Habitat: Grow in dry places in open areas.

Distribution: Bhutan, Nepal, India (Arunachal Pradesh, Assam, Meghalaya, Punjab, Kashmir).

Uses: Inflorescence used as broom.

139. *Typhonium trilobatum* (Linn.) Schott. [Araceae] 'Roppu'

Collection no: Bamin, 9.4.2011, *Bamin-160*

Description: A perennial tuberous herb. Leaves 3 lobed, pedate. Spathe, acuminate, pale green. Spadix elongate, red-purple. Petiole green or variously flushed with purple, leaf blade cordate-ovate in outline, usually deeply 3-lobed, rarely 5-lobed; central lobe ovate, acuminate, sometimes mucronate. Inflorescence appearing after leaves; peduncle elongating in fruit. Spathe convolute at base, outside green, inside green, ovoid or ellipsoid, constricted at apex; limb spreading, outside green, inside dark purple to reddish purple, ovate-lanceolate, apex acuminate.

Flowering & Fruiting: April- August.

Habitat: Found in moist shady places along road sides, streams, etc.

Distribution: Australia, Bangladesh, Bhutan, Myanmar, Nepal, Sri Lanka, Thailand, India (Arunachal Pradesh).

Uses: Whole plant is used as fodder and also the leaves are dried and burnt for making local salt.

140. *Vernonia cinerea* (Linn.) Less. [Asteraceae] 'Tapyo'

Collection no: Hapoli, 25.8.2010, *Bamin-158*

Description: Herbs, annual or perennial, to 100 cm tall. Root vertical woody, branched, with fibrous rootlets. Stems erect, usually branched above, or rarely from base, striate, gray adpressed puberulent with T-shaped hairs, glandular. Lower and middle leaves, leaf blade rhombic-ovate, rhombic-oblong, or ovate, abaxially gray-white or yellowish puberulent, especially along veins, both surfaces glandular, adaxially green, sparsely puberulent, base cuneately attenuate into winged petiole, margin remotely mucronate-serrate, or repand, apex acute or slightly obtuse.

Habitat: Mostly found in open areas and fields amidst grasses.

Flowering & Fruiting: August-November.

Distribution: Africa, Indonesia, Malaysia, Phillippines, Thailand, Vietnam, India (Arunachal Pradesh, Assam throughout tropics of India).

Uses: The whole plant is dried and is burnt to ashes and made into local salt 'Tapyo'. Leaves are used for wrapping the local salt.

141. *Viburnum foetidum* Wall. [Caprifoliaceae] 'Yoyu'

Collection no: Ring road 22.9.2009 *Bamin-66* [Pl. 11D]

Description: Shrubs, deciduous, erect or climbing of about 3-5m high; bark grayish or light brown. Leaves opposite, not clustered at apices of branchlets, leaf blades rhomboid to elliptic-lanceolate, hairy along nerves beneath. Matured fruits are red, ovoid-ellipsoid, base rounded, sweet-sour taste, bright red when ripe.

Flowering & Fruiting: April- September.

Habitat: Found along hill slopes and forest edges.

Distribution: Burma, China, India (North East India).

Uses: Fruits are edible.

142. *Wallichia oblongifolia* Griff. [Arecaceae] 'Tisse/Tashe'

Collection no: Hija, Kidi Santu, 19.2.2010, *Bamin-108*

Description: An erect palm, about 2-3 m tall, stem short, fibrous crowded with leaf sheath. Leaves arranged spirally, oblong, with several lobes, alternately arranged. Inflorescences unisexual, staminate and pistillate borne on separate stems. Fruits greenish brown, ovoid, ellipsoid.

Flowering & Fruiting: January- December.

Habitat: Found in forests especially in steep slopes.

Distribution: Bangladesh, Bhutan, Nepal, India (North East India).

Uses: The Rhizome and stem are used as food during drought periods. Leaves are also used for roofing.

143. *Zanthoxylum acanthopodium* DC. [Rutaceae] 'Yorkhung'

Collection no: Hapoli, Agey putu, 21.4.2010, *Bamin -149*

Description: Small shrub or tree, with aromatic smell, branchlets dense rusty robust, reddish brown prickles, pubescent. Leaves opposite, elliptic-lanceolate, acute-acuminate at apex, glandular. Flowers purple in axillary panicles. Seeds globose, glossy, black.

Flowering & Fruiting: December - May

Habitat: Found in open forests preferably in shaded areas.

Distribution: Bangladesh, China, Indonesia, Malaysia, Nepal, Vietnam, India (North East India, Uttar Pradesh, West Bengal).

Uses: Fruits are edible. The fruits are dried and taken as medicine for cough and cold. It is also eaten raw and is an appetizer. The fruits are used as spices in boiled food and also for making chutney.

144. *Zanthoxylum armatum* DC. [Rutaceae] 'YorjeyYorkhung'

Collection no: Agey putu, 7.4.2010 *Bamin-123*

Description: Small aromatic tree, stem thorny, bark greyish brown, blaze yellowish; leaves imparipinnate, rachis winged, 5-11 foliate. Leaves oblong-lanceolate, ovate to elliptic lanceolate, acuminate, obscurely serrulate, glabrous, nerves prominent beneath, spines straight or upcurved. Flowers small, greenish yellow, sepals; seeds black, shining globose, rugose.

Flowering & Fruiting: April- October.

Habitat: Found in open forest along hill slopes.

Distribution: Bangladesh, Bhutan, China, Indonesia, Japan, Korea, Myanmar, Nepal, Thailand, India (North East India, Bihar, Kashmir, Uttar Pradesh).

Uses: Fruits edible and used as spices also. The seeds are powdered and used for relief from cold and cough. It is also good for improving appetite.

145. *Zanthoxylum oxyphyllum* Edgeworth. [Rutaceae] 'Nemba yorkhung'

Collection no: Hong, Sari lenching, 12.4.2012, *Bamin-139*

Description: An erect slender shrub or small tree, about 3m tall, glabrous and prickled. Leaves ovate-lanceolate, long, rachis with prickles beneath, puberous or

glabrescent; leaflets alternate, ovate oblong, elliptic or lanceolate, acute base, acuminate, glabrous. Flowers terminal, panicled umbels yellow coloured. Fruits globose, black.

Flowering & Fruiting: April-November.

Habitat: Found commonly in deep forest preferably on the hill slopes.

Distribution: Bhutan, Myanmar, Nepal, India (North East India).

Uses: The dried fruits are taken during cold and cough. It is also eaten raw and is a good appetizer. The fruits are used as spices in boiled food and also for making chutney.

Fungi

146. *Cantharellus* sp. [Cantharellaceae] 'Taying'

Collection no: Hija, Aigira, 26.6.2009, *Bamin-23*

Description: Small or medium sized mushroom, fruiting body orange-yellow in colour, broadly convex, fleshy stem. It is one of the prefferred mushrooms. It tastes like meat and gives aroma.

Fruiting: July- September.

Habitat: Found in tree roots or hard woods, rotten plants in forests.

Uses: Fruiting bodies are boiled and eaten as food.

147. *Pleurotus* sp. [Pleurotaceae] 'Taying'

Collection no: Hong, Nyibioagiya, 14.9.2009, *Bamin-54*

Description: Commonly called Oyster mushroom. Small oyster shaped mushroom about 5 -25 cm tall, smooth, gills white to light brown colur, attached to cap (if there is no stem) and stem. Has a little smell when freshly collected.

Fruiting: July- September.

Habitat: Found growing on dead and decaying logs or dead trees.

Uses: Fruiting bodies are boiled and eaten as food.

From the above enumeration, a total of 147 species are found comprising of 118 genera under 65 families. These species belongs to the classes Angiosperms Gymnosperms, Pteridophytes and fungi with domination of Angiospermic species. The representation of all the taxonomic classes is indicated in the fig. 4.1a. Among the maximum used plant families for NTFPs the families like Rosaceae, Fagaceae, Arecaceae, Lauraceae, Lamiaceae, Araceae, Moraceae, Solanaceae are the most used

ones with at least 4 species and Poaceae and Asteraceae as the topmost dominant families (Fig. 4.1b.). The habitat wise grouping of the NTFPs showed that maximum species are under herb followed by trees, shrubs and climbers. (Fig. 4.1c.).

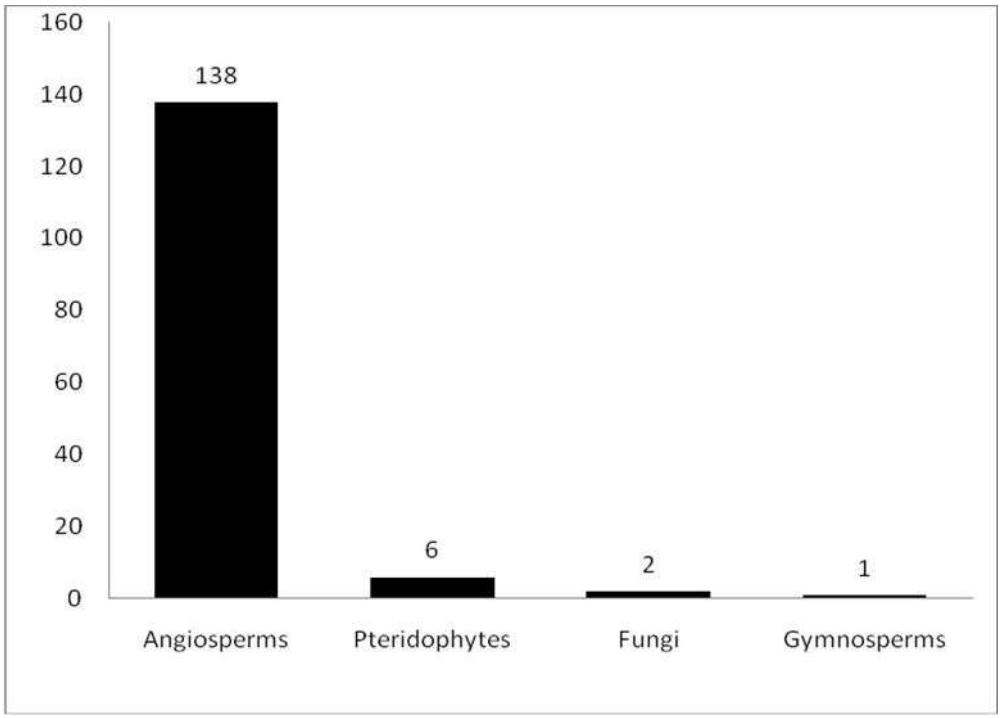


Figure 4.1a. Various groups of taxa used for NTFPs with number of species.

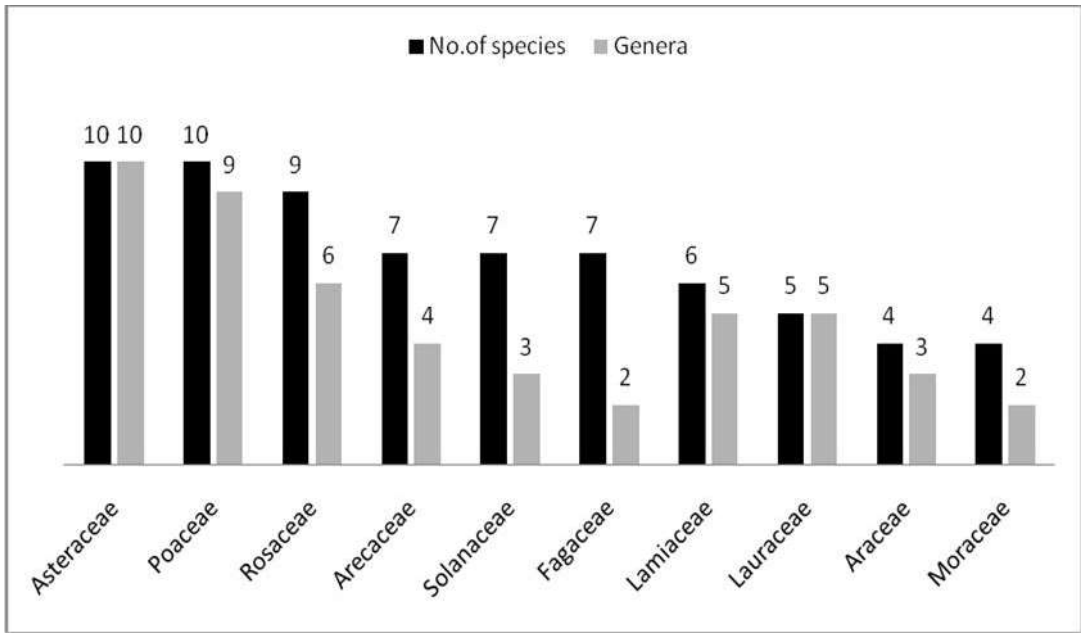


Figure 4.1b. Ten most dominant families used as NTFPs with numbers of species and genera.

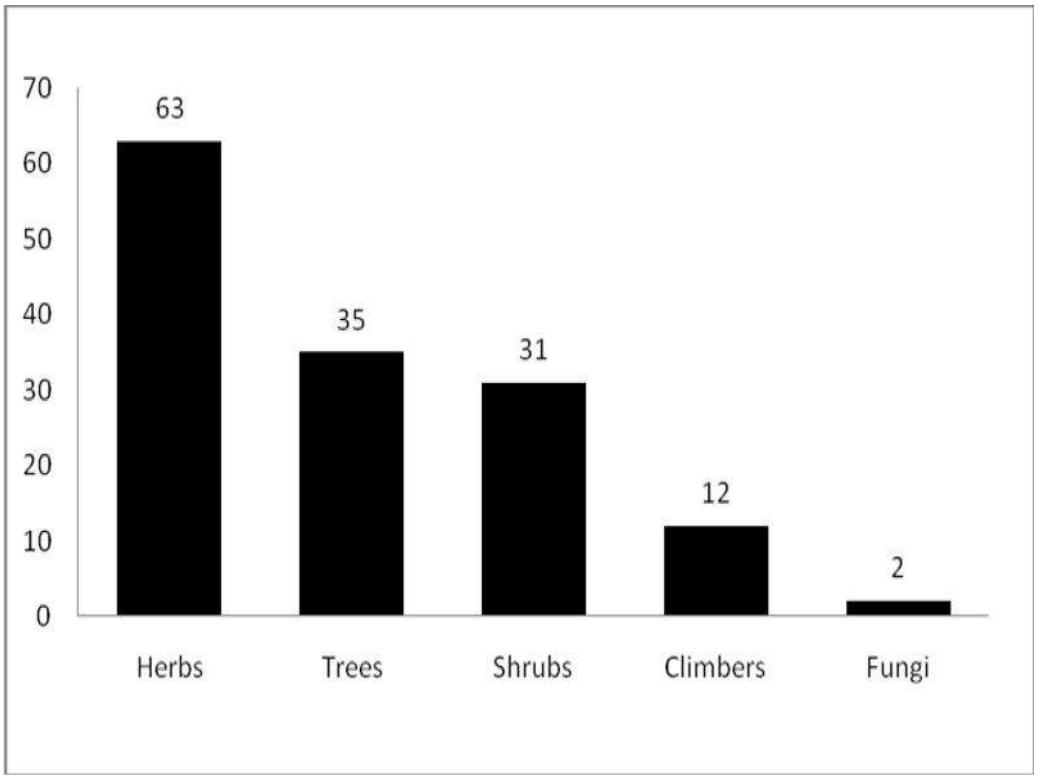


Figure 4.1c. Habit wise grouping of the plant species used by Apatani people.

4.2. Utilization Pattern of the NTFPs

The present study reveals that the Apatanis utilize the different species for various day to day needs and also for their economic benefits. A large number of forest produces in the form of non timber have been utilised and these products are obtained from 147 species under 118 genera and 65 families of plants which are already enumerated in the previous chapter. These NTFPs yielding species are mostly collected from wild and are used as per the need. In this chapter an attempt has been made to give the details of the utility pattern.

Based on their ways of utility all these NTFP species can be categorized as food plants (including vegetables, salt preparation, fruits, mushrooms), medicinal plants, fodder plants, firewood, house building materials (apart from timber), household items, dyes, gums, ornamental, ritual and miscellaneous. The plants used in food category is found to be the dominant with maximum species having a total of 88 species followed by medicinal plants (56 spp.), religious plants (19 spp.), firewood (15 spp.), fiber (5spp.), brooms and thatches (5 spp.), miscellaneous (14 spp.), house-building materials (14 spp.), fodder (12 spp.), handicrafts and household items (7 spp.), gums (4 spp.) and dyes (4 spp.). The various use categories with number of species are presented in (Fig.4.2a).

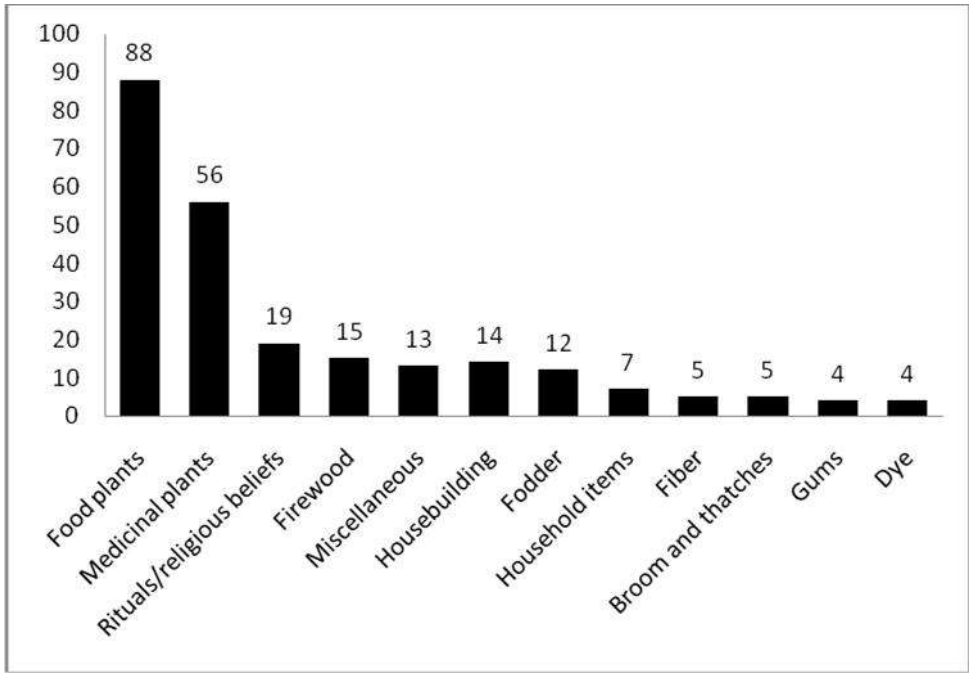


Figure 4.2a. Categorization of different uses of plants.

Among the plant parts used it has been found that leaf is the dominant part used and recorded in maximum cases (61 spp.), followed by fruits and seeds (43 spp.), stems (26 spp.) whole plant (24 spp.) where more than 10 species are used in each cases. The other parts like shoots, tubers, culms, bark, flowers and inflorescence, fruiting body, branch, pith, pseudo-stem, thorn, rhizome and resin are also used but the number of species used in each ranged from 1 to 10 species only (Fig.4.2b).

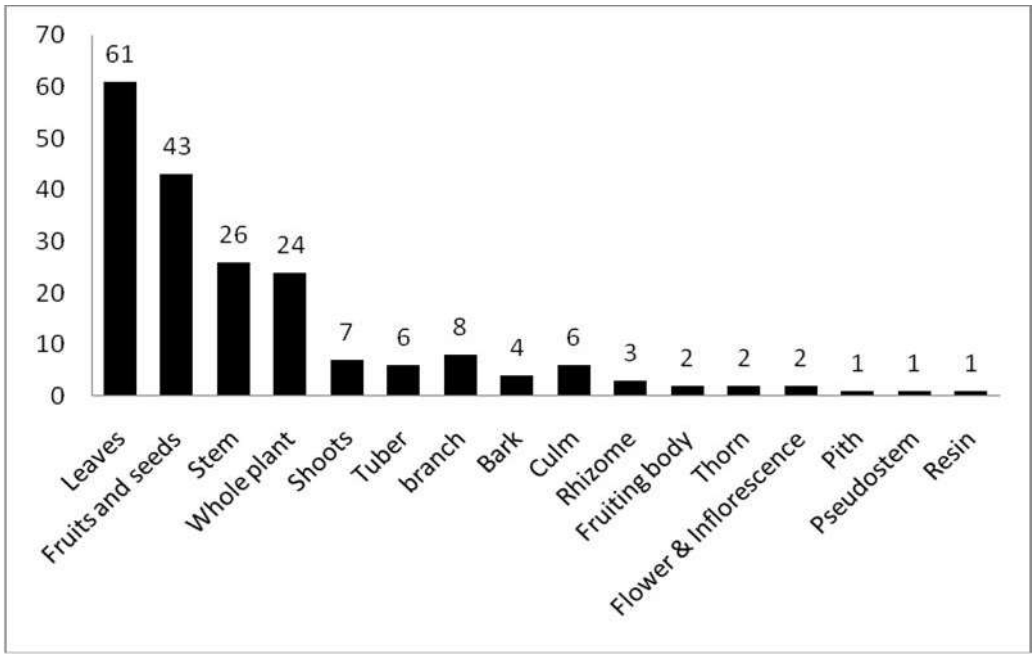


Figure 4.2b. Various plants parts used as NTFPs with number of species.

4.2.1. Food plants and their uses

Vegetables and allied plants:

Among the food items, maximum species were used as vegetables compared to other uses. These species were found to be the most preferred group of NTFPs and especially among the women folks. A total of 55 species were used as vegetable including the spices and condiments that are mixed with vegetables and the pickles and salad. In this category, the parts like leaves, stem, whole plants and rhizome are used (Table 4.2.1a). However, in maximum cases the Apatanis prefer leafy vegetable and 80% species are known for their leafy vegetable. Among the leafy vegetables species like *Acmella paniculata, Centella asiatica, Clerodendrum glandulosum, Houttuynia cordata, Hydrocotyle javanica, Cardamine hirsuta, Portulaca oleraceae, Piper pedicellatum, Oenanthe javanica*, etc. are some of the commonly available and

mostly preferred by the tribes. It has been found that the leafy vegetables are commonly consumed in simple boiled form with addition of just a pinch of salt along with water. To increase the taste and flavor sometime chilies, zinger, bamboo shoots and garlic are also added in the preparation. The young fruits of few species like *Litsea cubeba, Magnolia oblonga, Solanum kurzii* are also preferred for cooked vegetable. As the other tribe of north east India, the Apatanis also uses the bamboo shoot as one of the best tasty vegetable. It is consumed in various ways by every household. Two fungal species (Mushroom) namely *Pleurotus* sp. and *Cantharellus* sp. were also recorded to be used as vegetable and other delicacies.

The tubers of few species like *Dioscorea bulbifera, D. hamiltonii, Manihot esculenta* are also preferred for their tuberous roots and consumed as common food. They are either consumed as vegetable or as main food item along with other vegetables. *Allium* species are also commonly preferred by the people as vegetable, condiment and spices and used in high quantity. It has been found that the fruits and leaves of three *Zanthoxylum* species are also commonly used as vegetable, spice, condiments and flavouring agents.

Table 4.2.1a. List of plants used as vegetables.

Sl.No.	Name of species	Local name	Parts used
1.	*Acmella paniculata*	Yakhohamang	Leaves
2.	*Allium hookeri*	Lepi/Talley	Leaves
3.	*Allium tuberosum*	Talley/Lepi	Leaves
4.	*Amaranthus spinosus*	Pulu tayi hamang	Leaves, whole plant
5.	*Amaranthus tricolor*	Lancha tayi hamang	Leaves, whole plant
6.	*Artemisia indica*	Kukulyu/ kuku lyolye hamang	Leaves
7.	*Begonia obversa*	Lukhu	Leaves
8.	*Cardamine hirsuta*	Paddii hamang	Leaves
9.	*Centella asiatica*	Ngilyang khiko	Whole plant
10.	*Chimonocalamus callosus*	Riijang	Culms, shoots
11.	*Chimonocalamus griffithianus*	Tabiyo	Whole culm, young shoot
12.	*Cinnamomum verum*	Salley	Bark
13.	*Clerodendrum glandulosum*	Pato hamang	Leaves

14.	*Clerodendrum serratum*	Pato hamang	Leaves
15.	*Colocassia esculenta*	Inge	Tuber
16.	*Crassocephalum crepidioides*	Halyang hamang	Whole plant
17.	*Cyathea gigantea*	Tashe	Pith
18.	*Dioscorea bulbifera*	Engin/ Hula	Tuber
19.	*Dioscorea hamiltonii*	Engin	Tuber
20.	*Diplazium esculentum*	Hiika	Tender leaves/fronds
21.	*Elatostema platyphyllum*	Hiipe	Leaves
22.	*Eremocaulon capitatum*	Yabiing	Whole culm, shoots
23.	*Gonostegia hirta*	Hiipe hamang	Young leaves
24.	*Gynura bicolor*	Kochi hamang	Leaves
25.	*Houttuynia cordata*	Siiya hamang	Shoot, leaves
26.	*Hydrocotyle javanica*	Hiibyo	Leaves, Roots
27.	*Impatiens racemosa*	Aki tai	Leaves
28.	*Litsea cubeba*	Santero	Fruits
29.	*Magnolia champaca*	Salyo	Fruits
30.	*Magnolia oblonga*	Salyo	Fruits
31.	*Manihot esculenta*	Sann engine	Tubers
32.	*Musa x paradisiaca*	Kulu	Pseudostem, inflorescence
33.	*Oenanthe javanica*	Hugu hamang	Leaves
34.	*Oxalis corniculata*	Okhui hamang	Leaves
35.	*Paederia foetida*	Paritaro	Leaves, stem
36.	*Perilla frutescens*	Tining	Seeds
37.	*Phoebe goalparensis*	Samper	Fruit
38.	*Phyllostachys bambusoides*	Bije	Young shoots
39.	*Physalis angulata*	Apu byayung	Young leaves, fruits
40.	*Physalis minima*	Apu byayung	Young leaves, fruits
41.	*Piper hamiltonii*	Riidi	Leaves
42.	*Piper pedicellatum*	Raru/rari	Leaves
43.	*Plantago erosa*	Mepi	Leaves
44.	*Portulaca oleracea*	Lai hamang	Leaves, whole plant
45.	*Rumex nepalensis*	Tajang liho	Leaves
46.	*Schefflera elliptica*	Sanko	Fruits, young stems
47.	*Solanum kurzii*	Byako	Fruits

48.	*Solanum nigrum*	Hiiro hamang	Fruits, leaves, stem
49.	*Solanum torvum*	Byako	Fruits
50.	*Sonchus brachyotus*	Kochi/pakuharbu hamang	Leaves
51.	*Strobilanthes helictus*	Tagging	Young leaves
52.	*Wallichia oblongifolia*	Tisse	Rhizome, stem
53.	*Zanthoxylum acanthopodium*	Yorkhung	Fruits
54.	*Zanthoxylum armatum*	Yorkhung	Fruits
55.	*Zanthoxylum oxyphyllum*	Nemba yorkhung	Fruits, leaves

4.2.1b. Plants for salt preparation:

During the study it was found that the Apatanis commonly use the local salt called 'Tapyo' produced from various plants (Table 4.2.1b). They prepare the salt using different herbaceous plant species from forest. Six species have been listed namely *Cirsium interpositum, Cyatula prostrata, Vernonia cineria, Phragmites karka,* etc. that were used for making local salt. The whole plants especially from nearby streams or swampy areas are collected and burnt for making the local salt.

Table 4.2.1b. Plants used in preparation of salt.

Sl.No.	Name of species	Local name
1.	*Cirsium interpositum*	Lobyo/tipe tire
2.	*Cyathula prostrata*	Tapyo
3.	*Phragmites karka*	Pepu
4.	*Pogostemon yatabeanus*	Higu hiha
5.	*Typhonium trilobatum*	Roppu
6.	*Vernonia cinerea*	Tapyo

4.2.1c. Fruit Plants:

Utilization of NTFPs in the form of fruit is found to be one of the most important aspects of Apatani tradition. Wild fruits are taken raw and some of them are used for making chutney or as salad. A total of 25 species were eaten as fruit. These species belongs to 11 families where Rosaceae, Fagaceae, Moraceae, Actinidaceae, Anacardiaceae are the major family with at least 2 species in each. The maximum species is represented by the Rosaceae where 9 species under the genera *Pyrus, Prunus, Rubus,* and *Frageria* are documented. *Rubus* is the important genus for fruit species representing 3 species. Among the fruit species, *Pyrus pashia, Prunus spp,*

Rubus ellipticus, Myrica esculenta, Rubus niveus, Rubus rosaefolius etc are some of the highly preferred wild fruits by the Apatanis because of its taste, nutritions and easy availability. Majority of the fruit species are represented by tree habit. The shrubby species are represented by of *Cissus repens*, *Rubus spp*, and *Frageria vesca*. Among trees, *Actinidia, Pyrus, Ficus, Magnolia, Phoebe* and *Rhus* species are found very common. The list of all the fruit species is given in the table (Table 4.2.1c).

All these species are eaten as raw fruit after maturity or ripening and mostly they are fleshy and pulpy berries or drupes.The study also reveals that apart from the raw fleshy and pulpy fruits some dried fruits are also frequently used. The nuts of *Castanopsis* and *Quercus* are eaten after roasting.

Table 4.2.1c. List of plants used as wild fruits.

Sl.No.	Name of species	Local name
1.	*Actinidia callosa*	Hari Harkhu
2.	*Actinidia chinensis*	Antii Tarey
3.	*Castanopsis indica*	Kiira
4.	*Castanopsis tribuloides*	Korbing kira
5.	*Cerasus cerasoides*	Semo
6.	*Choerospondias axillaris*	Biiling
7.	*Cissus repens*	Hari harkhu/ taru beku
8.	*Elaeagnus caudate*	Hari ayi
9.	*Ficus auriculata*	Taro
10.	*Ficus sarmentosa*	Sireh myarung
11.	*Duchesnea indica*	Subu Tute jilyung
12.	*Frageria vesca*	Kidi nyimung
13.	*Mahonia napaulensis*	Taaming
14.	*Myrica esculenta*	Baching
15.	*Morus alba*	Gende
16.	*Prunus persica*	Takung ahii
17.	*Pyrus calleryana*	Piita ahii
18.	*Pyrus pashia*	Pecha
19.	*Quercus griffithii*	Sankhe
20.	*Quercus semicarpifolia*	Saii
21.	*Rhus chinensis*	Tamo
22.	*Rubus ellipticus*	Jilyung
23.	*Rubus niveus*	Henchi/ Nikhe
24.	*Rubus rosaefolius*	Hitung bulung
25.	*Viburnum foetidum*	Yoyu

4.2.2. Medicinal Plants:

The utilization of plant parts for medicine and nutrition is another important tradition of Apatanis. Like vegetable and fruits, a large number of species are used in the treatment of various ailments. A list of the types of different ailments and the number of species used as medicines have been given in Table 4.2.2a. These species of medicinal plants are used in each of the house hold almost on a daily basis. A total of 56 species were found to have medicinal values, represented by 46 genera and 38 families. In this category maximum of species belong to Asteraceae family followed by Acanthaceae, Piperaceae, Rutaceae, Lauraceae, and Verbenaceae. Majority of the species are herbaceous in nature except for a few trees and shrubs. Among the trees and shrubs, species of *Zanthoxylum, Litsea, Magnolia* and *Rhus* are used. So about 90% requirement of medicinal plant parts are obtained from herbaceous species. All the medicinal plants with their uses are listed in Table 4.2.2b.

Almost all the plant parts are found useful for medicine. The most utilized parts are leaves and tender shoots which are again consumed in its edible form either raw or cooked. The plants usesd as vegetable was mostly consumed in cooked form. They are used mostly in the form of paste and powder when applied externally. Some of the species like *Clerodendrum glandulosum, Houttuynia cordata, Centella asiatica, Oxalis corniculata, Gynura bicolor, Physalis angulata, Cardamine hirsuta* etc. have medicinal properties which are commonly consumed as vegetable. It is found that most of such species are either found supportive to stomach disorder or as tonic for health. So the women folks are always eager in collection and use of these plants from nearby forests or from home gardens. Species such as *Acorus calamus, Eupatorium odoratum, Hyptis suaveolens, Mikania micrantha, Christella parasitica,* etc. are crushed and its extract is used for healing cuts and wounds.

The fruits of *Piper hamiltonii, Zanthoxylum armatum, Zanthoxylum oxyphyllum, Berberis wallichiana, Schefflera elliptica* etc. are used or taken to get relief from cold and cough and mostly consumed with food items. The fruits of these species are also eaten as spices.

Table 4.2.2a. List of the different types of ailments and species used.

Sl.No.	Types of ailments	No. of species
1.	Cuts and wounds	12
2.	Gastrointestinal problems	31
3.	Cough/Cold/throat infection/ Nose blockade	13
4.	Blood pressure	2
5.	Appetizer	6
6.	Bone fracture	2
7.	Backache/Bodypain/Muscle pain/cramps	5
8.	Toothache	2
9.	Skin/allergy/fungal infection/Antibacterial/cracked heels /pesticide, etc.	7
10.	Blood purifier	1
11.	Headache	3
12.	Fever	2

Table 4.2.2b. List of plants used as Medicines.

Sl. No	Name of species	Parts used	Local name	Uses
1.	*Acmella paniculata*	Leaves	Yorkhung	Consumed raw against constipation.
2.	*Acorus calamus*	Rhizome	Kile tolyo	Crushed rhizome applied on cuts, wounds, paste applied on bone fracture and tied with a cloth to set it right and left for healing.
3.	*Ageratum conyzoides*	Leaves	Borbia tami	Leaf-paste stops bleeding in cuts and wounds.
4.	*Allium hookeri*	Tuber	Lepi	Tubers used in cold, vomiting, allergy, cuts and wounds, skin eruption, cough, anti-inflammatory, bone fracture.
5.	*Anisomeles indica*	Whole plant	Narutami	Paste applied on cuts, wounds and in muscle pain.
6.	*Artemisia indica*	Leaves	Kukulyu/ kukulyolye hamang	Strong smell of leaf gives relief from nose blockade, headache, fever and also used as pesticides.
7.	*Berberis wallichiana*	Fruit/ Bark	Tiipe tire/ Lobyotiire	Paste of the bark is applied on wounds and swelling

				for instant relief from pain. Fruit gives relief from indigestion.
8.	*Cardamine hirsuta*	Leaves	Paddii hamang	Used for stomachache, and leaf paste applied on cuts and wounds.
9.	*Centella asiatica*	Leaves	Ngilyang khiko	Remedy for gastritis, blood purification and also increases appetite.
10.	*Christella parasitica*	Leaves	Tari	Applied in cuts and wounds.
11.	*Clerodendrum glandulosum*	Leaves	Pato hamang	Boiled leaves remedy for blood pressure, fever, and cough.
12.	*Clerodendrum serratum*	Leaves	Pato hamang	Boiled leaves for remedy from blood pressure, fever, cough.
13.	*Crassocephalum crepidiodes*	Leaves	Halyang hamang	Raw or cooked leaves give relief from indigestion.
14.	*Croton roxburghii*	Leaves	Pai lamu	Relief from stomach disorder.
15.	*Cyathea gigantea*	Leaves	Tashe	Leaves as remedy against bodyache.
16.	*Dendrocnide sinuata*	Leaves	Hathi pata	Extracts of leaves and root used for fever and dysentery. Applied to get relief from muscle swelling, toothache.
17.	*Dioscorea bulbifera*	Tuber	Ingey/ Hulla	Cooked tubers good for indigestion problems.
18.	*Dioscorea hamiltonii*	Tuber	Engin	Cooked tubers good for indigestion problems.
19.	*Eremocaulon capitatum*	Shoot/ Culm	Yabing	The water or liquid inside the shoots gives relief from diarrohea, dysentery and other stomach problems. Tender shoots also acts as antibacterial and water purifier.
20.	*Eupatorium odoratum*	Leaves	Borbe tami	Leaf-paste applied on cuts and wounds.

21.	*Gonostegia hirta*	Leaves	Hiipe hamang	Consumed raw against constipation.
22.	*Gynostemma pentaphyllum*	Stem	Rikko	Dried, powdered stem taken with hot water or starch gives relief from cold, cough and throat infection.
23.	*Gynura bicolor*	Leaves	Kochi hamang	Leaf extract taken orally to get rid of intestinal worms.
24	*Houttuynia cordata*	Leaves, shoot	Siiya hamang	Gives relief from sleep disorder, appetizer and indigestion.
25.	*Hydrocotyle javanica*	Leaves	Hiibyo	Taken raw to get relief from indigestion.
26.	*Hyptis suaveolens*	Leaves	Narutami	Leaves crushed and applied on cuts and wounds to stop bleeding.
27.	*Litsea cubeba*	Fruit	Santero	Ripe or unripe fruits give relief from cold and cough.
28.	*Magnolia champaca*	Fruit	Salyo	Improves appetite and liver disorder.
29.	*Mikania micrantha*	Leaves	Riring hamang/ Maantami	Leaf Paste or stem made into and juice or liquid of leaves and stem are applied on rashes, wounds or clotting of blood, headache.
30.	*Nicotiana tabacum*	Leaves	Muku	Leaf placed on swelling joints gives relief.
31.	*Oenanthe javanica*	Leaves	Hiigu hamang	Raw leaf gives relief from indigestion.
32.	*Oxalis corniculata*	Leaves	Okhui hamang	Raw leaf gives relief from stomach ache.
33.	*Paederia foetida*	Leaves	Paritaro	Leaf extract gives relief from indigestion.
34.	*Perilla frutescens*	Seed	Tining	Used for fever, headache.
35.	*Physalis angulata*	Fruit	Apu byayung	Fruits give relief from gastric problems.
36.	*Physalis minima*	Fruit	Apu byayung	Fruits are taken to get relief from gastric problems.

37.	*Pinus wallichiana*	Resins	Saati	Resins give relief from cuts, wounds, crack heels, fungal infection.
38.	*Piper hamiltonii*	Fruit	Riidii	Fruits chewed to get relief from cough and cold.
39.	*Plantago erosa*	Leaves	Mepi	Raw leaf gives relief from constipation.
40.	*Rhus chinensis*	Fruit	Tamo	Gives relief from stomach disorder, blood dysentery.
41.	*Rubia manjith*	Roots	Tiiming	Powdered roots mixed with water and taken to get relief from cold, cough and dysentery.
42.	*Rubus ellipticus*	Fruit	Jilyung	Gives relief from indigestion.
43.	*Rubus rosaefolius*	Fruit	Hitung bulung	Gives relief from indigestion.
44.	*Rumex nepalensis*	Leaves	Tajang liho	Young leaves taken to get relief from indigestion.
45.	*Sageretia filiformis*	Bark/ stem	Miiji	Bark, stem is burnt and its smoke is used for giving heat on the corn for relief and cure.
46.	*Schefflera elliptica*	Fruit	Sanko	Taken raw to get relief from indigestion.
47.	*Solanum kurzii*	Fruit	Byako	Raw fruit with little salt is taken in stomach and is good for expelling worms, cough.
48.	*Solanum myriacanthum*	Fruit	Siit Byako	Chewed to get relief from toothache.
49.	*Solanum nigrum*	Leaves	Hiro hamang	Leaves good for stomach problems.
50.	*Solanum torvum*	Fruit	Byako	Fruit gives relief from cough, stomach problems and for skin problems.
51.	*Sonchus brachyotus*	Shoot	Kochi/ pakuharbu hamang	Shoot extract taken in stomach disorder.
52.	*Strobilanthes helictus*	Leaves	Tagging	Gives relief from indigestion.

53.	*Trichosanthes tricuspidata*	Fruit	Bullungkoa	Applied in wounds and sores.
54.	*Zanthoxylum acanthopodium*	Fruit	Yorkhung	Dry fruits taken during cold and cough. And is a good appetizer.
55.	*Zanthoxylum armatum*	Fruit	Yorkhung	Dry fruits taken during cold and cough; also eaten raw as a good appetizer.
56.	*Zanthoxylum oxyphyllum*	Fruit	Nemba yorkhung	Dry fruits taken during cold and cough. Also a good appetizer.

4.2.3. Plants used in rituals and ceremonies:

During the study it was been found that the Apatanis use a number of species for NTFPs where branches, leaves, fruits either fresh, dried or converted form are used. Species like *Calamus acantospathus, Castanopsis hystrix, Castanopsis tribuloides, Molineria capitulata, Kavalama urens, Phyllostachys bambusoides* etc. were some of the mostly prefferred and important species that were used in almost all of the rituals or ceremonies. Overall 19 species were used for performance of rituals and ceremonies by the Apatanis (Table 4.2.3). The bamboo and cane species namely *Phyllostachys bambusoides* and *Calamus acanthospathus* are used mostly as very essential materials along with the other species for making the sacred altar 'Agyang', sacred pillar 'Babo' for almost all the rituals, festivals or ceremonies at individual homes or community like 'Myoko', 'Murung' etc .

Table 4.2.3. List of plants used for religious purposes.

Sl.No.	Name of species	Local name	Parts used
1.	*Angiopteris evecta*	Chanyu	Stem.
2.	*Calamus acantospathus*	Taser	Stem.
3.	*Castanopsis armata*	Kira	Leaves, stem.
4.	*Castanopsis hystrix*	Kiira	Leaves, stem.
5.	*Castanopsis indica*	Rahu kira	Leaves, stem.
6.	*Castanopsis tribuloides*	Korbing kira	Leaves, whole plant.
7.	*Cephalostachyum mannii*	Tajer	Culm.
8.	*Cyclosorus glandulosus*	Milo Tarih	Leaves.
9.	*Eremocaulon capitatum*	Yabing	Culm.

10.	*Exbucklandia populnea*	Dolo yasang	Stem/ branches.
11.	*Ficus hookeriana*	Saro	Whole tree.
12.	*Kavalama urens*	Niji yanii	Leaves.
13.	*Ligustrum ovalifolium*	Sankhan melyan	Whole plant.
14.	*Loropetalum chinense*	Mari ripu	Branch, leaves.
15.	*Machilus villosa*	Sampe	Stem, branches.
16.	*Molineria capitulata*	Loli	Leaves.
17.	*Phyllostachys bambusoides*	Bije	Culm leaves.
18.	*Prunus persica*	Takung ahii	Whole plant.
19.	*Saccharum arundinaceum*	Peji Paelo	Leaves.

4.2.4. Plants used for firewood:

As Ziro area exhibit cold climate throughout the year and people suffer from very cold weather particularly during winter, they protect themselves from the cold using firewoods. These firewoods are also used for cooking at household level and community levels. Although many species are used, 15 plant species were recorded that were used as most common and preferred plants for firewood almost in all the villages of the Apatanis. *Castanopsis* sp., *Phyllostachys bambusoides*, *Magnolia champaca*, *Magnolia oblonga*, *Quercus griffithi*, etc. were some of the preferred species used as firewood (Table 4.2.4). All these species used for firewood are found to be common species that are also used to obtain other non timber produces like fruits.

Table 4.2.4. List of plants used as firewood.

Sl.No.	Name of species	Local name	Parts used
1.	*Alnus nepalensis*	Riime	Stem/branches.
2.	*Castanopsis armata*	Kiira	Branches.
3.	*Castanopsis hystrix*	Kiira	Whole plant.
4.	*Castanopsis indica*	Rahu kiira	Stem/branches.
5.	*Castanopsis tribuloides*	Korbing kiira	Stem/branches.
6.	*Chimonocalamus callosus*	Riijang	Culm.
7.	*Chimonocalamus griffithianus*	Tabiyo	Culm.

8.	*Dendrocalamus hamiltonii*	Yayi	Culm.
9.	*Ficus hookeriana*	Koa	Stem/branches.
10.	*Magnolia champaca*	Salyo	Stem/branches.
11.	*Magnolia oblonga*	Salyo	Stem/branches.
12.	*Phyllostachys bambusoides*	Bije	Culm.
13.	*Pinus wallichiana*	Pisa sati	Bark, cones, dried leaves, branches.
14.	*Quercus lamellosa*	Santii Sanii	Branches/stem.
15.	*Sagertia filiformis*	Miji	Branches/stem.

4.2.5. House building materials (non timber use):

As a NTFPs numbers of tree species were found in different uses as house building materials such as fibres for tying, wall partition, 14 plant species such as *Castanopsis armata, Castanopsis tribuloides, Magnolia champaca* etc were used as house building purposes (Table 4.2.5). The stem of these plants were used mainly as the post of the house whereas cane species like *Calamus acanthospathus, Plectocamia himalayana* were preferred for binding or tying and binding purposes. *Phyllostachys bambusoides, Dendrocalamus hamiltonii, Phragmites karka* etc. were used for making walls and flooring materials and sometimes were also used for roofing.

Table 4.2.5. List of plants used as house building materials.

Sl.No.	**Name of species**	**Local name**	**Parts used**
1.	*Calamus canthospathus*	Taser	Stem / branch.
2.	*Castanopsis armata*	Kira	Stem / branch.
3.	*Castanopsis tribuloides*	Korbing kira	Stem / branch.
4.	*Cephalostachyum mannii*	Tajer	Culm.
5.	*Chimonocalamus griffithianus*	Tabiyo	Culm.
6.	*Dendrocalamus hamiltonii*	Yayi byapu	Culm.
7.	*Lyonea ovalifolia*	Sarlang	Stem/branches.
8.	*Magnolia champaca*	Salyo	Stem / branch.
9.	*Magnolia oblonga*	Salyo	Stem / branch.

10.	*Pericampylus glaucus*	Rukki taru	Stem.
11	*Phragmites karka*	Pepu	Whole plant.
12.	*Phyllostachys bambusoides*	Bije	Culm.
13.	*Plectocomia himalayana*	Tarpi	Whole plant.
14.	*Quercus griffithi*	Sankhe, Santhii	Stem.

4.2.6. Fodder Plants:

During the study it was observed that the Apatani communities by and large rear Pigs only. Domestication of other animal was not recorded as common practices except in few instances. Very rarely they rear cattles. To feed the pigs they collect the leafy materials from 12 species where uses of 3 Araceae members under the genus *Colocassia* (2 spp.) and *Typhonium* (1 sp.) and species such as *Begonia obversa, Colocasia affinis, Dioscorea bulbifera, Gonostegia hirta, Persicaria barbata, Plantago erosa, Colocassia esculenta, Typhonium trilobatum, Cyathea gigantea and Phragmites karka* were used as fodder plants especially for pigs (Table 4.2.6). The leaves of these plants are collected, cut into pieces and boiled along with paddy husk for pigs.

Table 4.2.6. List of plants used as fodder.

Sl.No.	Name of species	Local name	Parts used
1.	*Begonia obversa*	Lukhu	Leaves.
2.	*Colocasia affinis*	Yarri	Leaves.
3.	*Colocasia esculenta*	Inge	Leaves.
4.	*Cyathea gigantea*	Tashe	Leaves and pith.
5.	*Dioscorea bulbifera*	Engin/ Hula	Leaves.
6.	*Dioscorea hamiltonii*	Engin	Leaves/whole plant.
7.	*Gonostegia hirta*	Hiipe Hamang	Leaves.
8.	*Persicaria barbata*	Luli	Leaves.
9.	*Phragmites karka*	Pepu	Leaves.
10.	*Plantago erosa*	Mepi	Leaves.
11.	*Rumex nepalensis*	Tajang liho	Leaves.
12.	*Typhonium trilobatum*	Roppu	Leaves/whole plant.

4.2.7. Plants used as Fiber:

Cane species such as *Calamus acantospathus*, *Calamus khasianus* and *Plectocamia himalayana* were reported to be some of the preferred species used as

fibre. The fibers were used for different purposes such as making different types of baskets for carrying grains, firewood, baskets used in fields, ceremonies etc. or for decorating or giving finishing touch to the baskets made. It is also plaited and used for making handle or straps of the baskets and also as binding material during house building. Besides the cane species, others such as *Pericampylus glaucus, Phyllostachys bambusoides* are also used as fiber (Table 4.2.7).

Table 4.2.7. List of plants used as fiber.

Sl.No.	Name of species	Local name	Uses
1.	*Calamus acanthospathus*	Taser	Stems used for making different baskets, housebuilding etc.
2.	*Calamus khasianus*	Tikhe	Stems used for making household items like rucksack, baskets etc.
3.	*Pericampylus glaucus*	Rukki taru	Stems used for tying material during house building and other works.
4.	*Plectocamia himalayana*	Tarpi	Stems used for making baskets, handles etc.
5.	*Phyllostachys bambusoides*	Bije	Stems used for binding during house building, used for decorating or giving finishing touch to baskets, etc.

4.2.8. Plants used for Household items:

Apatanis used certain plant species for making household items that are daily used at home for different purposes like *Phragmites karka* (used for making mat), *Eremocaulon capitatum* (making winnower), *Dendrocalamus hamiltonii, Phyllostachys bambusoides* (Culm used for making bamboo mug, spoons, basket for storing meat etc.). Cane species such as *Calamus acanthospathus* and *Calamus khasianus* used for making different baskets items like rucksack, baskets for carrying grains, clothes, firewood, etc. (Table 4.2.8).

4.2.9. Plants used for thatching and brooms:

Apatanis also use some NTFP species for roofing material such as the culm of *Phyllostachys bambusoides* were splitted in the middle for roofing, leaves of

Wallichia oblongifolia and bark of *Pinus wallichiana.* Young twigs of *Phyllostachys bambusoides* were also used as brooms in houses and in graneries. *Thysanolana maxima* are also used as brooms and these were mostly collected from the nearby areas of Ziro. (Table 4.2.9).

Table 4.2.8. List of plants used for house hold items.

Sl.No.	Name of species	Local name	Uses
1.	*Calamus acanthospathus*	Taser	For making different baskets.
2.	*Calamus khasianus*	Tikhe	Hosehold items like rucksack, baskets etc.
3.	*Dendrocalamus hamiltonii*	Yayi	Culm used for making bamboo mug, spoons etc.
4.	*Eremocaulon capitatum*	Yabiing	Culm used for filtering water, used for making winnower.
5.	*Phragmites karka*	Pepu	Leaves used for making mats.
6.	*Phyllostachys bambusoides*	Bije	Culm used for making spoons, basket for storing meat, bamboo mat etc.
7.	*Plectocamia himalayana*	Tarpi	Culm used for making haversack, baskets for rice storing, meat, etc.

Table 4.2.9. List of plants used as thatches and brooms.

Sl.No.	Name of species	Local name	Uses
1.	*Phyllostachys bambusoides*	Bije	Splitted culm used as roofing, young twigs with leaves used as broom.
2.	*Pinus wallichiana*	Pisa	Bark used as roofing.
3.	*Saccharum spontaneum*	Paelo	Leaves used for roofing.
4.	*Thysanolana maxima*	Ipinani	Dried leaves used as brooms.
5.	*Wallichia oblongifolia*	Tisse/Tashe	Leaves used for roofing.

4.2.10. Gums:

Uses of natural gum obtained from some specific plants for hunting and other large number of household activities was recorded. Four species were used for making gums (Table 4.2.10). These species were especially preferred for catching birds and other animals. The two parasitic angiospermic species *Balanophora dioica and Dendrophthoe falcata* growing in the forest are utilized by people especially for catching birds but over the years its number has hugely decreased and on verge of extinction. The rhizome of *Balanophora dioica* is collected washed and crushed into a paste till it becomes consistent and its sticky saps comes out. It is sometimes stored in a bamboo culm 'Sudu' for future use. In case of the other two species *Dendrophthoe falcata* and *Lasianthus longicauda* the small fruits are collected and put to boil in container till the hard cover of the seeds becomes soft. It is then put in cold water and smashed with hands and stored in a bamboo container wheras, incase of *Aspidopterys indica* the fibre or stem of the plant is cut into small pieces and the sap or liquid oozing out of it is collected for catching birds. The gum made of *Lasianthus longicauda* is mostly preferred by the community as it is the most effective.

Table 4.2.10. List of plants used as gums.

Sl.No.	Name of species	Local name	Parts used
1.	*Aspidopterys indica*	Tarru Payu	Stem
2.	*Balanophora dioica*	Kidi Payu	Rhizome
3.	*Dendrophthoe falcata*	Sani payu	Fruit
4.	*Lasianthus longicauda*	Santu Payu	Fruits, stems

4.2.11. Dye yielding plants:

The uses of plant species for extraction of dye is also found very unique in the Apatani culture. Although this practice is not so common anymore, some selective people still uses these natural colourant for colouring fabrics and other items. Four species namely *Rubia manjith*, *Begonia roxburghii*, *Eurya acuminata* and *Mahonia nepaulensis* were used for dying clothes mostly during the olden days. The stem, leaves, bark and tubers are found useful in extraction of the dye (4.2.11). The parts of these plants are collected and boiled till the desired colour is obtained and used for dying clothes.

Table 4.2.11. List of plants used as dye.

Sl.No.	Name of species	Local name	Uses
1.	*Begonia roxburghii*	Byukhu	Tuber boiled along with *Rubia Manjith* used for dying/colouring clothes.
2.	*Eurya acuminata*	Sankhii/ nausankhii	The leaves boiled along with *Rubia manjith*, water or starch used as dye.
3.	*Mahonia napaulensis*	Taaming	Bark is used for obtaining a deep yellow dye.
4.	*Rubia manjith*	Tiiming	Stem is used for dying traditional cloths.

4.2.12. Miscellaneous uses of plants:

Apart from the aforesaid specific uses some of the forest species are used for some other purposes like poison, trap, packaging, tattoing etc. Where only one or two specific plants were used. About 13 species are grouped in the miscellaneous category that include species like *Gnaphalium affine* (used for making fire), *Kavalama urens* (Packaging), *Juncus effesus* (used for tying vegetables), *Persicaria hydropiper* (fish poison), *Cinnamomum bejolghota* (used for making traditional umbrella), *Berberis wallichiana, Cirsium interpositum* (used for tattoing by the Apatani men and women), *Ligustrum ovalifolium*, *Symplocos paniculata* (used as fencing) (Table 4.2.12). Tattoo called as 'Tiipe' was done by collecting the thorns of *Berberis* or *Cirsium* and was tied to a bamboo stick in a bunch. A mixture of rice starch, bacon fats and the black ash deposited on cooking pots are prepared. A small strip of bamboo is dipped on it to mark the size of the tattoo required. The bunch of thorn is then slowly hammered on the face 2-3 times for better color. The starch helps in easy piercing on the skin and also gives relief from the pain, whereas the black ash gives dark colour to the tattoo. On drying it slowly turns to green. Among all these species, the use of *Kavalama urens* and *Juncus effesus* commonly for wrapping and tying of food items in household, during agricultural operations, forests work, festivals and rituals is a common practices of the people and hence the leaves and fiber of these species preferred by all. As per the information in the olden days the dried leaves of *Gnaphalium affine* with *Pinus wallichiana* were very commonly used to make fire. The dried leaves of *Gnaphalium affine* are rubbed between two flat stones for

lightening of fire when no fire sources were available. However, presently these species are used commonly as fuel.

Wild ornamental plants mostly for their flowers were preferred by the people and are occasionally used. Two species namely *Primula denticulata* and *Rhododendron arboreum* are used for their attractive flowers. The flowers of these species are collected during the flowering seasons and are used in decorative purposes.

Table 4.2.12. List of plants used in miscellaneous purposes.

Sl.No.	Name of species	Local name	Uses
1.	*Berberis wallichiana*	Tiipe tire/ Lobyo tire	Spines or thorns used for tattooing.
2.	*Cannabis sativa*	Bhang	The stem and leaves used for smokes.
3.	*Cinnamomum bejolghota*	Yatti /Sangin yanii	The leaves are used for making traditional rain shield 'Yatii'.
4.	*Cirsium interpositum*	Lobyo tire	Spines or thorns used for tattooing.
5.	*Dicranopteris linearis*	Takho	Stems are tied together like a long thread and used as traps for rodents.
6.	*Eremocaulon capitatum*	Yabiing	Culm used for filtering water Piece of culm also used for cutting umbilical cord of a new born baby.
7.	*Gnaphalium affine*	Miiyang	Dried leaves used for making fire.
8.	*Juncus effesus*	Mima	Leaves for tying vegetables, meat etc.
9.	*Kavalama urens*	Niji yanii	Leaves for wrapping different food items and covering local wine for fermentation.
10.	*Ligustrum ovalifolium*	Sankhan melyang	Used for fencing.
11.	*Persicaria hydropiper*	Roring	Leafy shoots as fish poison.
12.	*Primula denticulata*	Bagang-rinyo	Flower as ornamental.
13.	*Rhododendron arboreum*	Senyi apu	Flower as ornamental.
14.	*Symplocos paniculata*	Sankhi	Used for fencing.

4.3. Community structure, species composition and population status of NTFPs

4.3.1. Floristic diversity:

The community forests serving the sources of forest resources for the Apatani communities in Ziro Valley are found to be rich in flora with diversified species. The analysis of floristic diversity in the three selected study stands indicated occurrence of a total 138 species belonging to 70 families representing 116 genera. Out of these, 31 were tree species representing 27 genera under 17 families, 35 species were shrubs having 31 genera under 24 families and 72 herbs representing 56 genera under 41 families. List of family, genera and species of the selected study stands has been given in Table 4.3.1. Among the recorded 41 families, 3 are represented by Pteridophytes and one by Gymnosperm. Out of the 37 Angiospermic families, 8 belong to monocotyledons while the rests are dicotyledon. The 10 most dominant Angiospermic families are Araceae, Araliaceae Asteraceae Fagaceae, Lauraceae, Melastomataceae, Myrsinaceae, Rosaceae, Rutaceae and Urticaceae which comprises 3 or more than 3 species each. Asteraceae and Rosaceaeae exhibits maximum representation with 7 species each followed by Urticaceae with 4 species (Table 4.3.1). Among the dominant families Fagaceae, Lauraceae, Rosaceae and Rutaceae are also found to be important having NTFP yielding species. Besides Anacardiaceae Arecaceae, Liliaceae, Magnoliaceae, Moraceae, Piperaceae, Rubiaceae, Saururaceae, Zingiberaceae etc. are other important families with NTFP yielding species (Table 4.3.1).

4.3.2. Species richness:

Among the selected study stands Nyilii (Hong community forest) shows the highest number of species with 124 species representing 109 genera under 74 families, out of which 24 were tree species, 34 shrubs and 67 herbs (Table 4.3.2). In Dura (Hija community forest) a total of 101 species were found representing 89 genera and 64 families, out of which 21 were tree, 24 shrubs and 57 species of herbs. While Gyachi (Bulla community forest) showed least species richness with a total of 102 species representing 95 genera under 64 families where 23 species were trees 28 shrubs and 51 herbs (Table 4.3.2). In all the three forest stands, the diversity of herb species was maximum followed by shrubs and trees (Table 4.3.2).

Table 4.3.1. List of family, genera and species of the three selected study sites.

Family	No.of genera	No.of species	Family	No.of genera	No.of species
Acanthaceae	1	1	Melastomataceae	3	3
Actinidiaceae	1	2	Moraceae	1	2
Adoxaceae	1	1	Myricaceae	1	1
Anacardiaceae	2	2	Myrisinaceae	3	3
Apiaceae	2	2	Oleaceae	1	1
Araceae	2	5	Orchidaceae	2	2
Araliaceae	4	4	Oxalidaceae	1	1
Arecaceae	2	2	Pinaceae	1	1
Aristolochiaceae	1	1	Piperaceae	1	2
Asparagaceae	2	2	Plantaginaceae	1	2
Asteraceae	7	7	Poaceae	4	4
Athyriaceae	1	1	Polygalaceae	1	1
Balsaminaceae	1	2	Polygonaceae	2	2
Berberidaceae	3	3	Polypodiaceae	1	1
Betulaceae	2	3	Portulaceae	1	1
Bignoniaceae	1	1	Primulaceae	1	1
Caryophyllaceae	1	1	Pteridaceae	1	1
Dipteridaceae	1	1	Ranunculaceae	1	1
Eleagnaceae	1	3	Rosaceae	7	8
Ericaceae	1	1	Rubiaceae	2	2
Fabaceae	1	1	Rutaceae	1	2
Fagaceae	3	5	Sambucaceae	1	1
Gentianaceae	1	1	Saururaceae	1	1
Geraniaceae	1	1	Scrophulariaceae	2	2
Gleichinaceae	1	1	Selaginaceae	1	1
Hypoxidaceae	2	3	Smilaceae	1	1
Juglandaceae	1	1	Solanaceae	1	1
Lauraceae	5	5	Ternstrominaceae	1	1
Lindsaceae	1	1	Theaceae	2	2
Lomariopsidaceae	1	1	Thelypteridaceae	1	1
Loranthaceae	1	1	Thunbergiaceae	1	1
Lycopodiaceae	1	1	Urticaceae	5	7
Lythraceae	1	1	Verbenaceae	1	1
Magnoliaceae	1	2	Violaceae	1	1
Malvaceae	1	1	Zingiberaceae	1	2

4.3.3. Species Richness Index:

Menhinick species richness index was recorded highest at all layers in Nyilii stand while compared to Dura and Gyachi stands (Table 4.3.2). The Nyilii shrub layer indicated the highest value (2.55), followed by trees (2.25) and herbs (2.18), respectively. In Dura also the value for tree is higher (2.23), but followed by shrubs (1.78) and herbs (1.72). However, in Gyachi stand the species richness index is maximum for trees (2.17), followed by herb layer (2.03), and shrubs (1.74). The species richness index of the selected study sites shows the trend as Nyilii (Hong community forest): shrub > tree > herb; Dura (Hija community forest): tree > shrub > herb and Gyachi (Bulla community forest): tree > herb > shrub. The species richness index for tree layers in all the study stands exhibited almost similar while for shrubby layer the Nyilii stand showed much higher index. Among the herbaceous layers Dura stand showed the least species richness than Nyilii and Gyachi stands (Table 4.3.2).

4.3.4. Density:

The tree species density was recorded highest 456 individual's ha^{-1} in Nyilii (Hong community forest) followed by Dura (Hija community forest) with 424 individuals ha^{-1} and lowest (376 individuals ha^{-1}) in Gyachi (Bulla community forest) (Table 4.3.2, Figure 4.3.1, Annexure I). For shrubs the highest density was recorded in Dura with 3696 individuals ha^{-1} followed by Gyachi (3040 individuals ha^{-1}) and lowest in Nyilii (2848 individuals ha^{-1}) (Table 4.3.2, Annexure II). In case of herbaceous species the maximum stand density was recorded in Nyilii (36.64 individuals 100 m^{-2}) followed by Dura (35.12 individuals 100 m^{-2}) and minimum in Gyachi (31.44 individuals 100 m^{-2}) (Table 4.3.2, Annexure III). The forest canopy in all the selected forest stands is mostly composed of the tree species like *Alnus nepalensis, Castanopsis hystrix, Exbucklandia populnea*, *Lithocarpus dealbatus, Magnolia champaca*, *Myrica esculenta*, *Phoebe goalparensis*, *Pinus wallichiana Pyrus* sp., *Quercus lamellosa*, *Sauraria nepaulensis*. Among the tree species the density was found to be highest for *Alnus nepalensis, Castanopsis hytrix, Magnolia champaca*, *Pinus wallichiana* in all the three study stands with more than 20 individuals ha^{-1}. Although the density of *Callicarpa macrophylla* was recorded more than 20 individuals ha^{-1}, but found to be restricted to only in one stand i. e in Nyilii community forest. On the other hand species like *Betula alnoides, Camella lutescens,*

Quercus griffithii, *Quercus lamellosa*, *Juglans regia*, *Saurauria griffithii* exhibited the lowest density with less than 10 individuals ha $^{-1}$ in all the three stands (Annexure I). Among the shrubs, species like *Calamus acanthospathus*, *Laurocerasus undulata*, *Mahonia nepaulensis*, *Rubia manjith*, *Rubus ellipticus*, *Rubus rosaefolius*, *Strobilanthus helictus*, *Sambucus javanicus* etc. were recorded as densely occurring species in all the sites with more than 100 individuals ha^{-1}. *Chimonobambusa griffithianus* was also indicated higher density but only in two sites. Accordingly *Docynia indica*, *Elaeagnus caudate* and *Embelia ribes* were found occurring in only in one or two stands with limited density (Annexure II). For the herbaceous species the highest density was found for the species like *Amorphophalus* sp., *Athyrium* sp., *Cymbopogon* sp., *Fragaria vesca*, *Fagopyrum esculentum*, *Hydrocotyle* spp., *Houttuynia cordata*, *Impatiens urticifolia*, *Imperata* sp., *Lycopodium clavatum*, *Poa* sp., *Primula denticulata*, *Oenanthe javanica*, *Selaginella martensii*, *Urtica dioica* etc. on the ground level (Annexure III) with more than 6000 individuals ha^{-1}. The three grass species under the genera *Imperata*, *Poa* and *Cymbopogon* shows the maximum density among all the herbs in all the respective study stands with more than 12000 individuals ha^{-1}. However the species like *Crassocephalum* sp., *Galeola falconeri*, *Goodyera procera*, *Piper pedicellatum*, *Podophyllum hexandrum*, *Rotalia rotendifolia*, *Torenia asiatica*, *Viscum articulatum* exhibits the lowest density having less than 4000 individuals ha^{-1} and were not common in all the sites (Annexure III).

4.3.5. Basal area:

The total basal area was found to be highest in Dura (51.64 m^2 ha^{-1}) followed by Nyilii (25.32 m^2 ha^{-1}) and lowest in Gyachi (22.82 m^2 ha^{-1}) (Table 4.3.2, Figure 4.3.1, Annexure I). Tree species like *Castanopsis hystrix*, *Pinus wallichiana* and *Magnolia champaca* contributed the maximum basal area in all the three study stands with the value (5.44, 7.99, 3.68), (3.45, 5.86, 2.82) and (6.04, 11.77, 7.5), respectively. However the highest basal area was exhibited by *Magnolia champaca* in Dura (Hija community) forest with 11.77 m^2 ha^{-1} (Annexure I). Among the recorded tree species, *Brassiopsis glomerulata* which was occurring with low density (< 10 individuals ha^{-1}) was found with the least basal area in all the selected study stands (0.13, 0.04, 0.13 m^2 ha^{-1}). The other species which contributed with minimum

basal area were *Betula utilis*, *Camella lutescens*, *Eurea nitida*, and *Saurauria griffithii* that showed below 0.2 m^2 ha^{-1} (Annexure I).

Table 4.3.2. Species richness, density and basal area of trees, shrubs and herbs in the selected study sites.

Parameters /study sites	Nyilii	Dura	Gyachi
Trees			
Number of species	24	23	21
Number of genera	21	22	18
Number of family	15	14	12
Species richness index	2.25	2.23	2.17
Stand density (individuals ha^{-1})	456	424	376
Basal area (m^2 ha^{-1})	25.32	51.64	22.82
Shrubs			
Number of species	34	28	24
Number of genera	30	26	22
Number of family	21	19	17
Species richness index	2.55	1.78	1.74
Stand density (individuals ha^{-1})	2848	3696	3040
Herbs			
Number of species	66	51	56
Number of genera	58	47	49
Number of family	38	31	35
Species richness index	2.18	1.72	2.03
Stand density (individuals 100 m^{-2})	36.64	35.12	31.44

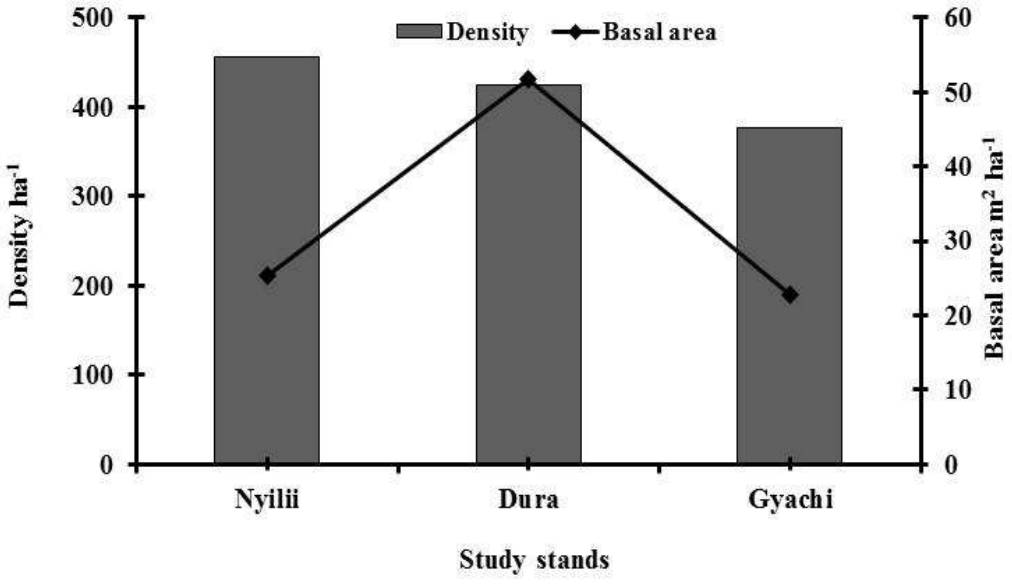


Figure 4.3.1. Stand density (individual's ha^{-1}) and basal area (m^2 ha^{-1}) of tree species in the selected study sites.

4.3.6. Dominance:

Based on the IVI the dominance of various species was calculated and the species with higher IVI values were the dominant species. Dominance-diversity curve for tree species showed that maximum IVI values in all the stands were mainly concentrated on few species (Figure 4.3.2). In Nyilii, species like *Magnolia champaca* (43.95), *Castanopsis hystrix* (40.9), *Pinus wallichiana* (25.5), *Exbucklandia populnea* (18.12), *Alnus nepalensis* (16.18), *Lithocarpus elegnus* (12.87), *Phoebe goalparensis* (11.93) were the main dominant tree species and *Strobilanthes helictus* (12.99), *Rubia manjith* (11.95), *Dipteris wallichi* (11.95), *Mahonia nepaulensis* (10.74) were the dominant shrubs while species like *Selaginella martensii* (5.34), *Oenanthe javanica* (4.80), *Fragaria vesca* (4.57), *Houttuynia cordata* (4.19), *Hydrocotyle sibthorpioides* (4.89) were the dominant herbs in the ground vegetation (Annexure I, II, III). In Dura, *Magnolia champaca* (39.24), *Pinus wallichiana* (30.62) and *Castanopsis hystrix* (28.89) *Rhus chinensis* (23.45), *Ficus auriculata* (21.5) and *Choerospondias axillaris* (13.69) were found as dominant tree species. The dominating shrub species are *Strobilanthes helictus* (14.22), *Rubus rosaefolius* (13.65), *Rubia manjith* (12.30), while *Houttuynia cordata* (6.91), *Lycopodium clavatum* (5.53), *Fragaria vesca* (5.27), *Fragaria vesca* (5.26), *Elatostema platyphyllum* (4.92) and *Selaginella martensii* (4.66) were the dominant herbs. In Gyachi forest also *Magnolia champaca* (54.28), *Castanopsis hystrix* (33.11), *Pinus wallichiana* (21.55), *Alnus nepalensis* (16.98), *Quercus griffithii* (16.29), *Pyrus pashia* (16.41), *Phoebe goalparensis* (11.87), *Exbucklandia populnea* (15.14) were found as the most dominant among the tree species. The shrubs species having maximum IVI includes *Strobilanthes helictus* (17.41), *Dipteris wallichi* (14.07), *Rubus rosaefolius* (10.73), *Maesia indica* (10.57). The herbaceous layer is dominated by *Houttuynia cordata* (7.16), *Dicranopteris linearis* (5.50), *Pteris vittata* (4.87) and *Pouzolzia hirta* (4.37) (Annexure I, II, III). Even though there were slight variations in the stand density but overall the most dominant tree species were found to be *Alnus nepalensis*, *Castanopsis hystrix*, *Exbucklandia populnea*, *Magnolia champaca* and *Pinus wallichiana* in all the selected study stands. Accordingly the *Mahonia nepalensis*, *Rubus rosaefolius*, *Rubia manjith* and *Strobilanthes helictus* were the dominant shrubs while *Houttuynia cordata*, *Elatostema platyphyllum* and *Oenanthe javanica* were the dominant herbs common to all the sites (Annexure II, III).

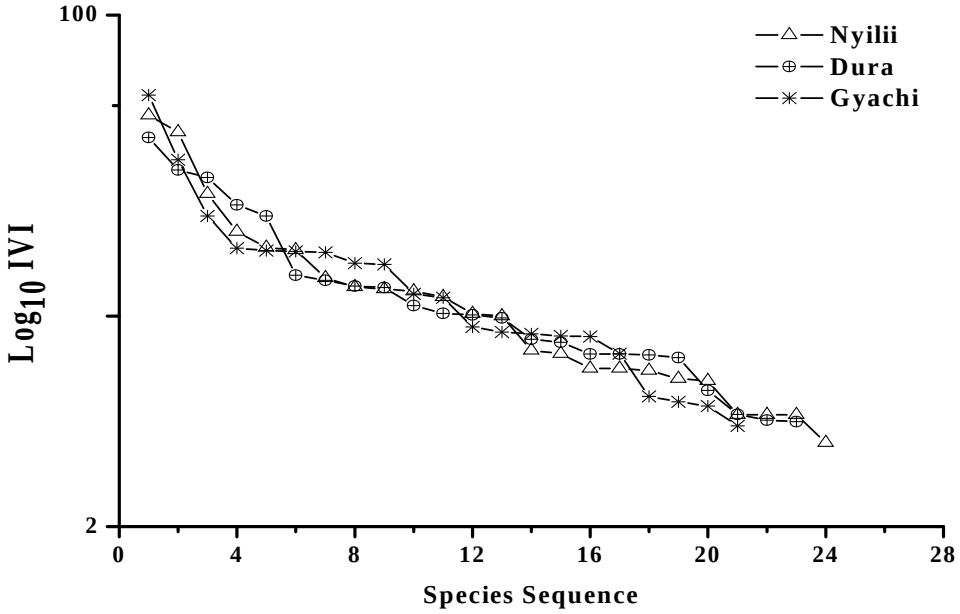


Figure 4.3.2. Dominance-diversity curve of tree species of the selected study sites. (Species sequence are given in Annexure I,II,III).

4.3.7. Diversity indices:

Shannon Weiner diversity index was found higher for shrub and herb layers in Nyilii except tree layer which was found highest in Dura (2.93). The diversity index for tree shrubs and herbs were recorded as 2.92, 3.42 and 3.97, respectively. In Dura the diversity index was 2.93, 3.27 and 3.749, while in Gyachi the values were found as 2.82, 3.09 and 3.85 for trees shrubs and herbs, respectively (Table 4.3.3).

Table 4.3.3. Diversity patterns of species in the three study sites.

Parameters /study sites	Nyilii	Dura	Gyachi
Trees			
Shannon diversity index	2.92	2.93	2.82
Simpson dominance index	0.07	0.06	0.08
Pielou's evenness index	0.92	0.93	0.92
Shrubs			
Shannon diversity index	3.42	3.27	3.09
Simpson dominance index	0.04	0.04	0.05
Pielou's evenness index	0.97	0.99	0.97
Herbs			
Shannon diversity index	3.97	3.75	3.85
Simpson dominance index	0.02	0.03	0.03
Pielou's evenness index	0.95	0.95	0.95

Among the three different habitats the diversity of herbs were found high followed by shrubs and trees indicating the rich diversity and dominance of herbaceous species. The species diversity indices showed the trend, herbs > shrubs > trees (Figure 4.3.3).

Simpson's dominance index for trees, shrubs and herbs were recorded highest in Gyachi 0.08, 0.05 and 0.03, respectively (Table 4.3.3). Simpson's dominance index for trees was highest in Gyachi (0.08) lowest in Dura (0.06), while in case of shrubs it was recorded highest in Gyachi (0.08) and lowest in both Nyilii (0.04) and Dura (0.04). For herbs, dominance index was highest in both Gyachi (0.03) and Dura (0.03) and lowest in case of Nyilii (0.02). Dominance index showed the trend as trees > shrubs > herbs (Figure 4.3.3).

Pielou's evenness index for trees, shrubs and herbs were recorded highest in Dura 0.93, 0.99 and 0.95, respectively. However, it was recorded highest for trees in Dura (0.93) and lowest in both Nyilii (0.92) and Gyachi (0.92) (Table 4.3.3). On the other hand, it was recorded maximum for shrubs in Dura (0.99) and minimum in both Nyilii (0.97) and Gyachi (0.97). The evenness index for herbaceous species showed similar value in all the selected study stands. The evenness index showed the trend as shrubs > herbs > trees (Figure 4.3.3).

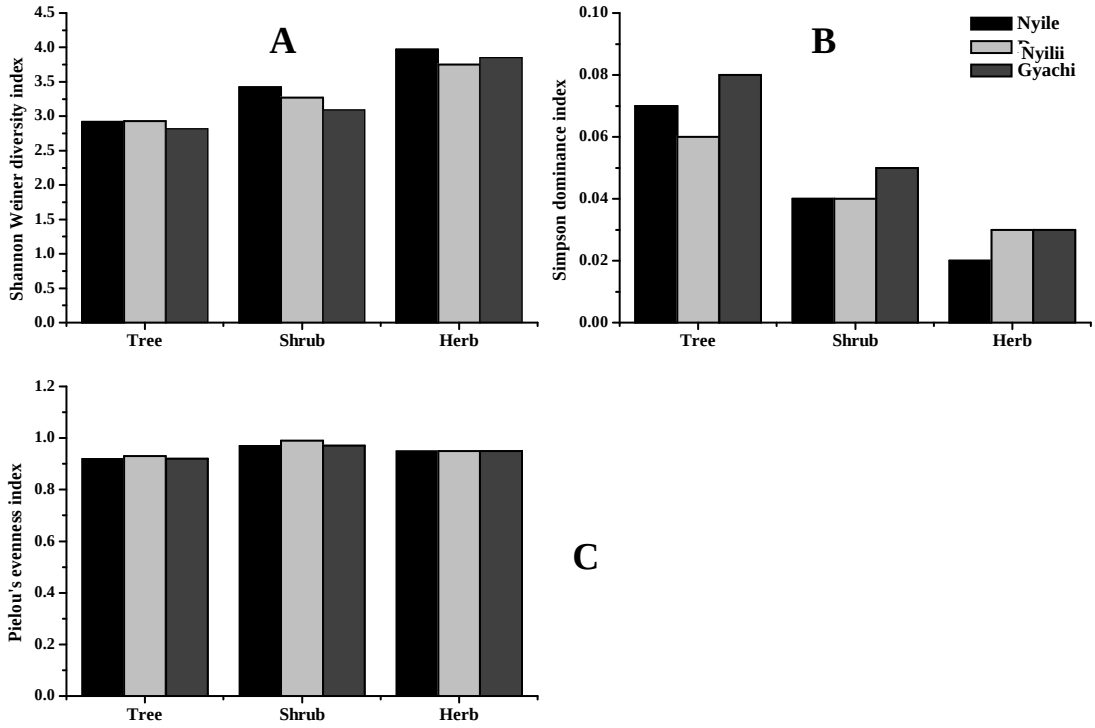


Figure 4.3.3. A, B, C. Diversity, dominance and evenness indices of life forms in the selected study sites.

4.3.8. Similarity index:

Overall Similarity index was highest between the plant species of Dura and Gyachi (82.35%) while lowest between the Nyilii and Dura (78.76%) study sites (Table 4.3.4). The value of similarity for tree species was maximum between the Nyilii and Gyachi Camp (75.56%) and minimum between Nyilii and Dura (68.09%). Shrub species showed maximum similarity index between Dura and Gyachi (88.46%) while it was least between Nyilii and Dura (77.42%) study sites. Herbaceous species exhibited higest between Nyilii and Gyachi (86.89%), while least similarity index was observed between Nyilii and Dura (78.63%) (Table 4.3.4).

Table 4.3.4. Sorenson's similarity index for different components of the selected study sites.

Study site /Habit		Gyachi				Dura				Nyilli			
		A	T	S	H	A	T	S	H	A	T	S	H
Nyilli	A	81.42	-	-	-	-	-	-	-	-	-	-	-
	T	-	75.56		-	-	-	-	-	-	-	-	-
	S	-	-	79.31	-	-	-	-	-	-	-	-	-
	H	-	-	-	86.89	-	-	-	-	-	-	-	-
Gyachi	A	-	-	-	-	82.35		-	-	-	-	-	-
	T	-	-	-	-		72.73	-	-	-	-	-	-
	S	-	-	-	-	-	-	88.46	-	-	-	-	-
	H	-	-	-	-	-	-	-	85.98	-	-	-	-
Dura	A	-	-	-	-	-	-	-	-	78.76	-	-	-
	T	-	-	-	-	-	-	-	-	-	68.09	-	-
	S	-	-	-	-	-	-	-	-	-	-	77.42	-
	H	-	-	-	-	-	-	-	-	-	-	-	78.63

A – All species, T – Trees, S – Shrubs, H – Herbs.

4.3.9. Distribution pattern:

Out of the total recorded tree species 79.17% of the species showed clumped distribution in Nyilii while 20.83% exhibited random distribution. Conversely, 78.26% of the tree species exhibited clumped distribution and 13.04% showed random distribution in Dura stand. Whereas 85.71% of the tree species showed clumped distribution and 14.29% of the species exhibited random distribution in Gyachi. However, not a single species showed regular distribution in the selected study stands (Figure 4.3.4).

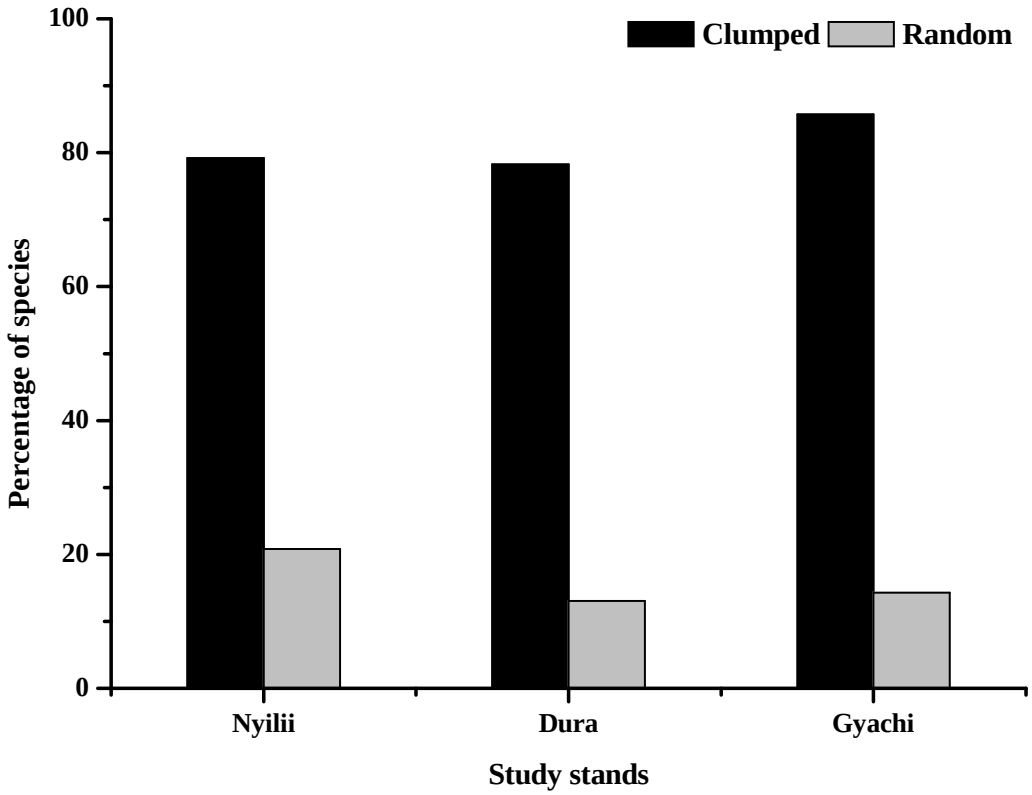


Figure 4.3.4. Distribution pattern of tree species in the selected study sites.

4.3.10. Population status of NTFP species:

The detailed phytosociological analysis in the selected study stands reveals the occurrence of more than 60 NTFP yielding species where 50 important NTFP yielding species which are being used commonly by the local communities (Table 4.3.5). Out of the total recorded plant species, trees are represented by 17 (55%) species, shrubs by 14 (40%) species and herbs by 19 (26%) species (Figure 4.3.5). Whereas, overall 36% of the total plant species are used by the Apatani people for their day to day life (Figure 4.3.5). Among the tree except *Castanopsis armata*, *Pyrus pashia*, *Rhus chinensis*, *Magnolia oblonga* all other were found to be distributed in all the three stands. As already presented in community structure the *Magnolia champaca*, *Castanopsis hystrix* and *Pinus wallichiana* are found to be dominated in all the three study stands with higher population density (> 25 individuals ha^{-1}). *Magnolia champaca* showed highest density (> 35 individuals ha^{-1}) and IVI (> 40) in all the selected study stands. However, in Dura stand the density have been found highest for *Pinus wallichiana* (48 individuals ha^{-1}) higher than *Magnolia champaca* (36 individuals ha^{-1}). Among the other important NTFP tree species the

Choerospondias axillaris the fruit yielding species and *Cinnamomum bejolghota* a ritually important species have been found in all the study stands but with comparatively lower density (< 16 individuals ha^{-1} and < 15 individuals ha^{-1}, repectively). The lowest density (8 individuals ha^{-1}) and IVI (6.44) were recorded for *Quercus lamellosa*. The rich diversity of tree NTFPs species were found highest in Gyachi and Dura and lowest in Nyilii stand. The four species which are used as NTFP for their fruits namely *Castanopsis armata*, *Litsea cubeba*, *Pyrus pashia*, *Rhus chinensis* were not recorded from the Nyilii study stand. *Litsea cubeba* a commercially potential medicinal tree was found with density of 28 and 16 individuals ha^{-1}. Like wise, *Pyrus pashia* extensively used for its tasty edible fruits showed a lower density with 12 and 20 individuals ha^{-1} in Dura and Gyachi, respectively. Among the selected study stands the lowest density and IVI was observed in *Juglans regia* (8 individuals ha^{-1} and IVI 4.72). When the IVI was calculated for all the species the highest IVI was found for *Magnolia champaca* in all the study sites (54.2 in Gyachi, followed by 46.5 in Nyilii and 39.2 in Dura) followed by *Castanopsis hystrix* (40.9 in Nyilii) and *Pinus wallichiana* (30.62 in Dura) (Table 4.3.5). The other species found with IVI value > 18 are *Alnus nepalensis*, *Ficus auriculata* and *Rhus chinensis*. The calculated basal area indicated that *Magnolia champaca* posses the maximum basal area in all the stands (6.04, 11.77, and 7.5 in Nyilii, Dura, and Gyachi, respectively) followed by *Castanopsis hystrix* (5.44, 7.99 and 3.68) and *Pinus wallichiana* (3.45, 5.86 and 2.82). It is interesting to note that the basal area for all these three species found higher in Dura study sites than the other study stands (Annexure I).

Among the shrubby NTFP yielding species many socioeconomically important species like *Berberis wallichiana*, *Calamus acanthospathus*, *Chimonobambusa griffithianus*, *Rubia manjith*, *Rubus* sp. were found to occur in the selected forests stands of study area. Species with higher density and IVI are *Calamus acanthospathus*, *Rubia manjith*, *Rubus rosaefolius* and *Strobilanthus helictus*. *Rubia manjith* one of the economically valuable plants extracted for dye was found with better density of distribution and IVI in all the three sites having highest value in Dura forest stand (272 individuals h^{-1} and IVI 12.3) (Table 4.3.5). However the maximum density among all the species was indicated by *Strobilanthus helictus* a medicinally important plant with 304 individuals ha^{-1} each in stand Dura and Gyachi.

Chimonobambusa griffithianus and *Wallichia oblongifolia* important NTFPs for the livelihood support for the community were found in all the three sites with comparatively lower population density. The density of *Chimonobambusa griffithianus* was highest in stand Dura (160 individuals ha^{-1}) followed by stand Gyachi (96 individuals ha^{-1}) and stand Nyilii (32 individuals ha^{-1}), while for *Wallichia densiflora* the density was highest in Dura and Gyachi stands (64 individuals ha^{-1} each) and lowest in Nyilii stand (32 individuals ha^{-1}) (Table 4.3.5). Another socio-economically feasible species and the only cane recorded in the study sites the *Calamus acanthospathus* was found with (96 to 128 individuals ha^{-1}). Among the shrubby layer, occurrence of other high value medicinal species namely *Berberis wallichiana, Embelia ribes*, *Mahonia nepaulensis* and *Zanthoxylum acanthopodium* were recorded with different population status. *Embelia ribes* was only distributed in Nyilii with comparatively low density (64 individuals ha^{-1}) (Table 4.3.5).

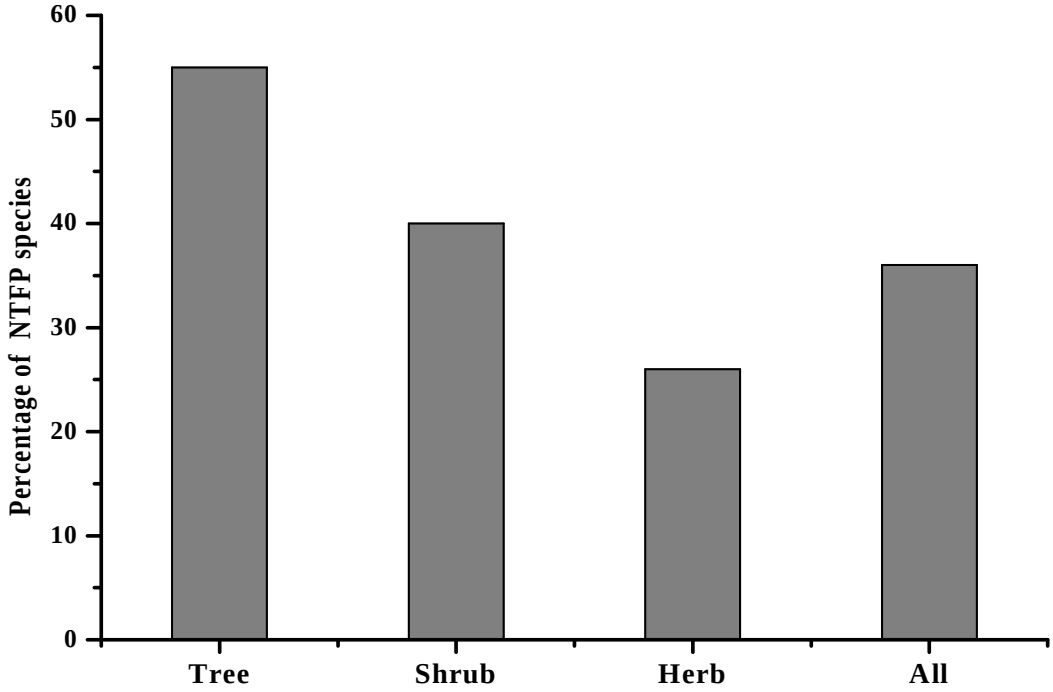


Figure 4.3.5. Habitat forms of major NTFP species used by the Apatanis in the selected study sites.

Many economically important herbs used as NTFP species were recorded in the present study. Out of about 50 herbaceous species more than 20 important NTFP yielding species were recorded in different study stands. Species like *Crassocephalum crepidioides*, *Diplazium esculentum, Elatostema platyphyllum, Houttuynia cordata, Oenanthe javanica, Pouzolzia hirta* which are used as vegetables are found to be

growing in all the selected study stands (Table 4.3.5). Among which *Houttuynia cordata* exhibits highest density with more than 12000 individuals ha^{-1} followed by *Oenanthe javanica* (> 6000 individuals ha^{-1}), *Diplazium esculentum* (> 5000 individuals ha^{-1}), *Pouzolzia hirta* (> 4000 individuals ha^{-1}), *Elatostema platyphyllum* (> 6000 individuals ha^{-1}). Besides, the *Fragaria vesca* another important NTFP yielding species have been found in all the three stands with > 6000 individual's ha^{-1} (Table 4.3.5). Among the selected study sites, the stand Dura have been found a comparatively a better habitat for herbaceous NTFPs where the density of majority of the species is found with higher value. The important vegetable plant *Piper pedicellatum* which is being mostly preferred by the communities have been found only in the Dura but with very low population density (2000 individuals ha^{-1}). *Podophyllum hexandrum* an important commercially high value medicinal plant was recorded only from the Nyilii study stand with lowest density among all the species (800 individuals ha^{-1}) (Table 4.3.5). The occurrence of some other important species like *Fagopyrum esculentum, Plantago erosa, Piper hamiltonii* and *Portulaca oleracea* in Nyilii stand exhibited that the diversity of distribution of important herbaceous NTFP is higher in Nyilii study stand in comparison to Dura and Gyachi. *Swertia angustifolia* another high value medicinal plant was recorded from all the sites having density of 2000 to 5000 individuals ha^{-1}. Based on the IVI value the *Houttuynia cordata* was found be most dominat NTFP species in all the study sites (4.19, 6.91 and 7.16, respectively). The IVI value of *Piper hamiltonii* and *Podophyllum hexandrum* was found < 2 indicating the least dominant species (Table 4.3.5).

Table 4.3.5. Density (individual's ha^{-1}) and IVI of various NTFPs species recorded from the the three study sites.

Sl. No.	Plant species	Habit	Nyilii		Dura		Gyachi	
			Density	IVI	Density	IVI	Density	IVI
1.	*Alnus nepalensis* D.Don	Tree	28	16.16	24	12.47	24	16.98
2.	*Castanopsis armata* (Rox.) Spach	Tree	-	-	20	12.61	12	8.56
3.	*Castanopsis hystrix* Hook. f. & Thomson ex A.DC	Tree	44	40.9	28	28.89	36	33.11
4.	*Choerospondias axillaris* (Roxb.)	Tree	12	6.1	24	13.69	12	9.21
5.	*Cinnamomum bejolghota* (Buch.-Ham.) Sweet	Tree	28	15.86	16	9.87	8	5.04
6.	*Exbucklandia populnea* (R.Br.ex Griff.) R. W. Br	Tree	24	18.12	16	10.1	20	15.14
7.	*Ficus auriculata* Corner	Tree	12	6.37	8	21.5	4	4.33
8.	*Juglans regia* Linn.	Tree	12	7.36	8	4.72	-	-
9.	*Litsea cubeba* (Lour.)Pers.	Tree	-	-	28	13.16	16	11.52
10.	*Magnolia champaca* (L.) Baill. ex Pierre	Tree	52	43.95	36	39.24	48	54.28
11.	*Magnolia oblonga* (Wall. ex Hook.f. & Thomson) Figlar	Tree	12	7.20	-	-	12	8.60
12.	*Myrica esculenta* Buch.-Ham. ex D.Don	Tree	20	11.93	12	8.19	8	5.42
13.	*Phoebe goalparensis* Hutch.	Tree	20	11.93	-	-	16	11.87
14.	*Pinus wallichiana* A.B.Jackson	Tree	28	24.11	48	30.62	16	21.55
15.	*Pyrus pashia* Buch.-Ham. ex D.Don	Tree	-	-	12	7.28	20	16.41
16.	*Quercus lamellosa* J.E.Smith	Tree	8	5.86	-	-	-	-
17.	*Rhus chinensis* var. *roxburghii* (DC) Rehder	Tree	-	-	24	23.45	12	8.74
18.	*Berberis wallichiana* DC	Shrub	80	5.93	80	5.16	80	6.34
19.	*Calamus acanthospathus* Griff.	Shrub	128	8.66	96	6.60	128	9.15
20.	*Chimonobambusa griffithianus* (Munro) Hseueh & T.P. Yi	Shrub	32	3.21	160	8.32	96	6.86
21.	*Embelia ribes* Burm.f.	Shrub	64	4.33	-	-	-	-
22.	*Ficus sarmentosa* Buch -Ham. ex. J. E. Sm.	Shrub	80	5.93	128	7.46	96	6.86
23.	*Mahonia nepaulensis* DC.	Shrub	128	10.74	208	9.63	176	10.73
24.	*Rubia manjith* Roxburgh ex Fleming	Shrub	192	11.95	272	12.3	256	14.59

25.	*Rubus ellipticus* Smith	Shrub	64	3.29	160	8.33	64	3.34
26.	*Rubus rosaefolius* Smith. ex. Baker	Shrub	176	10.35	320	13.65	176	10.73
27.	*Schefflera elliptica* (Blume) Harms	Shrub	64	5.37	64	4.73	48	5.28
28.	*Strobilanthus helictus* T. Anderson	Shrub	192	12.99	304	14.22	304	17.41
29.	*Wallichia oblongiflora* Griff.	Shrub	32	3.21	64	4.73	-	-
30.	*Zanthoxylum acanthopodium* DC.	Shrub	64	5.37	64	4.73	96	6.86
31.	*Zanthoxylum oxyphyllum* Edgeworth	Shrub	80	5.93	80	5.16	112	7.39
32.	*Athyrium* sp.	Herb	8000	4.13	5200	3.40	3200	2.87
33.	*Crassocephalum crepipioides* (Benth.) S. Moore	Herb	2400	1.82	-	-	4000	3.12
34.	*Dicranopteris linearis* (Burman f.) L.M.Underwood	Herb	2400	1.82	5600	3.52	6800	5.50
35.	*Diplazium esculentum* (Retzius) Swartz	Herb	6800	3.80	4000	2.68	2400	1.87
36.	*Elatostema platyphyllum* H.A.Weddell.	Herb	3600	1.76	9200	4.93	3600	1.89
37.	*Fagopyrum esculentum* Moench.	Herb	6000	3.19	-	-	-	-
38.	*Fragaria vesca* Linn.	Herb	9600	4.57	10400	5.27	6400	3.89
39.	*Houttuynia cordata* Thunberg	Herb	6800	4.19	14800	6.91	13200	7.16
40.	*Molineria capitulata* (Lour.) Herb.	Herb	7200	4.30	2800	1.95	4000	3.49
41.	*Oenanthe javanica* (Bl.) DC.	Herb	7600	4.80	6800	4.24	5600	4.00
42.	*Oxalis corniculata* Linn.	Herb	3600	2.15	2400	1.45	-	-
43.	*Piper hamiltonii* C.DC	Herb	2000	0.93	2000	1.72	-	-
44.	*Piper pedicelletum* C.DC	Herb	-	-	2000	1.72	-	-
45.	*Plantago erosa* Wall.in Roxb	Herb	4400	2.76	6800	4.24	3600	2.63
46.	*Podophylum hexandrum* Royle	Herb	800	1.00	-	-	-	-
47.	*Portulaca oleracea* Linn.	Herb	4400	2.37	-	-	2800	2.00
48.	*Pouzolzia hirta* Blume ex Hassk.	Herb	4400	3.15	6000	4.40	5600	4.37
49.	*Primula denticulata* J. E.Smith	Herb	6000	3.58	6000	3.25	6000	3.39
50.	*Swertia angustifolia* Buch.-Ham.ex D.Don.	Herb	2000	2.10	3600	2.95	4800	4.49

Annexure I. Density (individual's ha^{-1}), basal area (m^2 ha^{-1}) and IVI of tree species in selected study sites.

SL. No.	Tree species	Family	Nyilii			Dura			Gyachi		
			D	BA	IVI	D	BA	IVI	D	BA	IVI
1.	*Alnus nepalensis* D.Don	Betulaceae	28	1.16	16.16	24	0.58	12.47	24	1.01	16.98
2.	*Betula alnoides* Buch.-Ham. ex D.Don.	Betulaceae	8	0.16	4.56	8	0.57	5.26	-	-	-
3.	*Betula* utilis D.Don	Betulaceae	-	-	-	16	0.16	7.49	-	-	-
4.	*Brassiopsis glomarulata* (Blume) E.A.V.Regel	Araliaceae	12	0.13	6.41	16	0.04	8.40	8	0.14	5.19
5.	*Callicarpa macrophylla* M.Vahl	Verbenaceae	28	0.33	11.79	-	-	-	-	-	-
6.	*Camellia lutescens* Dyer	Theaceae	8	0.19	3.59	-	-	-	-	-	-
7.	*Castanopsis armata* (Roxburgh) Spach	Fagaceae	-	-	-	20	1.14	12.61	12	0.38	8.56
8.	*Castanopsis hystrix* Hooker f. & Thomson ex A.DC	Fagaceae	44	5.44	40.91	28	7.99	28.89	36	3.68	33.11
9.	*Choerospondias axillaris* (Roxb.) B.L.Burtt & A.W.Hill	Anacardiaceae	12	0.27	5.87	24	1.80	13.69	12	0.81	9.21
10.	*Cinnamomum bejolghota* (Buch.-Ham.) Sweet.	Lauraceae	28	0.81	15.86	16	0.80	9.87	8	0.10	5.04
11.	*Eurya nitida* P.W.Korthals	Theaceae	8	0.15	4.52	8	0.16	4.47	-	-	-
12.	*Exbucklandia populnea* (R. Br.ex Griff.) R. W. Br	Lauraceae	24	1.88	18.12	16	0.92	10.10	20	0.83	15.14
13.	*Ficus auriculata* Corner	Moraceae	12	0.12	6.37	8	8.98	21.55	8	0.22	4.33
14.	*Heteropanax* sp.	Araliaceae	-	-	-	8	0.16	4.47	-	-	-
15.	*Juglans regia* Linn.	Juglandaceae	12	0.37	7.36	8	0.29	4.72	-	-	-
16.	*Lithocarpus elegans* (Blume) Soepadmo	Fagaceae	20	0.77	12.87	-	-	-	12	0.45	8.87
17.	*Litsea cubeba* (Lour.) Pers	Lauraceae	-	-	-	28	0.45	13.16	16	0.53	11.52
18.	*Magnolia champaca* (Linn.) Baill. ex Pierre	Magnoliaceae	52	6.04	43.95	36	11.77	39.24	48	7.50	54.28
19.	*Magnolia oblonga* (Wall. ex Hooker.f. & Thomson) Figlar	Magnoliaceae	12	0.33	7.20	-	-	-	12	0.39	8.60
20.	*Myrica esculenta* Buch.-Ham. ex. D.Don	Myricaceae	20	0.34	11.16	12	1.01	8.20	8	0.19	5.43
21.	*Persea* sp.	Lauraceae	-	-	-	20	0.44	10.11	-	-	-
22.	*Phoebe goalparensis* Hutch.	Lauraceae	20	0.81	11.93	-	-	-	16	0.61	11.87

23.	*Pinus wallichiana* A. B. Jackson	Pinaceae	28	3.45	24.11	48	5.86	30.62	16	2.82	21.55
24.	*Pterospermum acerifolium* (Linn.)Willd.	Malvaceae	16	1.08	11.03	-	-	-	-	-	-
25.	*Pyrus pashia* Buch.-Ham.ex D.Don.	Rosaceae	-	-	-	12	0.54	7.28	24	0.88	16.41
26.	*Quercus griffithii* Hook.f. & Thomson ex Miq.	Fagaceae	8	0.14	4.48	8	0.78	5.67	24	0.57	16.29
27.	*Quercus lamellosa* Smith	Fagaceae	8	0.49	5.86	-	-	-	-	-	-
28.	*Rhus chinensis* Mill.	Anacardiaceae	-	-	-	24	6.25	23.45	12	0.42	8.74
29.	*Saurauia napaulensis* DC.	Actinidiaceae	20	0.28	9.84	24	0.33	10.84	28	0.38	16.52
30.	*Saurauria griffithii* Dyer	Actinidiaceae	12	0.14	6.45	-	-	-	12	0.14	7.51
31.	*Schima wallichii* Choisy	Ternstrominaceae	16	0.44	9.59	12	0.62	7.44	20	0.77	14.87
	Total		**456**	**25.32**	**300**	**424**	**51.64**	**300**	**376**	**22.82**	**300**

Annexure II. Density (individuals ha^{-1}) and IVI of shrub species recorded in selected study sites.

Sl. No.	**Shrub species**	**Family**	**Nyilii**		**Dura**		**Gyachi**	
			Density	**IVI**	**Density**	**IVI**	**Density**	**IVI**
1.	*Berberis wallichiana* DC	Berberidaceae	80	5.93	80	5.16	80	6.34
2.	*Calamus acanthospathus* Griffith	Arecaceae	128	8.66	96	6.60	128	9.15
3.	*Chimonocalamus griffithianus* (Munro) Hsueh & T.P.Yi	Poaceae	32	3.21	160	8.33	96	6.86
4.	*Crotalaria pallida* W. Aiton	Fabaceae	48	3.77	112	7.03	80	7.57
5.	*Dipteris wallichii* (R.brown) T.Moore	Dipteridaceae	192	11.95	192	10.19	240	14.07
6.	*Docynia indica* (Wallich) Decne.	Rosaceae	32	3.21	-	-	-	-
7.	*Elaeagnus caudata* Sch. ex Momi.	Elaeagnaceae	48	4.81	-	-	-	-
8.	*Elaeagnus pyriformis* Hook. f.	Elaeagnaceae	48	3.77	80	5.16	32	3.52
9.	*Elaeagnus* sp.	Eleagnaceae	96	7.54	-	-	-	-
10.	*Embelia ribes* Burm.f	Myrsinaceae	64	4.33	-	-	-	-
11.	*Ficus sarmentosa* Buch -Ham. ex. J. E. Sm.	Moraceae	80	5.93	128	7.46	96	6.86
12.	*Laurocerasus undulata* (Buch.-Ham. ex D.Don) Roemer	Rosaceae	112	7.06	-	-	64	4.57

13.	*Ligustrum* sp.	Oleaceae	-	-	144	7.90	160	8.97
14.	*Maesa indica* (Roxb.) A.D.C	Myrsinaceae	16	1.60	112	6.03	96	10.57
15.	*Mahonia napaulensis* DC.	Berberidaceae	128	10.74	208	9.63	176	10.73
16.	*Melastoma malabathricum* Linn.	Melastomataceae	80	4.89	112	6.03	-	-
17.	*Mussaenda treutleri* Stapf	Rubiaceae	64	5.37	64	4.73	96	8.10
18.	*Myrsine semiserrata* Wall.	Myrsinaceae	80	3.85	96	4.60	80	3.87
19.	*Osbeckia nutans* Wallich ex C.B.Clarke	Melastomataceae	80	5.93	144	7.90	160	8.97
20.	*Photinia integrifolia* Lindl.	Rosaceae	80	4.89	96	5.60	80	5.10
21.	*Polygala arillata Buch.*-Ham. ex D. Don	Polygalaceae	32	3.21	-	-	-	-
22.	*Rosa brunonii* Lindley	Rosaceae	48	2.73	80	4.16	-	-
23.	*Rubia manjith* Roxb. ex Fleming	Rubiaceae	192	11.95	272	12.36	256	14.59
24.	*Rubus ellipticus* Smith	Rosaceae	64	3.29	160	8.33	64	3.34
25.	*Rubus rosaefolius* Smith ex Baker	Rosaceae	176	10.35	320	13.66	176	10.73
26.	*Sambucus javanica* Blume	Adoxaceae	96	6.50	128	7.46	-	-
27.	*Schefflera elliptica* (Blume) Harms.	Araliaceae	64	5.37	64	4.73	48	5.28
28.	*Smilax* sp.	Liliaceae	64	4.33	112	5.03	-	-
29.	*Strobilanthus helictus* T. Anderson	Acanthaceae	192	12.99	304	14.23	304	17.41
30.	*Thunbergia coccinea* Wallich	Acanthaceae	80	4.89	-	-	-	-
31.	*Vaccinium* sp.	Ericaceae	80	4.89	128	6.46	160	8.97
32.	*Viburnum nervosum* D. Don	Adoxaceae	96	7.54	96	6.60	160	10.20
33.	*Wallichia oblongifolia* Griffith	Arecaceae	32	3.21	64	4.73	-	-
34.	*Zanthoxylum acanthopodium* DC	Rutaceae	64	5.37	64	4.73	96	6.86
35.	*Zanthoxylum oxyphyllum* Edgeworth	Rutaceae	80	5.93	80	5.16	112	7.39
	Total		**2848**	**200**	**3696**	**200**	**3040**	**200**

Annexure III. Density (individuals ha^{-1}) and IVI of herbaceous species in selected study sites.

Sl. No.	Herb species	Family	Nyilii		Dura		Gyachi	
			Density	IVI	Density	IVI	Density	IVI
1.	*Amorphophallus* sp.	Araceae	7200	3.91	6800	3.47	2800	2.37
2.	*Arisaema consanguineum* H.G.Schott.	Araceae	4400	2.76	6000	4.40	2800	2.37
3.	*Arisaema erubescens* (Wallich).H.G.Schott	Araceae	5200	2.98	-	-	-	-
4.	*Arisaema intermedium* Blume	Araceae	1600	1.60	-	-	2000	1.75
5.	*Arisaema jacquemontii* Blume	Araceae	4000	2.65	1600	1.99	2800	2.37
6.	*Aristolochia* sp.	Aristolochiaceae	1200	1.11	-	-	-	-
7.	*Athyrium* sp.	Athyriaceae	8000	4.13	5200	3.40	3200	2.87
8.	*Bignonia* sp.	Bignoniaceae	2400	1.82	-	-	-	-
9.	*Christella parasitica* (Linn.) Holttum	Thelypteridaceae	5200	3.36	-	-	3200	2.87
10.	*Crassocephalum crepidioides* (Benth.) S.Moore	Asteraceae	2400	1.82	-	-	4000	3.12
11.	*Molineria capitulata* (Lour.) Herb.	Hypoxidaceae	5600	3.08	5600	3.13	4400	2.88
12.	*Curculigo orchioides* Gaertn.	Hypoxidaceae	6400	3.69	4000	3.06	3600	2.63
13.	*Cymbopogon* sp.	Poaceae	32400	13.12	-	-	41600	17.68
14.	*Dicranopteris linearis* (Burm. f.) Underw.	Gleicheniaceae	2400	1.82	5600	3.52	6800	5.50
15.	*Dicrocephala bicolor* (Roth) Sch.	Asteraceae	2000	1.32	2000	1.34	4000	2.75
16.	*Diplazium esculentum* (Retz.) Sw.	Athyriaceae	6800	3.80	4000	2.68	2400	1.87
17.	*Elatostema platyphyllum* H.A.Weddell.	Urticaceae	3600	1.76	9200	4.93	3600	1.89
18.	*Elatostema* sp.	Urticaceae	6000	3.19	5200	2.63	4400	3.25
19.	*Erigeron bonariensis* Linn.	Asteraceae	5200	3.36	6400	4.90	3600	2.63
20.	*Fagopyrum esculentum* Moench	Polygonaceae	6000	3.19	-	-	-	-
21.	*Fragaria vesca* Linn.	Rosaceae	9600	4.57	10400	5.27	6400	3.89
22.	*Galeola falconeri* Hook.f.	Orchidaceae	2000	1.71	-	-	-	-
23.	*Galinsoga quadriradiata* A.J.Cavanilles	Asteraceae	4400	3.15	8000	4.97	2800	2.74
24.	*Geranium nepalense* Sweet	Geraniaceae	-	-	-	-	2400	1.50

25.	*Gnaphalium hypoleucum* DC.	Asteraceae	2800	1.15	3600	1.79	2400	1.50
26.	*Gonostegia hirta* (Blume ex Hassk.)Miq.	Urticaceae	3600	2.54	6800	4.63	5200	4.25
27.	*Goodyera procera* (J.B.Ker Gawler) Hooker	Orchidaceae	2400	1.43	-	-	4400	2.88
28.	*Hedychium coccineum* Buch.-Ham. ex Sm.	Zingiberaceae	2400	1.04	4400	2.79	-	-
29.	*Hedychium spicatum* Smith	Zingiberaceae	4800	2.87	7200	4.74	2800	1.63
30.	*Houttuynia cordata* Thunb.	Saururaceae	6800	4.19	14800	6.91	13200	7.16
31.	*Hydrocotyle himalaica* P.K.Mukherjee	Apiaceae	4800	2.87	6400	4.90	5200	3.14
32.	*Hydrocotyle sibthorpioides* Lam.	Araliaceae	10800	4.89	6800	4.24	5600	3.26
33.	*Impatiens scabrida* DC	Balsaminaceae	4400	2.76	2800	2.72	4400	2.88
34.	*Impatiens urticifolia* Wallich	Balsaminaceae	6000	3.19	6000	3.25	6000	3.39
35.	*Imperata* sp.	Poaceae	20800	9.57	28800	12.43	24800	11.59
36.	*Lepisorus* sp.	Polypodiaceae	3600	2.54	-	-	2800	2.37
37.	*Lycopodium clavatum* Linn.	Lycopodiaceae	6400	3.30	10000	5.54	7200	4.14
38.	*Mimulus tenellus var. nepalensis* (Benth.) Tsoong	Schropulariaceae	1200	0.72	-	-	3200	2.87
39.	*Molineria capitulata* (Lour.) Herb.	Hypoxidaceae	7200	4.30	2800	1.95	4000	3.49
40.	*Molineria* sp.	Hypoxidaceae	5600	3.08	5600	3.13	4400	2.88
41.	*Nephrolepis cordifolia* (Linn.) Presler	Lomariopsidaceae	3600	2.15	2800	2.34	5200	3.88
42.	*Oenanthe javanica* (Bl.) DC.	Apiaceae	7600	4.80	4400	2.79	5600	4.00
43.	*Ophiopogon japonicus* (L.f.) Ker Gawl.	Asparagaceae	4000	2.26	6800	4.24	3600	2.26
44.	*Osbeckia stellata* Buch.- Ham.ex Ker Gawl	Melastomataceae	2000	2.10	3200	2.07	3600	3.37
45.	*Oxalis corniculata* Linn.	Oxalidaceae	3600	2.15	2400	1.45	-	-
46.	*Pilea scripta* (Buch.-Ham.ex D.Don) ex Weddell	Urticaceae	2800	1.15	-	-	-	-
47.	*Piper hamiltonii* C.DC	Piperaceae	2000	0.93	2000	1.72	-	-
48.	*Plantago asiatica subsp. erosa* (Wall.) Z.Yu Li	Plantaginaceae	4400	2.76	6800	4.24	3600	2.63
49.	*Plantago major* Linn.	Plantaginaceae	3200	2.04	-	-	-	-
50.	*Poa* sp.	Poaceae	41200	15.52	33200	13.30	26000	11.60

51.	*Podophyllum hexandrum* Royle	Berberidaceae	800	1.00	-	-	-	-
52.	*Polygonum runcinatum* Buch.-Ham. ex D.Don	Polygonaceae	4000	1.87	-	-	2400	1.87
53.	*Portulaca oleracea* Linn.	Portulaceae	4400	2.37	-	-	2800	2.00
54.	*Pouzolzia* sp.	Urticaceae	4400	3.15	6000	4.40	5600	4.37
55.	*Primula denticulata* Smith	Primulaceae	6000	3.58	6000	3.25	6000	3.39
56.	*Pteris vittata* Linn.	Pteridaceae	5200	2.98	4400	2.79	6000	4.87
57.	*Ranunculus* sp.	Ranunculaceae	2400	1.04	3200	2.07	2800	2.00
58.	*Rotala rotendifolia* (Buch.-Ham.ex Rox.)Koehne	Lythraceae	-	-	3200	2.83	2000	1.75
59.	*Selaginella martensii* A. F. Spring	Selaginaceae	9600	5.34	9600	4.66	8000	4.03
60.	*Senecio* sp.	Asteraceae	3200	1.65	5600	3.52	4000	2.38
61.	*Solanum dulcamara* Linn.	Solanaceae	-	-	4400	2.02	2400	2.24
62.	*Sonchus arvensis* Linn.	Asteraceae	-	-	2400	1.84	3600	1.89
63.	*Sphenomeris chinensis* (Linn.)Maxon	Lindsaeceae	3200	2.04	5600	3.90	4400	3.25
64.	*Stellaria media* (L.) Vill.	Caryophylllaceae	2400	1.04	4000	2.68	1200	0.75
65.	*Swertia angustifolia* Buch.-Ham. ex D.Don	Gentianaceae	2000	2.10	3600	2.95	4800	4.49
66.	*Cyperus* sp.	Poaceae	-	-	38400	15.16	-	-
67.	*Torenia asiatica* Linn.	Scrophulariaceae	3200	1.65	-	-	-	-
68.	*Tupistra* sp.	Asparagaceae	4000	2.26	-	-	2800	2.00
69.	*Urtica dioecia* Linn.	Urticaceae	6000	3.97	1600	1.22	2400	1.87
70.	*Urtica parviflora* Roxburgh	Urticaceae	4000	3.04	6400	4.90	3200	3.61
71.	*Viola sikkimensis* W.Becker	Violaceae	3600	2.54	2800	2.34	4400	3.99
72.	*Viscum articulatum* Burman f.	Loranthaceae	1600	1.21	2000	1.72	-	-
	Total		**366400**	**200**	**351200**	**200**	**314400**	**200**

4.4. Market and Non-market Potential of NTFPs

Forest and forest resources are the main source of providing sustenance to millions of people in the world. It is a common fact that every people who reside in the vicinity of forests or in remote areas are dependent on forest resources. As per the estimation of the World Bank in 2000, one out of each four person of the world's total populations depend directly or indirectly on forest for their livelihood. However, non-timber forest products play very important and vital role among the tribal people and provides a source of income and subsistence. Majority of the tribal communities of the north eastern part of the country and almost all in the state of Arunachal Pradesh are direct dependent of NTFPs for livelihood and economy. The Apatani plateau have been found a good and rich store house of various NTFPs having both socio economically and ecologically important species as evident from previous chapters. Among the species of socioeconomic importance the forest produces have been utilized for fulfillment of various sociocultural needs (non market potential) and also for earnings of revenues (market potentials). The majority of the population in the present study site are mostly dependent on agriculture besides depending on other means of income generation for their livelihood. But there are large number of population who still are dependent on many of the forest resources for their sustenance and daily consumption. Even though they do not get benefitted much from the income earned from such forest resources and forest products but for those who have no other means of income generation it is their only means for their socio-economic dependency. They depend on the NTFPs especially for their food, housing, firewood and other daily household activities. The observations and results of the studies on the market and non market potentials of NTFPs have been presented here.

4.4.1. Market potential of locally used NTFPs:

A thorough market survey was made to find out the economic potentiality of NTFPs species and products. The pricing details and marketing link of the high value market potential products have also been recorded. For better understanding the market potentiality and prices of both the local markets in Ziro and markets of capital complex viz, Itanagar and Naharlagun was also observed. During the survey it was observed that among the 147 NTFPs documented in the present study about 25% of

the species having various yields and products are found in the market. It has been found that among all the NTFPs, common food plants and the bamboo species have better market potentiality and sold in the regular basis. While the other NTFPs are found occasionally in the market in a specific period and need. The details of market potential and price value of the regularly sold NTFPs have been presented below.

i. Marketing of food plants

Besides the bamboo and fire wood which have maximum uses, the other NTFPs sold in the market comprises, vegetables, spices and condiments, fruits and medicinally used parts. In the local market the items are mostly sold by women folk who were found as the main collectors of these products. The marketed products were mostly in the form of leaves, fruits, root and tubers etc. when analyzed, it was found that the products were obtained from 25 plant species. All the species with their parts and product, specific uses and price per unit have been presented in table 4.4.1a. Among the 23 species majority are trees (9 spp) followed by herbs (12 spp.) and shrubs (3 spp.), climbers are represented by (1sp.). Among the products leaves were found to be sold for 6 spp. while fruits are sold for 7 spp., whole plant 5 spp. Shoots and tubers 2 spp. each. Most of them are found to be produced from tree and herb species, and the leaves and fruits of these species have market value. Among these the species such as *Clerodendrum glandulosum, Myrica esculenta, Zanthoxylum armatum, Piper pedicellatum, Houttuynia cordata, Centella asiatica, Acmella paniculata, Solanum kurzii, Elatostema plathyphllum, Litsea cubeba, Amaranthus spinosus* were regularly sold in the market with a price ranging between Rs. 40-80 Kg^{-1}. Species such as *Phyllostachys bambusoides, Castanopsis, Actinidia, Dendrocalamus, Magnolia champaca, Phoebe goalparensis,* were sold at a cost of Rs.100-300 Kg^{-1}.

The leaves and shoots for vegetable comprises of species like *Clerodendrum colebrookianum, Zanthoxylum armatum, Piper pedicellatum, Houttuynia cordata, Centella asiatica, Diplazium esculentum, Acmella paniculata, Plantago erosa, Elatostemma platyphyllum*. The young fruits of *Litsea cubeba, Scheffelera elliptica, Solanum kurzii, Phoebe goalparensis, Magnolia champaca* are some of the wild fruits sold as vegetable in the market. These fruits are taken as vegetables and also as an ingredient for making local chutney called “Pikey”. As a nutritious fruit the species

namely *Myrica esculenta, Actinidia callosa* are sold in the market but comparatively in higher prices than vegetables.

The species which are also sold in the outside area of Ziro mostly in the capital markets are listed with their comparative prices (Table 4.4.1b). Among these the leafy shoots of species such as *Clerodendrum glandulosum, Myrica esculenta, Zanthoxylum armatum, Piper pedicellatum, Houttuynia cordata, Centella asiatica, Acmella paniculata, Solanum kurzii, Plantago erosa, Elatostema plathyphllum, Litsea cubeba, Amaranthus spinosus* were regularly marketed and traded outside Ziro and are supplied in higher quantity since they are also preferred by other tribal communities. The price of the products in the two markets showed a minimum difference of Rs. 20 to a maximum of Rs. 100 depending on the demand in the market and including the other charges such as transportation etc.

Most of the products like vegetables, fruits are sold out in the town markets of Itanagar, Naharlagun during seasons as some of the products like bamboo shoots, and other fresh vegetables have a large demand and preference in Itanagar and Naharlagun markets. Though people prefer buying products from Ziro but the inflow of such products are little less. The reason mainly being it gets spoilt many times during transportation and since the same products are brought from nearby markets like Sagalee, Yazali, etc the demand in the Itanagar, Naharlagun market becomes less and they get less profit. Except for some forest products like bamboo shoots and other horticultural products like fruits and vegetables.

ii. Market value of Apatani bamboo

The local bamboo *Phyllostachys bambusoides* are in such high demand and preferred that it also fetches a good market demand in the local markets and sometimes even in nearby markets outside. Although people mostly collect bamboos from their respective individual bamboo grooves or community bamboo grooves but for some who does not own a bamboo groove they buy it from neighbouring villages or from neighbours. At present the average cost of one bamboo culm in the study area is Rs. 40 Kg^{-1}. However the same bamboo culm is sold in Rs 50-60 Kg^{-1} when brought from far forest areas. This species as not found in other areas hence when marketed outside are sold in very high prices up to Rs 100 Kg^{-1} particularly in the capital complex. The demand and marketing of young shoots of *Phyllostachys*

bambusoides are equally high and is sold in regular basis. Young bamboo shoots called as “Byapu” or “Behey” is highly preferred both by the Apatanis and also in the neighbouring areas as well and is one of the most preferred delicacies even for the people residing outside Ziro. The Apatanis usually grow and collect young bamboo shoots for their own consumption as it is one of their most preferred delicacies and eagerly wait for harvesting young shoots and prefer sharing their bamboo shoots with their neighbours, relatives and loved ones. But in recent times due to its high demand and good market potential it is also sold at local markets. It is sold at Rs.50 per bundle (5 pieces in a bundle) in local markets in Ziro. It also fetches a good market in Itanagar, Naharlagun and in the neighbouring state of Assam where it is sold at Rs. 100-120 per bundle.

The pattern of marketing the bamboo culm among Apatanis is quite unique as they do not have a proper bamboo depot like other tribes or places. Since most of the local people have their own bamboo garden so most of their requirement is met from it. Except in some cases for those people who does not own a bamboo garden or those who are in need of bamboo in large scale they buy from the neighbours or from the nearby villages. But many a times because of the people live in a close knit family, their needs are fulfilled from bamboo gardens of their own family members or relatives.

Table 4.4.1a. List of vegetable and fruit plants marketed in study area.

Sl. No.	Name of Species	Local name	Parts used	Price (Rs/kg)
1.	*Actinidia callosa*	Wild Kiwi	Fruit	100
2.	*Acmella paniculata*	Yakho hamang	Leafy shoot	50
3.	*Allium hookeri*	Taley/Lepi	Whole plant	50
4.	*Amaranthus spinosus*	Tayihamang	Whole plant	50
5.	*Castanopsis hystrix*	Kira ayi	Fruit	100
6.	*Centella asiatica*	Ngilyang hikho	Whole plant	40
7.	*Clerodendrum glandulosum*	Pato	Leafy shoot	40
8.	*Colocasia esculenta*	Ingey	Tuber	40
9.	*Dendrocalamus hamiltonii*	Hikhu	shoots	100
10.	*Dioscorea esculenta*	Engin	Tuber	80

11.	*Diplazium esculentum*	Hiika	Young shoot	40
12.	*Elatostema plathyphylum*	Hipe	Leafy shoot	50
13.	*Houttuynia cordata*	Siahamang	Whole plant	50
14.	*Lageneria siceraria*	Supung pinta	Fruit	300
15.	*Litsea cubeba*	Santero	fruit	50
16.	*Magnolia champaca*	Salyo	Fruit	120
17.	*Myrica esculenta*	Baching	Fruit	60
18.	*Nephrolepsis sps.*	Pila	Extract	60
19.	*Oenanthe javanica*	Higu	Leafy shoot	40
20.	*Phoebe goalparensis*	Samper	Fruit	300
21.	*Phyllostachys bambusoides*	Byapu	shoot	100
22.	*Piper pedicellatum*	Raru	Leafy shoot	50
23.	*Schefflera elliptica*	Sanko	Leafy shoot	50
24.	*Solanum kurzii*	Byako	Fruit	80
25.	*Zanthoxylum armatum*	Yorkhung	Fruit	80

Table 4.4.1b. Comparison of prices of species marketed in Ziro and Naharlagun market during 2013.

Sl. No.	**Name of species**	**Local name**	**Price (Rs/kg)**		**Difference**
			Ziro	**Naharlagun**	
1.	*Actinidia callosa*	Wild Kiwi	100	140	40
2.	*Acmella paniculata*	Yakho hamang	50	80	30
3.	*Allium hookeri*	Taley/Lepi	50	100	50
4.	*Amaranthus spinosus*	Tayi hamang	50	100	50
5.	*Castanopsis hystrix*	Kira ayi	100	120	20
6	*Centella asiatica*	Ngilyang hikho	40	80	40
7.	*Clerodendrum glandulosum*	Pato	40	80	40
8.	*Colocasia esculenta*	Ingey	40	80	40
9.	*Dendrocalamus hamiltonii*	Hikhu	100	250	150
10.	*Dioscorea esculenta*	Engin	80	100	20
11.	*Diplazium esculentum*	Hiika	40	80	40

12.	*Elatostema plathyphylum*	Hipe	50	80	40
13.	*Houttuynia cordata*	Siahamang	50	100	50
14.	*Lageneria siceraria*	Supung pinta	300	300	Nil
15.	*Litsea cubeba*	Santero	50	100	50
16.	*Magnolia champaca*	Salyo	120	140	20
17.	*Myrica esculenta*	Baching	60	80	20
18.	*Nephrolepsis sps.*	Pila	60	80	20
19.	*Oenanthe javanica*	Higu	40	80	40
20.	*Phoebe goalparensis*	Samper	300	400	100
21.	*Phyllostachys bambusoides*	Byapu	100	120	20
22.	*Piper pedicellatum*	Raru	50	80	30
23.	*Schefflera elliptica*	Sanko	50	80	30
24.	*Solanum kurzii*	Byako	80	100	20
25.	*Zanthoxylum armatum*	Yorkhung	80	120	40

4.4.2. Pattern of price change in the last 3 years:

It was found that 25 species were sold in the market during the year 2011, 2012 and 2013 (Table 4.4.2). A comparative study was done on the pattern of change in the price rise of these products in three years. It was found that species mostly vegetables like *Diplazium esculentum, Clerodendrum colebrookianum, Houttuynia cordata, Allium hookeri, Centella asiatica are* some of the species that were sold at a price of Rs.20-25 Kg^{-1} in 2011 with gradual rise to Rs. 40-50 Kg^{-1} by 2013. Other important species like *Magnolia champaca, Phoebe goalparensis, Dendrocalamus hamiltonii* showed a increase of price ranging from Rs. 50-100 Kg^{-1} in the last three years. Such species besides being prefferd are difficult to collect and process due to which its market price gradually increases. Species like *Lageneria siceraria* showed a increase in its price from Rs. 150-300 over the last three years. This is mainly due to its importance in the socio-religious ceremonies of the Apatanis which leads to high market demand and cost.

Phoebe goalparensis, Magnolia champaca, Allium hookerii, Allium tuberosum, Litsea cubeba, Oenanthe javanica, Acmella paniculata, Solanum kurzi, Amaranthus spinosus etc., are some of the highly preferred species for vegetables and other delicacies by the Apatanis which has high market demand and also fetched good market value. And due to its preference its price gradually increased during the last three years.

When analyzed, it was found that out of the 25 plant species marketed they were mostly sold in the form of leaves, fruits, root and tubers etc. collected freshly. However, few processed products like bamboo shoots, cane products, local salt and vinegar are also marketed.

Over all change in price over the last three years has not changed much except in few cases. This could be mainly because the vendors do not get much profit out of the forest products sold because of the availability of the same products during seasons and many of the vendors selling the same products. Besides the products especially vegetables, fruits *etc*., sometimes get rotten and become unfit for selling in the next day. Thus, they do not get much profit and sometimes sell the products in more quantity at a minumum cost to attract costumers..

Table 4.4.2. Market price of NTFPs during 2011- 2013.

SL. No.	Name of Species	Local name	Parts used	Price (Rs/kg.)		
				2011	2012	2013
1.	*Actinidia callosa*	Wild Kiwi	Fruit	80	90	100
2.	*Acmella paniculata*	Yakho hamang	Leafy shoot	25	50	50
3.	*Allium hookeri*	Taley/Lepi	Whole plant	25	50	50
4.	*Amaranthus spinosus*	Tayi hamang	Whole plant	25	50	50
5.	*Castanopsis hystrix*	Kira ayi	Fruit	60	60	100
6.	*Centella asiatica*	Ngilyang hikho	Whole plant	20	40	40
7.	*Clerodendrum glandulosum*	Pato	Leafy shoot	20	20	40
8.	*Colocasia esculenta*	Ingey	Tuber	20	40	40
9.	*Dendrocalamus*	Hikhu	Culm	50	100	100

	hamiltonii					
10.	*Diplazium esculentum*	Hiika	Young shoot	20	40	40
11.	*Dioscorea esculenta*	Engin	Tuber	40	80	80
12.	*Elatostema plathyphylum*	Hipe	Leafy shoot	25	50	50
13.	*Houttuynia cordata*	Siahamang	Whole plant	25	50	50
14.	*Lageneria siceraria*	Supung pinta	Fruit	150	200	300
15.	*Litsea cubeba*	Santero	fruit	25	50	50
16.	*Magnolia champaca*	Salyo	Fruit	50	100	120
17.	*Myrica esculenta*	Baching	Fruit	50	60	60
18.	*Nephrolepsis sps.*	Pila	Extract	25	40	60
19.	*Oenanthe javanica*	Higu	Leafy shoot	20	20	40
20.	*Phoebe goalparensis*	Samper	Fruit	100	200	300
21.	*Phyllostachys bambusoides*	Byapu	Culm	60	60	100
22.	*Piper pedicellatum*	Raru	Leafy shoot	25	50	50
23.	*Schefflera elliptica*	Sanko	Leafy shoot	25	25	50
24.	*Solanum kurzii*	Byako	Fruit	40	80	80
25.	*Zanthoxylum armatum*	Yorkhung	Fruit	25	50	80

4.4.3. Non market values of NTFPs:

The study revealed that although the Apatanis are dependent on agriculture (wet land cultivation of paddy) for their livelihood, growing various vegetable and fruit crops in their home garden and collections of NTFPs for fulfillments of various socio-cultural needs is an unavoidable part of the Apatani society. Their life style is encompassed in the forest and forest resources in and around their inhabitant. The resources which are found in abundance in adjacent regions and have socio cultural values are also maintained in the community forest. In socioeconomic point of view particularly, they collect and uses the NTFPS to meet the nutritional, medicinal, fuel and energy supply and material for ritual and festivals. The important aspects of socioeconomic value of NTFPs and the major species used as per the tradition and culture have been listed in the table (Table 4.4.3a and 4.4.3b). The uses of these species for various socio cultural needs can be considered as non market potential species.

Apatanis even though utilize many of the forest products for food, medicines, house hold items and house building materials etc. There are certain plants species or NTFPs which are being used by the Apatanis on daily basis and preferred by all the household. These species are being used by the communities since time immemorial and have become an important part of the various socio-cultural activities of Apatanis. So such species are collected and used by each and every household. These NTFPs are collected from the deep forests or community forests, home gardens, bamboo gardens etc.

Table 4.4.3a. Uses of NTFPs for livelihood and socioeconomic aspects.

Uses categories	Uses	Number of species preferred	Total species used	Percentage of total species used.
Nutrition	Vegetables	31	50	15.5
	Fruits	9	25	2.25
Medicine	Edible and non edible medicinal plants	24	54	12.96
Fuel and energy	Fire wood	8	14	1.1
	As fuel	3	3	0.09
Shelter	House building	7	12	0.84
	Fencing	3	3	0.09
Tradition and culture	Rituals and festivals	12	19	2.28

Table 4.4.3b. Important NTFPs species linked with livelihood and socio-culture.

Socio-cultural needs	Used for	Preferred species
Nutrition	Vegetables	*Acmella paniculata, Allium hookeri, Amaranthus spinosus, Cardamine hirsuta, Centella asiatica Clerodendrum glandulosum, Diplazium esculentum, Houttuynia cordata, Magnolia champaca, Piper pedicellatum, Zanthoxylum armatum*, etc.
	Fruits	*Actinidia callosa, Choerospondias axillaris, Myrica esculenta, Morus alba, Rubus ellipticus, Rubus rosaefolius, Rubus niveus, Viburnum foetidum.*
Medicine	Edible and non edible medicinal	*Acorus calamus, Ageratum conyzoides, Anisomeles ovata, Centella asiatica, Clerodendrum glandulosum, Gynostemma*

	plants	*pentaphyllum, Houttuynia cordata, Pinus wallichiana,* etc.
Fuel and energy	Fire wood	*Alnus nepalensis, Castanopsis* spp., *Magnolia champaca, Machilus villosa, Phyllostachys bambusoides, Quercus lamellose,* etc.
	As fuel	*Pinus wallichiana, Gnaphalium affine, Phyllostachys bambusoides*
Shelter	House building	*Calamus acanthospathus, Phyllostachys bambusoides, Magnolia champaca, Castanopsis s*pp., *Pinus wallichiana,* etc.
	Fencing	*Phyllostachys bambusoides, Ligustrum ovalifolium,* etc.
Tradition and culture	Rituals and festivals	*Castanopsis* spp., *Loropetalum chinensis, Machilus villosa, Cyclosorus glandulosus, Saccharum arundinaceum, Cephalostachyum manii*, etc.

The result presented in the above tables (Table 4.4.3a, 4.4.3b) clearly indicated that large numbers of NTFPs are being used of which some are mostly preffered species in the day to day life of the communities. Besides the common uses for food, medicine and materials, they are found as integral parts of rituals and festivals. It has been found that out of the 147 species recorded in the present study about 60 NTFP species are found to be unavoidable and strongly attached to the Apatanis. Among these 31 spp. for vegetables (15.5%), 9 spp. for fruits (2.25%), 24 spp. for medicine (12.96%) and 12 spp. for rituals (2.28%) are some of the major used species. The 10 species used for shelter (housing 7 spp. 0.84% and fencing 3 spp. 0.09%) and 11 spp. used for fuel and energy (1.1% for firewood and 0.09% for fuel), mostly as firewood, although do not have market potential but are very important for their livelihood. Some of the species that are directly or commonly associated with the daily uses for nutrition of the Apatanis are *Allium hookeri, Acmella paniculata, Amaranthus spinosus, Amaranthus tricolor, Artemisia indica, Centella asiatica, Diplazium esculentum, Magnolia champaca, Litsea cubeba, Zanthoxylum armatum, Clerodendrum glandulosum, Solanum kurzii,* etc., which are used in the form of vegetables, fruits and medicine. Uses of certain medicinal plants from forests for curing common health ailments were found an important aspect of Apatani culture.

These species are generally collected whenever they need for the purpose and are preferred because of its taste and nutritious values and their occurrence and availability in the nearby areas. Because of their high preference among the communities they are also sold in the market. As per the information of the villagers the uses of most of these species have been inherited through culture. Species such as *Phyllostachys bambusoides, Calamus* spp., *Magnolia* spp., *Ligustrum ovalifolium* etc. are used for shelter (housing and fencing). Species such as *Loropetalum chinensis, Bamboo, Machilus, Saccharum* spp, *Castanopsis* etc. are highly used in every religious purpose and for fuel and energy species like *Pinus wallichiana, Quercus lamellosa, Machilus vilosa, Bamboo* spp. etc are some of the major and highly linked with their socio-cultural activities. *Myrica esculenta, Pyrus pashia, Rubus ellipticus, Prunus persica, Rubus niveus, Rubus rosaefolius* etc., are some of the wild edible fruits that are commonly preferred and easily available in the vicinity of the forests and nearby home gardens. Species such as *Myrica esculenta, Prunus persica, Pyrus pashia* etc., are also commercialized and adds to the economic benefit of the people.

Out of the many NTFPs used by the Apatanis, in maximum, bamboo and cane species are one of the most widely used forest resources. *Phyllostachys bambusoides* commonly known as Apatani bamboo 'Bije' is the most commonly used bamboo species, every household in the village make use of these bamboo species for their food, handicrafts, housing materials, fences, rituals, firewood etc. and are also in demand in local as well as nearby markets. Because of its high importance every individual in the community owns a bamboo garden from where they can meet their daily needs. There are other bamboo species such as *Dendrocalamus hamiltonii, Chimonocalamus griffithianus* etc., but they are less preferred on day to day works except in some cases and for some particular works. Cane species like *Calamus acanthospathus, Plectocamia himalayana* etc are mostly used in day to day activities for works such as fibre, housing, handicrafts, rituals etc. *Juncus effuses* 'Mima' is one such plant species that has maximum use by the Apatanis. They use this plant mainly for tying the marketed forest products like vegetables, meat etc. Since it is available in plenty in nearby areas it is not sold in the market but it is used on daily basis at home and also by the local market vendors especially by the local Apatani women. *Phoebe goalparensis, Magnolia champaca, Allium hookeri, Allium tuberosum, Litsea cubeba, Oenanthe javanica, Acmella paniculata, Solanum kurzii, Amaranthus spinosus,* etc.,

are some of the other maximum preferred species for vegetables and other delicacies by the Apatanis on daily basis and during its availability in particular seasons.

4.5. INDIGENOUS KNOWLEDGE SYSTEM ASSOCIATED WITH NTFPS

Since time immemorial the Apatani tribes have developed unique Indigenous Knowledge System (IKS) inhabiting in the remote forested areas of Ziro valley closely linked with nature. The IKS such developed are still being found traditionally practiced by the people. The Apatani as known for their rich culture and tradition, they are intermingled with the forest resources for fulfillment of various cultural and traditional requirements apart from their day to day need. The IKS of the Apatanis associated with uses of forest and forest resources particularly the NTFPs are well reflected in their resource utilization pattern. This chapter mainly deals with IKS of the Apatanis in relation to some specific uses of NTFPs which have been long used based on cultural and traditional preferences with main emphasis on plants used in rituals and festivals having traditional beliefs and taboos.

4.5.1. IKS associated with uses of NTFPs for common needs:

Uses of the NTFPs occurring in the vicinity forests of the villages have been commonly practiced. As indicated in the preceding chapters (chapter 4.3 & 4.4) although a large numbers of NTFPs yielding species are used, some specific resources and the products have been deeply connected with the Apatani tradition and culture. The Apatanis in particular had been preferring the uses of these forest resources from time immemorial and still being continued because of the preferences by the ancestors. As per the information of the old aged and knowledgeable people the preferences of selection and uses of the NTFPs for the common need is mostly based on the following criterion:

a) Availability in natural surroundings (for all groups).
b) Easy collection and processing (for all groups).
c) Freshness, softness, and easily digestible and cooked (for vegetable groups).
d) Tasty, juice, nutritious and energetic (vegetable and fruits).
e) Fast growing and durable with ease for processing (for house building materials and household items).
f) Natural drying and shedding, quick drying and long lasting fire (for firewood).
g) Fulfills more than one need.

The Apatanis have been using these forest resources for vegetables, fruits, firewoods, house hold items etc for domestic purposes. Forest resources have always been considered as the purest and healthiest besides being the most useful for both human and animal consumption. And the resources available are believed to be the safest and most durable. Besides during olden days there were no alternative resources available and moreover it was affordable. As such the Apatanis do not have very specific taboos associated with the collection of resources. Resources are collected mainly based on the preference or use of the individuals. Based on their use and requirement they are collected at any time of the season. Especially in forest areas people mostly prefer collection of those plants like vegetables, fruits etc that are also consumed by birds or animals. As they believe this signifies that those plants can also be edible for human beings. If animals or birds do not eat them it signifies that those plants may cause harm to them which may affect their health. Based on this most of the plants are selected when one goes for collection of food in the forests. They also consume and prefer taking only those wild forest products that has been taken by their ancestors since ages and prefer not to try eating or tasting any forest products whether edible or non- edible that is not eaten before or by any one. It has been found true from the observation that the species like *Paris polyphylla, Panax pseudo gingseng, Illicum grifithii* etc. presently known as high value NTFPs worldwide are not used by the Apatanis even though they are found in the area. A large number of forest based species used as NTFPs are collected from the forests and used by the Apatanis. Apatanis always prefer the naturally growing species for food, vegetable, medicine etc. The commonly used species are also grown in home gardens and preserved in community forests.

Even though many of the resources are obtained from forests but depending on the preferences some of the plant species like *Myrica esculenta, Magnolia champaca, Pyrus pashia, Phoebe gaolparensis, Prunus* spp, *Pinus wallichiana,* etc. are preserved and planted in the nearby forests of village called ‘Sansung’ and in bamboo gardens. As per the tradition the bamboo species *Phyllostachys bambusoides* locally known as the ‘Bije’ and commonly as Apatani bamboo is being found the mostly supportive NTFP species uses for numerous purposes. In the similar way the cane species *Calamus acantospathus* is believed to be the natural gift to the Apatanis, fulfilling their most of the materials requirements along with the bamboos species. Following

unique tradition adopted by the ancestors a large number of household items for specific requirement have been designed from bamboo and cane species and used. (Table 4.5.1) (Plate 13)

4.5.2. IKS associated with use of NTFPS in Festivals and Rituals:

The Apatanis are very observant of their rituals and festivals and their belief on these rites and rituals is very deeply connected with their everyday life. Besides the common tradition that are being followed in Apatani society like birth ceremony, marriage ceremony, death etc the Apatanis have some special festivals that are being celebrated in the region and reflects their unique and rich culture. Although some important contributions have been made by various workers in understanding the resource utilization pattern of Apatanis time to time (Kohli, 2001; Kala, 2005; Srivastava *et al*., 2010; Bamin *et al*., 2013, etc.), the traditional knowledge including the beliefs and taboos in relation to utilization of forest resources in tradition and culture have not been documented.

Apatanis have mainly 3 types of festivals called 'Murung', 'Myoko' and 'Dree' which are celebrated in the months of January, March and July respectively. 'Murung' festivals are mainly celebrated in the early and mid part of January. It is performed by individual person and is done for the well being of the concerned persons or family who is performing the 'Murung' and the whole clan in general for avoiding any untoward incident in the family or clan and also for a better future, prosperity and happiness. 'Myoko' festival is celebrated in the month of March. It is celebrated to welcome the ancestors 'Ato Dihu' and 'Ato Raru' who were the first ancestors to perform this festival, mainly for the welfare of the humankind. This is one such festival which is celebrated in alternate manner wherein villages are formed into 3 groups/zones and each year they celebrate the festivals on rotational basis Hari-Bulla comprising of Hari, Kalung, Reru, Tajang, Lempia (*Talyang Hao*) in the first year, Bamin-Michi, Mudang-Tage, Dutta and Hija (*Tiinii Diibo-Diire Hija*) in the second year and Hong (*Niichi Niitiiin*) in the third year. The third major festival Dree is celebrated with great pomp and merry making in the month of July. All these festivals are mainly celebrated for better cultivation, protection from storms, pests and other natural calamities, good bumper harvest and for the well being of all plants, animals and mankind. Besides these other rituals like 'Yapung', 'Myokung', etc. are

also performed by every village. All these festivals are important for the well being of the human kind. The Apatanis make use of different types of forest resources particularly the plant parts of different forest species during these festivals and rituals and also help in the preservation of the different species be it plants or animals used for these purposes besides keeping intact to the age old traditional knowledge associated with it.

Besides the major festivals celebrated in some specific season, like 'Myoko', 'Murung', 'Dree' some other rituals are also being performed at individual homes like 'Chantung', 'Udeh Uii', 'Korlang', 'Tamu', 'Danyi Kharung', 'Roppi', 'Udeh Tenii', 'Moreh eha', 'Aji eha' etc. and at community level some rituals related to agriculture are performed like 'Myokung', 'Danyi', 'Yapung', 'Tamu', 'Myokung' is mainly performed for the fertility of soil in the month of March. This is done after seeds are sown in nurseries and all god and goddess are called together and sacrificial are offered. 'Danyi' (God of Sun) is performed mainly for the well being of entire human beings, plants and animals as without the rays of sun no living beings can survive. 'Yapung' (Goddess of the Sky) is performed mainly to appease the goddess of sky in the month of September for good weather conditions and for sufficient rain water for good growth of the plants and paddy. 'Tamu' (God of insects and pests) is observed when crops are transplanted from nurseries to field in the month of April-May. The rituals related to agriculture are again of importance for the people as it is their main source of livelihood. The list of major rituals and festivals with their season and social beliefs are tabulated here (Table 4.5.2).

A large number of species with their timber and non- timber forest products have been found useful in the rituals and culture of Apatanis. Among the best used resources bamboo (*Phyllostachys bambusoides),* cane (*Calamus acanthospathus),* species of *Castanopsis, Magnolia, Machilus, Saccharum,* etc were mostly preferred in the major rituals and ceremonies. The Bamboos and cane species are again of importance in death mainly for making the burial place. Depending on their richness or their popularity their grave is decorated with bamboo beds in a step by step manner slanting at the top for male and round shape at the top for female called 'Dui Khating'. In case of the renowned and rich person and of renowned priests it is made in A- shaped structure depending on their popularity known as 'Lyalo'. Bamboo

species called ‘Tapyu’ is used as a flute in the death of some well known rich person or renowned priests or elders as a mark of respect to the departed soul and as a sign of last tribute.

In case of natural death, of older men and women rituals rituals called ‘Tazer Hulii’ is performed wherein chicken is sacrificed. The chicken liver is seen that testifies whether the departed soul would rest in peace or not and accordingly rituals are performed. In case the chicken liver is good it indicates good sign for the family and peace of the departed soul and if it is not good it indicates that the deceased soul is not at peace and its family members may not have a peaceful life and may further face troubles in days to come. In case of un-natural death which may have caused due to accident, a ceremony ‘Ropii’ (*Talii Gontii*) is performed. During this the priests and relatives or family members whoever takes part in the death procession puts a piece of *Cyclosorus glandulosus* ‘Millo Tarih’ on their hair-knot on the forehead ‘Piiding’, rucksack ‘lecha’ so as to protect themselves from the spirits of the souls who died in unnatural deaths.

Sometimes in some cases of some un-natural death if the body of the dead person could not be traced in case of accidents caused due to being prey to wild animals, drowning etc. An effigy (man-like structure) in the name of that person is made of the stumps of *Castanopsis* sp. along with its leaf branches to perform the last rites of the person called as ‘Byum-lidu’, ‘Ropi’, ritual is also performed after hunting the wild animals belonging to cat family or feline family like Tiger, Leopard, Panther etc.

The observation on the plants used as NTFPs to fulfill the various requirements during the celebration of these festivals and rituals are tabulated in table 4.5.3 and Table 4.5.4 along with the products name and utility pattern. It has been found that about 19 species of plants were selected and their non timber products were used to meet the various requirements. The details of the utilization with traditional knowledge and taboos’ associated with some of these NTFPs species is presented in the following para giving the family of the species in parenthesis and the local names in inverted commas:

i. *Angiopteris evecta* (Marattiaceae) 'Chanyu/Tari'

It is used for preparing the ash called 'Piyu', local salt 'Tapiyo'. The ashes of this plant after burnt gives a salty taste. These are then filtered and the liquids are again permangated in solid form and smoked-dried and made into a salt cake. It is believed to have used as cure against Goitre since time immemorial. The local priests and even guests during festivals like 'Myoko', 'Murung', 'Mida' etc or during any occasions at home or community and even on other usual days prefer it along with the local rice beer 'O'. It is offered to all the guests as a token of respect. It is considered to help in digestion. The stem and branches of this plant was used especially for performing rituals during outbreak of epidemics like measles, chicken pox etc.

ii. *Calamus acantospathus* (Arecaceae) 'Tisser Yasso'

The stem and leaves are used mainly for rituals like 'Myoko', 'Murung' festivals etc for preparation of altar and other decorative items used in the altar while sacrifying the animal Mithun during 'Subu ritual' for making plaited cane 'Subu saha' for tying the mithun to be sacrificed in the ritual. The leaves are also used during a social procession in the village called 'Tiiper liini' during this all the male members young or old take part holding the leafy branch shouting slogans as 'Ho- Ho'.(Plate 14C.) It is one of the most important part of 'Myoko' festival which is performed on the third day after the start of 'Myoko'. In the meantime the priests chants inside the sacred altar, a small house made of wood, bamboo called 'Nago'. Now a days it is also made of cement and bricks. A monkey skull with the leaves of *Calamus acanthospathus* 'Tisser' on its nostrils is kept inside the 'Nago'. On putting this leaves on the nostrils of the monkey it vibrates and signifies the arrival of the Myoko god. After the end of the procession all the male taking part in the procession puts the leaves of *calamus* in the main altar.

It is believed that the God accepts the altars that are mainly made of this species only. It is also used for making household and handicraft items that are used in festivals and other rituals besides being used for daily purpose. The leaves are used for decorating or covering the jar or container 'Pinta' that is used for carrying local rice beer 'O' and also for making the handle of the 'Pinta'.

iii. *Castanopsis* spp. (Fagaceae) 'Kiira'

C. hystrix 'Rihhing Kiira' and *C. tribuloides* 'Korbing Kiira' are used during 'Myoko' festival. It is used as the main sacred pole or ritual pole with a T-shaped structure called as 'Babo'. It is erected near common platform 'lapang 'of each clan as decoration and as an indication of 'Myoko' being celebrated at that village and at individual homes. The 'Babo' mainly symbolizes the male members in a family. It is believed that the tree hardly produce any fruit. As such no taboos are associated with its use but due to its erect stem and since it is less affected by insects it is preferred. 'Riihing' is also used as one of the most preferred species for house building especially for the post structure of house. No insects can destroy and damage easily. On the other hand the leaves of *C. indica* 'Rahu Kiira' are mostly preferred during preparation of Altar 'Agyang' for different rituals and local traditional rituals like 'Tamu agyang', 'Kharung agyang' etc. or for any rituals to be performed at individual homes or community. It is believed that the plant is mostly preferred by the God 'Uii' and is harmless to mankind.

iv. *Cephalostachyum manii* (Poaceae) 'Tazer'

During 'Myoko' festival the stems of this climbing bamboo are used as 'Byokho' of the main priest. The priest put the well decorated 'Byokho' on the forehead called 'Piiding' so that it protects him from evils (Plate 14A). 'Tazer' is also used for making many decorative items and the outer cover decoration of jar used for storing local rice beer. It is also used in house construction as fiber/rope as it has more strength compared to other canes.

v. *Cyclosorus glandulosus* (Thelypteridaceae) 'Millo Tarih, Millo Riji'

It is used during myoko festival for performing rituals called as 'Methi' for the wellbeing of all family members from effecting destruction by evil spirits. It is also used during rituals done after hunting of Tiger 'Pattii Roppi' and rituals after hunting Leopard 'Hogya Roppi', so that the soul of animals that have been killed rests in peace and does not harm or take revenge on the persons who killed them unintentionally. It is a belief that men do not kill tiger who is believed to be ancestor of human being 'Abang Patii'. 'Roppi' meaning carries deep relation with oral version of begging pardon or excuses of its unintentional killing thereof.

vi. *Eremocaulon capitatum* (Poaceae) 'Yabing'

The culm of this species is used as blade 'Aha pornanii' for cutting out of the heart of the sacrificed animals 'Aha porko' like pig, cow etc. in 'Myoko', 'Murung' and for cleaning the hair 'Yoh alyo Khapa nanii' on the sacrificed pig's body. Not all people can do this so only some selected elders are chosen for doing this. Also preferred for cutting the umbilical cord of a new born baby, when delivered at home during olden days.

vii. *Kavalama urens* (Sterculiaceae) 'Niiji Yanii'

The leaves of this plant are mostly used during Myoko, Murung festival as well as when local rituals are performed. It is mainly used for covering the local beer 'O' prepared for the festival and also for special offering to the priests and the 'Myoko Uii'. It is also used for wrapping the powdered rice 'yatang' that is applied on the animals that are to be sacrificed and also on the altar (Plate 15C). The offering that is given to the god or the food that is served to the priests like meat, local salt and other eatables are also wrapped on 'Niiji Yanii' *as* traditional way of presentation or offering. Besides this leaves are also used for wrapping meat for the guests and the bride-groom during the different ceremonies of marriage like formal sending off of the bride to her in-laws by the parents 'Eli-baniing', final sending off of the bride to her husband along with blessings to prosper and lead happy life with their kit and kins 'Mida', formal invitation of the groom by the bride's parents 'Mabo inchi' etc. It is mostly preferred as it has been used since long by the ancestors and is considered to be pure and free from insects and other harmful things that could affect human health.

viii. *Lageneria siceraria* (Cucurbitaceae) 'Yaju/Pinta'

It is used for making ladle used for serving rice beer called 'Yajju' and small jar or pot used for storing rice beer called 'Pinta' which are one of the most important product used in all the festivals like 'Myoko', 'Murung', 'Dree' etc and any important rituals or ceremonies like 'Mida', 'Supung' etc for offering the rice beer to the god and goddess and also for offering to the local priest 'nyibus' and other guests and for storing the local rice beer (Plate 15C). It also has significane in the 'Mabo inchi' which is part of the marriage ceremony as 'Mabo Yajju', ladle offered to the son-in-law. It is given to the son-in-law by the bride's family as a token of love and acceptance. Best of the ladle is chosen and offered to the groom or son–in-law.

ix. *Loropetalum chinense* (Hamamelidaceae) 'Mari / Mari Ripu'

The Leaf branch of this plant is put in the corner of the grainary 'Nesu' on the morning of the occasion performed after 15 days at the end part of 'Myoko Aji eha' to keep away evil spirits or to prevent returning of 'Myoko' god. This ritual is performed only by those who sacrifices pig during the month long festival.

x. *Magnolia champaca* (Magnoliaceae) 'Salyo Sanii'

The community platform 'Lapang' are repaired or replaced during every 'Myoko' festival using the stems. Only the male members are allowed to stand or use this platform. It is used during festivals, 'Bulyangs', individual rituals and festivals that are performed for the well being. It is often believed a disgrace when women members climb on the platform. But over the years this restriction is not very prevalent now.

xi. *Mahonia napaulensis* (Magnoliaceae) 'Taaming'

A shrub or small tree with spiny leaves and bluish-black fruits. The plant is used in different religious ceremonies for protection from various evil spirits. The bark of the tree along with its leaves is kept around the corner of the house to keep evil spirits away during bad health conditions. Fruits are edible and its bark is used as dye for obtaining deep yellow colour 'Pyaming'.

xii. *Molineria capitulata* (Hypoxidaceae) 'Loli'

The leaves of this plant are especially used during chanting of ritual when a pregnant lady even after the pain starts, suffers from delayed delivery. It is called as 'Hiibi hagi' (delivery/child birth). After chanting of this it gives relief from the pain and easy delivery. The leaves are also used for tying the animals mostly the hens that are to be sacrificed during the festivals like 'Myoko', 'Murung', 'Dree' etc.

xiii. *Machilus villosa* (Lauraceae) 'Sampe Yasang'

The branches of *Machilus villosa* are used during Myoko festival as firewood 'Sama yasang' (Plate 14B). At least two branch sticks is counted against each household and kept at the sacred chanting place called 'Myoko yugyang'. These are then distributed amongst the members of every family of a particular clan after 15 days of the festival and are used in cooking of fish and also for frying rice 'Empi khedu' at the very end of the celebration which is later on eaten as sacred food by the

family and distributed to one and all as a last feast. This is done to break the long restrictions of Myoko festival with a view to get relief from the various restrictions followed during the month long festival and also that the god of harvest will be happy and in turn bless for prosperity among mankind.

Ancestors and the elders have the belief that the fruits of this tree normally eaten by birds and so it was easier for hunting birds for their survival in jungle. It is also considered to have anti-poisonous properties. Although it does not have any scent but it is believed to be the most purified wood for pleasing God 'Myoko Uii'.

xiv. *Phyllostachys bambusoides* (Poaceae) 'Bije'

It is believed that it is the only bamboo that was recognized and preferred by the ancestors due to its strength and easy availability, and hence it is highly used and found in the Apatani plateau. It is mostly used for preparation of the altar 'Agyang' used during different rituals and festivals (Plate 14D). To symbolize the end part of 'Myoko' the bamboos are spilt into thin strips and put around the houses, granaries, sacred platform etc 'Takho bening'. The young bamboo branches with leaves are also used while chanting hymns used for various other uses in other rituals, ceremonies etc such as 'Ropii' so it has become mandatory to use 'Tanii bije' during rituals and festivals. Besides this, it is also useful in construction of house and also for making other decorative items, handicrafts, household items, etc. decorated bamboo stick 'Takutam panyi' are used by the young boys during the 'Penii' procession in 'Murung' festivals.

xv. *Prunus persica* (Rosaceae) 'Takung sanii'

The flowering season of this tree symbolizes the arrival of 'Myoko' festival. People believe that when it starts blooming, it gives an indication of right time for the festival to begin and accordingly people starts preparing for 'Myoko' It is honoured as a sacred tree since it symbolizes the main sacred altar 'Myoko Yugyang', where the important rituals, chanting and sacrificial of the animals takes place to mark the celebration of 'Myoko' (Plate 15D). One tree in each altar and sacred groove of the villages are well preserved and is considered as main altar. It is believed that the tree does not die as long as it gets destructed by insects there off. In case it dies, it is an indication of bad omens, epidemic etc. It is also believed that the survival of

‘Takung sanii’ nurtures human life and well being and so people often apply or offer rice beer and rice powder to it during ‘Myoko’ festival.

xvi. *Saccharum arundinaceum* (Poaceae) ‘Peji pelo’

The upper branches and leaves of this plant called as ‘Peji-Pelo’ is used by the Priest ‘Nyibu’ during chanting of hymns in ‘Dree’ (Plate 15B) and ‘Myoko’ festival. It is also used in house like structure used as altar where the main rituals are performed. It is placed in the three rows of the ‘Nago’ (Plate 15A). It symbolizes to keep away the bad spirits. It is also used during the marriage ceremony where leaf of this plant is kept in the corner of the granary or on door of the granary to symbolize that no evil spirits are allowed to enter after the paddy is brought from the bride’s parent’s home.

Besides the different plants used for various festival, rituals, ceremonies certain animals are also used during such festivals and rituals (Table 4.5.5) Animals such as pig, cow, mithun are the mostly used animals besides chicken without which no chanting of rituals takes place. Animals like, Monkey are used mainly for important festivals like ‘Myoko’, ‘Murung’ and Squirrel are used for ‘Mabo inchi’. The use of monkey is a must during ‘Myoko’ festivals. Since human beings are believed to have evolved from monkey or the apes so monkey’s are a very important part of this festival and without this animal the festival cannot be started or is believed to be a bad omen without the skull of the monkey being used in ‘Myoko’. Especially on the third day of the festival called ‘Tiiper Liining’ gathering by all the male members of the clan who holds a branch of the C*alamaus acanthospathus* ‘Tiiper’ and shouts ‘Ho-Ho’ to welcome the ancestor’s soul ‘Myoko uii’ as a mark of welcome and to be part of the celebration and to get blessings from the god of ‘Myoko’.

4.5.3. The preparation and uses of Herbal salt: A unique Apatani tradition.

Apatanis have a unique culture of preparing traditional salt since time immemorial. They have been consuming the locally prepared salt called ‘Tapyo’ not only for daily consumption but are also being used in every rituals and festivals. It is regarded as a important part of the tradition of the Apatanis to offer ‘Tapyo’ to every guests in any occasions like festivals, marriage ceremonies, social gathering etc.

Besides its taste it is also considered to be a local medicine as it helps in increasing appetite and also is applied in wounds or cuts as antiseptic. They have a unique way of preparing the local salt from the plants collected from nearby forest areas or villages. The plant especially found growing in streams or swampy areas are preffered as they believe it gives better taste. Such plants are collected and sun dried and some prefer to burn it without drying. It is allowed to burn completely to ashes. The ashes 'Piyu' (Plate 16A), then are allowed to cool and then put in a funnel shaped structure made of bamboo called 'Pila hubiyo' (Plate 16B). Water is slowly poured on it from top so as to get the liquid filtrate called as 'Pila' (Plate 16C). A pan or tin plate is then heated on fire with a little oil applied on it so that the liquid filtrate does not stick and also for marking the size of the 'Tapyo' (Plate 16D). Then the liquid filtrate is poured over it slowly as marked by the oil and it is allowed to evaporate. Once the filtrate gets condensed into a solid form it is taken off from the fire slowly taking care not to break it. After it gets cooled it is wrapped properly and tightly in leaves of *Molineria capitulata* called 'loli yani' and is also sometimes wrapped by the dried paddy husk and is kept on top of the basket where rice beer is stored. It is put on top of the rice beer basket to add more flavors and after 2-3 days it is kept on the top of the fire place so that it dries properly and is ready for use. The liquid filtrate used for making this salt can also be stored and kept as flavoring agent in making local delicacies made of bamboo shoots, bacon, chilli called 'Pila' (Plate 16 E) or 'Pikey' (Plate F).

4.5.4. Indigenous Knowledge of Apatanis and Forest Conservation.

The people of Apatani are very much aware of their natural surroundings and are in constant relationship with their environment and the resources available at their disposal, and in accordance to that they collect whatever resources are to be used so that they are collected at the right time and also give way for natural regeneration of those plant species. As such no beliefs are associated but they collect resources depending on its season and availability. Species like bamboos and canes are collected at any time of the year for other day to day uses but they mostly prefer collection of bamboo in the month of September- November as these are the right time for construction or renovation of houses or fences in their respective house, forests or gardens. Cane species are mostly preferred collecting during August-March. Fruits like *Myrica esculenta, Pyrus* spp., *Magnolia* spp., etc preferred

collecting in the month of July -August. Since these are the seasons when they fruit and hence they are collected at the right time because they believe that untimely collection and destruction of forest resources may affect the whole natural resources and also affect in the regeneration of such plants, besides their taste being much better on timely harvesting. As such no taboos or beliefs are linked with the collection of any plants or forest products for consumption and can be collected at any time of the year depending on its availability and fruiting seasons.

The Apatanis even though are directly or indirectly always dependent on the forest resources for their living and for performing any kind of festivals, rituals or ceremonies still do realize the importance of these resources and its conservation for future use . So they always make it a point or it is a part of the custom to plant more and more trees every time they cut down a tree or destroy any plant for its basic needs. Different types of rituals, sacrificials are performed during festivals like 'Myoko', 'Murung' etc wherein they also make it a point to thank the god 'Uii' for the bountiful resources and believe that the 'Uii' of the natural forests will be pleased with such acts and bless them and shower them with more forests and forest products in future.

The Apatanis believe that preservation of forest be it individual or community forests is a must as these rich resources helps in the survival of human and animals besides maintaining the ecological balance. It is also believed that conserving forests provides sufficient water for drinking and paddy cultivation. Hence, they never destroy or burn the forest for jhuming or any other reasons except in cases of natural disasters that it gets destroyed. Rather they perform certain rituals for the protection of forest and bamboo gardens by the natural deities called as 'Moreh Eha' and 'Bije Eha'. These particular rituals are done to appease the goddess of forest once in a year during 'Myoko' festival in the month of March for healthy growth of the forests and its resources. Apatanis believe that without the forest resources the survival of human nature would be extinct. Therefore every individual takes it as a collective responsibility for the preservation of the natural resources. Individual forest or private forests are conserved by the individual owner by proper fencing so as to protect from trespassing or illegal feeling of trees. It is the general practice of every Apatanis to plant 4-5 plants as against every tree that is felled for their domestic use.

There is a belief in Apatanis that forests are the abode of spirits and they follow certain restrictions or taboos for use of certain species. ‘Saro’ (*Ficus* spp.) is considered to be one of the most sacred trees by the Apatanis. There are certain restrictions in the felling of this tree for using as firewood or any other uses. There is a belief that attending natures call or spitting in front of this tree is a bad omen and it may either bring bad health to the person concerned or may affect any member in his family or bring bad luck. As they believe that evil spirits resides in such trees and it’s their resting place.

Apatanis consider it as a bad omen to cut any big tree, trunk (*Castanopsis* spp, *Pinus* sp.) etc. that is branched in the middle of the stem with a big hole in it or that is hollowed in the middle of the trunk ‘Sangonii sanii’. They consider it as place where spirits reside and disturbing such spirits by way of felling, burning or harming such trees in any way may bring bad fortune to the person or the community as a whole.

They also have the belief that when one go to the deep forests he/she should not make much noise or shout as they believe the diety of forests ‘Moreh Uii’ would be disturbed and may harm the person. There is said to be certain instances wherein some people is believed to be lost in the jungle for days, tracelessly called as ‘Yapung bobidu’. Even ladies and young childrens are restricted from entering the deep jungle because of the fear of this belief and omen. Though ladies are allowed to go to nearby forests for collection of firewood but is it mostly avoided and especially during hunting as they believe when a female member goes along with them the male member gets distracted known as ‘Alo du’.

One of the best way Apatanis believe they can conserve their forest and its resources is through the sacred grooves called as ‘Lyago or Ranthii’. Every village in the study area has a scared groove wherein some of the important vegetations are conserved. No human or animal interference is usually allowed in such areas. It is also considered as a sacred place for some of the important rituals wherein the ‘Nyibus’ or the ‘Gorras’, the local priest who performs such rituals enters and performs the rituals like ‘Myokung’, ‘Danyi’ etc and also during festivals like ‘Myoko’. And in case of collection of any plant species that are used for rituals or festivals these ‘Nyibus’

collect it from the forests in case it is found in the sacred grooves. They observe certain taboos, festivals, rituals etc for conservation and preservation of forest

resources. Restrictions in the form of felling trees, hunting etc are followed in such forest areas for conserving the rich flora and fauna.

Table 4.5.1. Some specific household items made of bamboo, cane and other NTFPs.

Sl. No.	Name of items	Species used	Uses
1.	Yadin	*Phyllostachys bambusoides.*	Basket for storing clothes, jewellery, etc.
2.	Yagii	*Plectocamia himalayana, Phyllostachys bambusoides.*	Different types of baskets used for carrying grains, vegetables, utensils, etc.
3.	Lera	*Plectocamia himalayana.*	Haversack used for carrying water, local rice beer, water etc while going for jungle trips.
4.	Chiiba	*Plectocamia himalayana,*	Basket use for carrying rice.
5.	Khanchu	*Plectocamia himalayana, Phyllostachys bambusoides.*	Used for storing rice grains.
6.	Supun Piinta	*Lageneria sicereria, Calamus acanthospathus, Plectocamia himalayana.*	Used for carrying local rice beer 'O' during rituals and have great significance in rituals and festivals performed at individual home or community as a whole.
7.	Pater	*Phyllostachys bambusoides.*	Used for storing meat.
8.	Yatii	*Phyllostachys bambusoides, Plectocamia himalayana and Cinnammomum bejolgotha.*	Traditional rain shield used to protect from rain.
9.	Yakhang	*Plectocamia himalayana, Phyllostachys bambusoides.*	Used for storing local rice beer. It is made of cane and the inner portion contains a coated surface of tar.
10.	Yormii sudu	*Phyllostachys bambusoides.*	Traditional mortar used for storing and powdering chilly.
11.	Lecha	*Plectocamia himalayana.*	Type of a haversack covered with fur like substance. Also used during jungle trips and during specific rituals.
12.	Subu Saha	*Calamus acanthospathus.*	Plaited cane rope for taming animals/cattles.
13.	Kele/Kedu	*Phyllostachys bambusoides.*	Bamboo stick used in

			weeding which supplement hoe.
14.	Miige	*Phyllostachys bambusoides.*	Tongs made of bamboo split. Used in kitchen.
15.	IIpnan	*Phyllostachys bambusoides.*	Bunch of dried bamboo twigs used as broom at home and also in granaries.
16.	Apii, Alyi/Agey	*Phyllostachys bambusoides.*	Traditional bow and arrows.
17.	Turla	*Dendrocalamus hamiltonii.*	Bamboo mug used for drinking water and local beer.
18.	Piipin	*Phyllostachys bambusoides.*	Bamboo mat used for drying paddy grain.
19.	khanchu	*Phyllostachys bambusoides, Calamus acanthospathus.*	Used for storing grains.
20.	Palii	*Phyllostachys bambusoides.*	Used for weeding in the garden or in the paddy field. It is made of a single piece of bamboo split.
21.	Raju	*Plectocamia himalayana, Phyllostachys bambusoides.*	Basket for carrying firewood or soil in the field.
22.	Siicho	*Phyllostachys bambusoides.*	Used for draining water in the paddy field. It is either made of bamboo or wood.
23.	Punyu	*Phyllostachys bambusoides.*	Spoon made of spiltted bamboo stick used for cooking and also for eating.
24.	Yapiyo	*Eremocaulon capitatum.*	A-shaped winnower used for cleaning rice.

Table 4.5.2. List of major rituals and festivals of Apatanis with their season and social beliefs.

SL. No.	Festival rituals with season of celebration	Traditional beliefs associated	Taboos and restrictions
1.	**Myoko** 20^{th}-18^{th} April.	For the welfare of human beings. Celebrated in village level group wise.	The group performing this festival are restricted from going to their fields or forests for 15-20 days or till the end of Myoko They have the belief that if one breaks this taboo they may suffer from severe dysentery 'Ichang sadu'. And for those who sacrifice animals during the month long festival there is restriction 'anyodu' of consuming certain food items like pumpkin, beans etc. for almost a month.
2.	**Dree** 4^{th} -5^{th} July.	Agriculture festival for better productivity. Celebrated in village level.	It is celebrated to get bumper harvests. Certain taboos are followed during where no one is allowed to go to their fields or forests for a minimum of 7 days.
3.	**Murung** 10-20^{th} January Depending on the omen after seeing the egg.	Performed for the well being of family and clan in household level.	The performer are restricted from going to fields and forests and follow taboos by not consuming food such as pumpkin, potato, beans etc and also are restricted from visiting 'Sima udeh' the house where someone has died for 7-8 months till the harvesting of *Elusine coracana* 'Subu sarse' in the month of Sept- Oct.
4.	**Subu** Mostly in the month of January, March and November.	It is an individual festival/ritual performed for the well being of family and clan.	They are restricted from going to fields and forests for 10 days. and follow taboos by not consuming food such as pumpkin, potato, beans etc and also are restricted from visiting 'Sima udeh'the house where someone has died
5.	**Tamu/Myokung** April- May after the omen.	To protect forests and insects.	Restrictions from going to fields/forests for 3-4 days from the start of the 'Tamu' ritual. Restrictions from going to fields/forests or felling trees, cutting

	MiyuYapung (March-April) **ElyangYapung** (September).	performed for the god of skies not to harm the humankind and to protect the paddy fields from the effect of hailstorms.	bamboo etc for 4-5 days from the start of the ritual.
6.	**Moreh/Bije eha** 16-17th day of myoko.	Part of Myoko, Murung, Subu etc usually performed at the end of the month long festival.	Food 'kaji', meat, rice beer etc are offered to the god and goddess of forests as thanks giving and prayer for better fauna and fauna. They believe if the gods of forests are pleased they protect them from any unforeseen incidents in future.
7.	**Aji eha.**	Part of Myoko, Murung, Subu etc usually performed at the end of the festival.	Food 'kaji', meat, rice beer offered to the god and goddess of agriculture to overcome the restriction for going to fields. They believe if the god of agriculture is pleased they would provide better paddy harvest.
8.	**Mabo inchi**.	Part of marriage ceremony.	No such beliefs or taboos followed. It is a form of formal engagement between the newly wed couplete.
9.	**Eli baniing** October-November during harvesting season.	Part of marriage ceremony.	For 3 nights the husband and wife who perform such ceremony are not allowed to go out of their compound and do not visit relatives or give away any belongings from their home. They believe this will help them in prospering in future.
10.	**Mida** During winter.	Part of marriage ceremony.	Performed by the girl's parents. It is believed that blessing in the form of performing 'Mida' helps in the prosperity and well-being of their daughter in her in-laws and brings happiness in her family.
11.	**Kharung** Depending on situation .	Individual ritual.	3-4 days they are restricted from going out of the house and does not allow any visitors at home. They put a crossed stick on the entrance or a single stick made of bamboo.

Table 4.5.3. List of plants used in festivals along with its local name, product name and uses.

Sl. No.	Botanical Name	Use in festivals	Local product	Nature of the products	Parts used	Uses
1.	*Calamus acanthospathus*	Myoko, Murung, Dree	Subu saha, Liia yagii and kaji yagii, Yakkhang, Ekkho liia.	For tying baskets, Jug or storage and animal.	Leaves stem.	For tying the items used in preparing altar, for tying mithun; during procession in Myoko, baskets for carrying rice powde; for making and covering the container for local beer.
2.	*Castanopsis hystrix*	Myoko, Murung, Dree	Agyang, Babo.	Altar.	Leaves stem.	For making Altar, for making sacred pole 'Babo'.
3.	*Castanopsis tribuloides*	Myoko	Babo, Agyang.	Altar.	Leaves stem.	For making Altar.
4.	*Cephalostachyum manii*	Myoko	Liiha, Pinta pubyung, Supung Pinta, Byokho.	Baskets.	Stem.	For making baskets and other items used during rituals.
5.	*Cyclosorus glandulosus*	Specific rituals in individuals houses.	Milo Tarih.	Altar.	Leaves.	For some specific rituals to be performed at individual homes during Myoko festival called 'Metii agyang'.
6.	*Eremocaulon capitatum*	Myoko, Murung	Aha pornanii, Yoh alyo Khapa nanii.	Traditional blade.	Culm.	Used during cutting out of the heart of the sacrificed animals during Myoko, Murung 'aha porko'.
7.	*Exbucklandia populnea*	Myoko	Lapang.	Ritual platform.	Stem.	For making platform where rituals and chanting are done.
8.	*Kavalama urens*	Myoko, Murung, Dree	Liiah hagru nanii / Yo apu nanii.	Used as wrapper.	Leaves.	For covering local rice beer and wrapping meat, rice powder.

9.	*Lagenaria siceraria*	Supung, Dree, Myoko, Murung	MijiYajju, Miji Pinta, Supun Pinta.	For carrying and offering rice beer.	Fruits.	Used in all the festivals for carrying and offering local rice beer to the priests, guests, etc.
10.	*Loropetalum chinense*	Myoko	Mari Yanii.	To keep away from bad omen.	Leaves/ Branch.	Leaves of this plant are used at the end part of Myoko (after 15 days) to keep away from evil spirits or any bad omen.
11.	*Machilus vilosa*	Myoko	Sama yasang.	Firewood.	Stem.	During the start of Myoko this are used as firewood that is piled up in a square shape called 'Sama yasang'.
12.	*Molineria capitulata*	Myoko, Murung, Dree	Paro, pachu ngananii.	Chanting of rituals.	Leaves.	For tying the animals that are to be sacrificed during ferstivals and rituals.
13.	*Phyllostachys bambusoides*	Myoko, Murung, Dree	Agyang, Nago, Taku tamu panyi.	Altar, decorated bamboo stick.	Whole plant except roots.	For making altar like 'Nago', 'Agyang', 'Takutam panyi'decorated bamboo stick, used by the young boys during the 'Penii' procession of Murung festivals.
14.	*Prunus persica*	Myoko	Yugyang.	Alter	Whole plant.	Used as the sacred altar where the main Myoko rituals are performed.
15.	*Saccharum arundinaceum*	Dree	Pelo.	Chanting of rituals.	Upper branch/ leaves.	Used by the Priest 'Nyibu' during chanting of Dree festivals. It is put in the three rows of a small house like structure used as altar 'Nago piiding'.
16.	*Zingiber officinalis*	Myoko, Murung, Dree	Kaji khiyo nanii, Yatang -yho alii nanii.	Spice and condiments.	Rhizome.	Used as spice for cooking 'Kaji' rice mixed with pork and in rice powder that is offered to god 'Uii' during the festivals and rituals.

Table 4.5.4. List of plants and their uses during common rituals and ceremonies.

Sl. No.	Botanical Name	Local name	Rituals/ Ceremonies	Parts used	Uses
1.	*Castanopsis hystrix*	Kiira	Myokung, Danyi, Yapung, Tamu, Korlang, Kharung.	Leaves.	Sacred Altar 'Agyang'.
2.	*Castanopsis tribuloides*	Korbing Kiira	Myokung, danyi, Yapung, Tamu, Korlang, Kharung.	Leaves.	Sacred Altar.
3.	*Cyclosorus glandulosus*	Milo Tarih	Ropii, unnatural death.	Branch, leaves.	Leaves are put in the head or the ruck sack 'lera', 'lecha' carried by the priests and persons taking part in 'Ropii'. It is used to keep away from harmful spirits or from protecting oneself from the soul of the dead person.
4.	*Kavalama urens*	Niji yanii	Myokung, Danyi, Yapung, Tamu, Korlang, Kharung.	Leaves.	Sacred Altar.
5.	*Lagenaria siceraria*	Yajju, Pinta	Mabo inchi	Fruit.	Ladle offered to groom'Mabo Yajju'.
6.	*Phyllostachys bambusoides*	Bije	Myokung,Danyi, Yapung,Tamu,Korlang, Kharung	Leaves, whole culm.	Different Altars 'Agyang', 'Kharung' 'Agyang' made at the front side of house, and back side of the house 'Danyi agyang'.
7.	*Zingiber officinalis*	Taki yanii	Eli baniing (Part of marriage ceremony).	Whole plant with its leaves.	For decorating ceremonial basket 'Eli Yagii'.

Chapter 5

DISCUSSION

Apatanis, inhabiting in the Apatani Plateau or Ziro Valley of Lower Subansiri district are well known for their rich traditional systems of resource utilization and forests management (Sundriyal and Dollo, 2004; Chaudhry *et al.*, 2011). The age-old agricultural practice of growing paddy with fishes is world famous (Rai, 2005). As other tribal communities of India, the Apatanis are also found to be strongly associated with the forest resources for their livelihood and economy. The culture and traditions of Apatani reflects the direct relationships of forest species and the people. The present study undertaken to document the NTFPs and the Traditional Knowledge Systems of Apatani tribe of the state Arunachal Pradesh have resulted in some important findings. It revealed the diversity status of NTFPs species found in the vicinity of their villages, their present status of the utility pattern, the IKS associated with some specific species and the traditional conservation practices of resources by the communities. Besides, the floristic composition and population status of NTFPs in the nearby forests and marketing potentiality of some of the species have been worked out, that indicated the potentiality of NTFPs for socioeconomic development of the Apatani plateau in Arunachal Pradesh. This chapter deals with the discussion of the results obtained during the present study which is presented here as per the sequence and headings of the chapter results.

5.1. Diversity of NTFP species used by Apatanis.

The result presented in chapter 4.1 and 4.2 on NTFPs used by the Apatani people revealed that the community is using diversified forest resources for their livelihood. They are still entirely dependent on the forest resources and forest products for their various daily requirements like food, fruits, vegetables, medicines, dyes, household materials, firewood and also for other household needs and religious purposes. It was observed that a total of 147 species of plants (with 2 fungal species) have been found commonly used by the Apatanis to fulfill their various requirements as non timber forest products. The details of all the species with their botanical identity, common name, parts used and utilization pattern have been provided in the chapter i. e chapter 4.1. These includes 138 species belonging to Angiosperm (93.8

%) followed by 1 species of Gymnosperm (0.68%), 6 species of Pteridophytes (4.08 %) and 2 species of Fungus (1.36%) (Fig.4.1a). The 138 Angiospermic species are represented by 58 families and 99 genera where dicotyledons are dominant with 121 species under 86 genera and 54 families. In comparison the monocotyledons are fewer in numbers and represented by only 17 species under 13 genera and 4 families. The habit wise grouping of the NTFPs revealed that the maximum were herbs followed by trees, shrubs, climbers and fungi (Fig. 4.1c). The domination of herbaceous NTFP species is probably because of the high preference of wild vegetable and medicine which are mostly seasonal plants and the bamboos by the communities. The tree species are mostly preferred for fruits, firewood and ritual performances.

Because of the distinct subtropical and temperate vegetation the families like Rosaceae, Fagaceae, Asteraceae, Arecaceae are found among the dominant families. The uses of Rosaceae and Fagaceae as dominant families have been found interesting and distinct from the result obtained by Angami *et al.* (2006), Sarmah (2006), Kagyung (2014), etc. in their studies on NTFPs and ethno botany from the state where mostly the families like Solanaceae, Asteraceae, Acanthaceae, Zingiberaceae, Poaceae and Arecaceae were found to be always dominant. Because of the climatic features and the forest types, the members of Rosaceae and Fagaceae are commonly found in the area and at the same time the families bear numerous useful species under the genera like *Rubus, Rosa, Pyrus, Prunus, Castanopsis, Quercus* etc. The lone Gymnospermic species has been represented by *Pinus wallichiana*. The preferences of these species and families by the Apatanis have also been highlighted by previous workers (Srivastava *et al.*, 2010; Sundriyal and Dollo, 2013; Bamin *et al.*, 2013).

5.2. Utilization patterns of NTFPs.

All these NTFPs species documented in the present study have been found under diversified uses categories and can be grouped into 12 distinct categories according to their utility pattern viz food (88 spp. including vegetables, fruits, herbal salt and mushrooms), medicinal plants (56 spp.), ritual and religious plants (19 spp.) firewood (15 spp.), house building materials (14 spp.), fodder plants (12 spp.), household items (7 spp.), gums (4 spp.) dyes (4 spp.) and 14 species of miscellaneous uses (Fig.4.2a). It was found that almost all the plant parts of species had specific

uses. Overall 16 different categories were recorded where leaves were used in maximum cases (Fig. 4.2b).

Among the different categories of the uses the group food is the main category where the Apatanis uses 88 species. Among the food plants, vegetables are represented by 55 species, fruits by 25 species, plants used for making local salt by 6 species and mushrooms by 2 species. The uses of a large number of species in the vegetables and fruits indicate the dependency of the community on wild plants and nutritional care. Among the vegetables the species like *Acmella paniculata, Allium tuberosum, Clerodendrum glandulosum, Houttuynia cordata, Cardamine hirsuta, Portulaca oleraceae, Piper pedicellatum,* etc. are some of the commonly available and mostly preferred by the tribes. It has been found that commonly the leafy vegetables are consumed in simple boiled form with addition of just a pinch of salt along with water. To increase the taste and flavor sometime chillies, zinger, bamboo shoots and garlic are also added in the preparation. Among the fruit species *Pyrus pashia, Prunus* spp, *Magnolia champaca* and *Myrica esculenta* are highly preferred by the Apatanis because of its taste, nutritious and easy availability. The uses of many of these vegetable and alike species like *Amaranthus spinosus, Colocassia esculenta, Diplazium esculentum, Houttuynia cordata, Portulaca oleraceae, Piper pedicellatum, Oenanthe javanica, Solanum nigrum, Zanthoxylum oxyphyllum,* etc. are also used by other communities of the region (Gajurel *et al*., 2006; Murtem and Das, 2005; Angami *et al*., 2006; Sarmah and Arunachalam, 2011; Jeri *et.al.*, 2011, Panmei *et al*., 2014). However the uses of about ten species namely *Begonia obversa, Cardamine hirsuta, Clerodendrum glandulosum, Eremocaulon capitatum, Impatiens racemosa, Magnolia champaca, Piper hamiltonii, Sonchus brachyotus, Strobilanthes helictus, Wallichia oblongifolia* as vegetable or food items are found interesting and rarely reported.

Next to the food the preference of more NTFPs are in the form of medicinal plants where 55 species have been recorded as the ethnomedicinal plants of the Apatanis. Majority of the medicinal plants are also used as edible plants as vegetable and also common in food categories like *Clerodendrum glandulosum, Solanum kurzii, Rhus chinensis, Houttuynia cordata, Gynostemma pentaphyllum, Centella asiatica*, etc. are mostly used for various stomach disorders. The other important

species used medicinally are *Acorus calamus, Anisomeles ovata, Mikania micrantha, Oxalis corniculata, Rubia manjith,* etc. The uses of these species as medicinal plants have also been commonly reported from other part of the state indicating the similar preference of the species by Apatanis. About 158 species of ethno medicinal plants used by the Apatanis have been reported by Kala (2005), which includes many species like *Coptis teeta, Bauhinia variegata, Eclipta prostrata* etc. but are naturally not found in the area. Such species are not included in the present study as the study is aimed for the NTFPs naturally found in the vicinity of the study area and have been associated with IKS from Apatanis. Moreover the species like *Paris polyphylla, Taxus wallichiana, Panax* spp, which are otherwise high value medicinal plants occurring in adjacent areas of Ziro are excluded in the present study as no specific uses by the communities have been recorded.

Among the other utility group, plants used in religious aspects is another important sector of NTFPs uses by the communities. Although many species of plants and even the forest as a whole was found associated with the traditional rituals, 19 species are found more commonly and profusely used where Bamboos, Cane and tree species like *Castanopsis spp, Magnolia*, *Pyrus* etc. which are used in most of the celebrations. These species are used in special ways which are found different with other communities. Because of the cool climatic weather and remoteness of the locality the uses of NTFPs for firewood is a common and essential requisite in the Apatani plateau. Besides the uses of the Apatani bamboo i.e *Phyllostachys bambusoides* some specific trees are preferred as firewood where 15 species were found. Particularly the *Pinus wallichiana* and species of *Castanopsis* and *Quercus* were extensively used. The uses of bark and dried parts like leaves and cones of the pine as fuels for firewood burning have been found very important.

In the category of household building and household items the uses of the cane and bamboo species along with the *Castanopsis, Quercus,* and *Magnolia* have been very common. Out of the about 14 species used in these two categories, 4 species of bamboo *i.e Chephalostachyum manii, Chimonocalamus griffithianus, Dendrocalamus hamiltonii* and *Phyllostachys bambusoides* and two cane species namely *Calamus acanthospathus and Plectocomia himalayana* fulfill most of the need (about 80%). The preference of bamboos and canes as major NTFP species by the Apatanis revealed that like the other tribal communities of the region bamboo and cane are

integral part of the livelihood and economy. Besides the timber, uses of the trees in house building, they are also used as NTFP species where the stem and branches of these species are used in partition, roofing, common platforms in the house building. However, in household items like kitchen items, materials for storage, baskets, furniture, etc. the products of bamboo and cane dominate.

Uses of NTFPs like gum, resins and dyes have been found important in the Apatani culture. Apart from the commonly known species *Rubia manjith,* the uses of tuber of *Begonia roxburghii*, leaves of *Eurya acuminata* and bark of *Mahonia napaulensis* are very unique and rarely known to be used as dye in other parts of the region and country. Although the uses of *Begonia* sp for dye have been reported sometime, the use of *Eurya acuminata* is very interesting. The phytochemical investigation of such species would be of immense value for their commercial uses and exploitation. Dyes of plant origin have immense value and have long been associated with culture and tradition along the human civilization. The uses of fodder plants have been found limited only for piggery as other animals like cattle are rarely domesticated. Although the Mithun is reared but they are left to graze freely in forest areas. Apart from the fodder uses of species of *Colocasia* and *Alocasia* as other communities, the Apatanis also use species of *Dioscorea*, *Plantago* and *Typhonium* as fodder plant. Uses of *Plantago erosa* as fodder NTFP is again very uncommon practice in any part of the country. About 14 species are grouped in the miscellaneous category which includes plant used for poison, trap, packaging, etc. Among them the leaves of *Kavalama urens* and *Juncus effesus* have been found to be unavoidable in the Apatani tradition and culture. They are being used for wrapping and tying of different food items, vegetables, meat and also covering local wine during fermentation. Likewise the uses of spines or a thorn of *Berberis wallichiana* for tattooing in the body is a unique use of the plant. Anthropologically and historically the uses of the tattoo have been found very important. Historically the Apatanis were commonly being identified with their tattoo called ‘Tippe’. The culm of *Eremocaulon capitatum* used for filtering water and for cutting umbilical cord of a new born baby (mostly in the olden days) is hitherto unknown in ethnobotany.

Like the other tribes of northeast India, the uses of bamboo species is another important aspects of Apatani livelihood. The bamboo species used extensively are

Cephalostachyum manii, Chimonocalamus callosus, Chimonocalamus griffithianus, Dendrocalamus hamiltonii, Phyllostachys bambusoides and *Eremocaulon capitatum*. However the *Dendrocalamus hamiltonii* occur naturally only in areas of lower elevation and cultivated by few people. When compared with the other tribes, it has been found that about 50 plant species like *Artemisia indica, Ageratum conyzoides, Acorus calamus, Castanopsis hystrix, Allium tuberosum, Cardamine hirsuta, Litsea cubeba, Magnolia champaca, Zanthoxylum armatum, Impatiens racemosa, Centella asiatica, Angiopteris evecta, Clerodendrum glandulosum, Plantago erosa, Houttuynia cordata, Berberis wallichiana, Castanopsis indica,* etc. recorded in the present study are also found to be used in similar way by other communities of the state (Murtem, 2000; Kar, 2004; Yonggam, 2005; Kar *et al.*, 2005; Angami *et al.*, 2006; Tag *et al.*, 2006; Bhuyan, 2007, Tarak *et al.*, 2009; Srivastava and Adi community, 2009 and Sarmah, 2006, 2010).

Srivastava *et al.* (2010) in their studies on indigenous biodiversity of Apatani plateau reported about 100 species used by the Apatani and adjacent Nyishi communities. It has been found that about 45 species recorded in the present study are rarely reported in the earlier studies for their present reported uses. Among these the species like *Angiopteris evecta* (food), *Alnus nepalensis, Ficus auriculata* (fruit and firewood), *Ficus hookeriana, Kavalama urens, Castanopsis hystrix, Eremocaulon capitatum* (in religious and rituals); *Cardamine hirsuta, Choerospondias axillaris* (fruits), *Piper pedicellatum, Gonostegia hirta,* (vegetable) *Collocasia affinis* (vegetable and fodder) are important and highly preferred by the Apatanis.

5.3 Species composition and population status of NTFPs.

The study of species composition and community structure by selecting the specific forests have been found helpful in evaluating the diversity, distribution and population characters of many NTFP yielding species. Majority of the locally used plant species particularly the timber and non timber forest products have been collected by the community from the nearby forests areas. Three community forest stands namely Nyilii (Hong community), Gyachi (Bulla community) and Dura (Hija community) were studied.

Selected study stands shows a good floristic diversity representing a typical temperate vegetation characterized by the dominance of species under the genera like *Pinus*, *Alnus*, *Castanopsis*, *Quercus*, *Rubus*, *Rosa*, *Fragaria*, *Primula*, *Rubia*, *Inula*, *Rananculus*, *Sauraria* etc. Occurrence of a total 138 species under 70 families and 116 genera with a minimum representation of 100 species in each study stand indicates a rich floristic diversity. The present reported diversity have been found higher than the reports of Behera *et al.* (2002) temperate forest of Lower subansiri, Paul (2008) from temperate broad leaved forest of Tawang and West Kameng districts. Dolezal and Srutek (2002) from central Himalaya and Semwal *et al.* (2010) from Kedarnath Wildlife Sanctuary, Central Himalaya. Species richness of the selected study stands showed the trend as herb layer > shrub layer > tree layer which is similar to that reported by Khera *et al.* (2001). Occurrence of species varies from stand to stand according to the preferences of the species towards the micro environmental conditions. Among the plant families the Fagaceae, Betulaceae, Magnoliaceae, Lauraceae among the tree, Rutaceae, Rosaceae, Eleagnaceae, Rubiaceae for the shrubs and Poaceae, Araliaceae, Araceae, Hypoxidaceae, Asteraceae and Urticaceae for herbs are found dominant families with more than 3 species in each category. However, Araceae, Asteraceae, Fagaceae and Rosaceae are represented by at least 5 species each. Among the families which are utilized for NTFPs, the families Rosaceae, Urticaceae, Araceae, Fagaceae, Poaceae, Zingiberaceae, Lauraceae, Rubiaceae, Moraceae stand in top with more than 2 major economically important species. Occurrence of many primitive families like Magnoliaceae, Rananculaceae, Fagaceae, Lauraceae, Rosaceae, have also been found which are associated with livelihood of the communities. Occurrence of 5 fern families namely Selaginaceae, Pteridaceae, Lomariopsidaceae, Lycopodiaceae, Polypodiaceae and Thelypteridaceae indicated the domination of fern population in the study sites. Pinaceae represented by *Pinus wallichiana* is the only Gymnospermic family but with a high socioeconomic and ecological value in the area.

Density of tree species of the present study found to vary from stand to stand. Tree density ranged 376 to 456 individuals ha^{-1} is within the range of reported value 140 to 750 individuals ha^{-1} from Pindari catchments forest (Pangtey *et al.*, 1989), 634 to 843 individuals ha^{-1} from sub-alpine zone of west Himalaya (Gairola *et al*., 2008) and 420 to 1640 individuals ha^{-1} from temperate forests of Kumaon Himalaya (Saxena

and Singh, 1982). The present shrub density ranged (2848 to 3696 individuals ha^{-1}) and herbaceous species density (14380 to 45000) is within the range value of 504 to 3576 individuals ha^{-1} reported by Paul (2008) from temperate forest of Western Arunachal Pradesh.

The present recorded basal area ranged between 22.82 to 51.64 m^2 ha^{-1} is within the range of 16.17-71.23 m^2 ha^{-1} from températe forest of Uttarkasi (Rajwar, 1991); 10.38-31.70 m^2 ha^{-1} from temperate forest of Garhwal Himalaya (Kumar *et al*., 2009). However, basal area recorded in the present study is much lower than the reported value of 9.22 to 137.35 m^2 ha^{-1} from Arunachal Himalaya (Paul, 2008). Variation in basal area of the present study may be due density, diversity of trees and favorable micro climatic condition for growth. Moreover, presence or absence of higher number of individuals having larger girth contributes towards the variation in basal area of the respective study stands.

The Shannon-Wiener index of trees, shrubs and herbs was much less than the value reported by Behera *et al*. (2002) in temperate-subalpine forest (5.82) however, nearly same in case of subtropical pine forest (3.25). The calculated values in the present study are almost same as reported elsewhere (Dolezal and Srutek, 2002; Kunwar and Sharma, 2004). Simpson's dominance index for trees, shrubs and herbs were found to be higher than the value reported by Behera *et al*., (2002) in temperate/subalpine forest (0.3) and subtropical pine forest (0.78) of Arunachal Pradesh. Paul (2008) also reported higher dominance index from temperate broad leaved forest of Arunachal Pradesh. Lower value of Shannon-Wiener diversity index of life form of the selected study stands indicated that the ecological structure is less complex (Odum, 1971).

Fairly similar geographic location and climatic condition exhibited more than 70% similarity of value between the study sites. Species having wide geographical distribution attributed to the highest similarity between the study sites. While, lowest similarity index between Nyilii and Dura study sites may be because of change in micro climatic and edaphic conditions between these two stands attributed to the turn over of plant species. Dominance-diversity curve for tree species showed that most of the IVI in all the stands were mainly concentrated in few dominant species. However, Behera *et al.*, (2002) and Paul (2008) reported that single species contributed

maximum IVI and density in temperate/subalpine and subtropical forest of Arunachal Pradesh.

In all the selected study stands nearly 80% of the tree species showed clumped distribution while only few species exhibited random distribution. None of the species showed regular distribution. Present distribution pattern of the plant species may be due to lack of competition for the resources among the individuals of the species for the growth and survival. Similar results were reported by Paul (2008) in temperate broad leaved forest of *Rhododendron* from Western Arunachal Pradesh.

Out of the total species recorded more than 50 important NTFP yielding species have been found in these three study stand comprising all the habit form. Among the tree species the very important ones having socio economic impacts are *Castanopsis armata*, *Castanopsis hystrix*, *Choerospondias axillaris*, *Cinnamomum bejolghota*, *Litsea cubeba*, *Magnolia champaka*, *Pinus wallichiana*, *Pyrus pashia* and *Rhus chinensis*. The density of distribution of these species revealed that except *Castanopsis armata*, *Magnolia champaca* and *Pinus wallichiana* all other species have very limited and poor representation in the forests with the density less than 15 individuals ha^{-1}. The other two very important species namely *Phoebe goalparensis* and *Litsea cubeba* used as NTFP for their fruits are also found with a better representation in population density with > 15 individuals ha^{-1}. Species like *Juglans regia* and *Ficus auriculata* that are found supportive to the communities represented with low density and frequency and are restricted to one or two sites only.

Among the shrubby layers about 12 high value NTFP species like *Berberis wallichiana*, *Calamus acanthospathus*, *Chimonobambusa griffithianus*, *Embelia ribes*, *Mahonia napaulensis*, *Rubia manjith*, *Rubus* sp. and *Zanthoxylum acanthopodium* have been recorded that can contribute to the economy of the poor people. Among these the density of population of the two species *Rubia manjith* and *Calamus acanthospathus* is found better in all the three sites. The *Rubia manjith* which have a high market demand for its dye yielding property was although found with the maximum density among all the shrubs in the Gyachi forest (272 individuals ha^{-1}), the density was comparatively lower in the other two forests indicating the Gyachi forests a better site for its growth. However the population density recorded here was found far below the value recorded by Gajurel (2012). The *Calamus acanthospathus* a cane

species of commerce and highly used by the communities indicated a good population density in all the sites (96-128 individuals ha^{-1}). The population of *Wallichia oblongifolia* which was also observed in all the three sites was found with a high population density in the Gyachi (Bulla) and Dura forests (Hija) with the value of 64 individuals ha^{-1} than the Nyilii forest with 32 individuals ha^{-1}. Another two socioeconomically important species used for spices and medicine namely *Zanthoxylum acanthopodium* and *Zanthoxylum oxyphyllum* were also recorded from all the three sites with an average population density (64-112 individuals ha^{-1}). Although the populations of majority of the shrubby or small tree species were found in all the sites, the species like *Docynia indica*, *Elaeagnus caudata*, *Embelia ribes* and *Thunbergia coccinea* were restricted to only in Nyilii forest indicating the diversity of NTFP species is high in the Nyilii forest.

The diversity of herbaceous plant in the ground vegetation is also found high and highest among all the habit form. More than 70 species of herbs with many economically important NTFPs have been found distributed in the sites. Occurrence of species of *Piper*, *Smilax*, *Pouzolzia*, *Oenanthe*, *Diplazium*, *Podophyllum*, *Houttuynia*, *Elatostema*, *Swertia* etc. which are very commonly preferred by the communities are found in the sites with different population status. Among all the herbs the density and frequency of population are found very high for some unused species like the three grass species and two fern species with more than 10000 individuals ha^{-1} indicating the dominancy of these species that may suppress the growth of the many useful herbs like *Elatostema platyphyllum*, *Houttuynia cordata*, *Oenanthe javanica*, *Pouzolzia hirta*, *Piper pedicellatum*, *Plantago erosa* which are highly preferred vegetable of the communities as well other important species like *Podophyllum hexandrum*. Among these important useful plants the highest density of distribution was exhibited by the vegetable plant *Houttuynia cordata with* >10000 individuals ha^{-1} in all the sites. However all other vegetable species like *Oenanthe javanica*, *Pouzolzia hirta*, *Elatostema platyphyllum*, *Piper pedicellatum*, *Plantago erosa* etc. exhibit comparatively low density (< 8000 individuals ha^{-1}) indicating comparatively poor population. However *Elatostema platyphyllum* showed a better population density in the Dura forest with more than 9000 individuals ha^{-1}. On the other hand the most preferred vegetable plant the *Piper pedicellatum* was recorded from only one stand but with very low population density. As the species preferred

moist humid soil with abundant growth in tropical and subtropical forests mostly below 1500 m (Gajurel *et al*., 2008), the present study sites are not found suitable for the growth of the species. Two very high value medicinal plants *Podophyllum hexandrum* and *Swertia angustifolia* were also recorded from the study sites where the former species could be located only from the Nyilii forest with very minimal population, while the later one was found in all the sites but with better frequency and density. It is interesting to note that these two species are mostly found in pure temperate forests in the state mostly beyond 2000 m (Gajurel, 2012) and occurrence of these species in the present study site clarify that the nature of the three community forests is temperate in nature.

The present study reveals that all the three forests stands comprise numerous important NTFPS having socioeconomic value and supporting the livelihood of the communities. Among the three study site overall diversity of NTFP have been found in the Nyilii forests stand but the density of population have been found better in Dura and Gyachi forests stands. All these forests have potentiality to grow the high value NTFP yielding species and if managed properly they can support the economy of the poor communities. Among the high value plants the population and regeneration of *Rubia manjith*, *Houttuynia cordata*, *Calamus acanthospathus* etc. are found good while the population status of *Piper pedicellatum*, *Podophyllum hexandrum*, *Pouzolzia hirta* etc. are very low. The low population of many species is because most of them are continuously harvested by the communities without any sustainable management.

5.4 Market and non-market potential of NTFPs.

The socio-economic importance and the value of NTFPs in the tropical countries are now well recognized (Gupta and Guleria, 1982; FAO, 1995). Especially the tribal populations not only in India but worldwide are the most benefitted from such forests and forest resources for their livelihood. The rich forests of Arunachal Pradesh support the diversity of both timbers as well as non-timber yielding species for the daily requirement of the people especially for those who live in the deep forests. The non-timber forest products (NTFPs) possess imperative part of the traditional life style in Arunachal Pradesh (Sarmah *et al*., 2008). NTFPs are often used as multipurpose products. NTFPs like fuel-wood, medicinal plants, wild edible

vegetables, house building materials etc. are integral part of day-to-day livelihood activities especially for tribal people (Sarmah, 2006). Unlike the other tribal communities of the state the Apatanis are not dependent on shifting cultivation and by virtue of their tradition and geographic location of the plateau, settled agriculture makes them partially self sufficient. However besides the agriculture, their socioeconomic life is also based on forest resources particularly the NTFPs. Their livelihood and economic condition is also contributed by the NTFPs, like the other majority of the tribes of north east India.

The study clearly revealed that among the various requirements, the NTFPs fulfilled the nutritional, medicinal, shelter, materials and ritual cultural needs, where nutritional, materials and rituals needs are more strongly supported by the NTFPs. Using wild vegetables and fruits as per the tradition and seasonal availability have been found as major socioeconomic aspects and these resources have potentiality for income generation too, due to high preference to all the communities. Bamboos and canes are regarded as part and parcel of the tribes of north east India (Sundriyal *et al.,* 2002). The Apatanis livelihood too is strongly associated with these species. However it has been found that the species *Phyllostachys bambusoides* famous as Apatani bamboo and the cane species *Calamus acantospathus* fulfilled majority of the needs like shelter, materialis, energy and rituals. Because of the temperate climate the other common species of Bamboo such as *Bambusa tulda, B. pallida, B. zygenteus* etc. used by most of the tribes are not available in the region. The Fagaceae members under the genera *Castanopsis* and *Quercus* locally referred as 'Kirah' are also unavoidable species that supports many NTFPs for house building, energy, items in festivals and rituals, fruits.

The present investigation revealed that about 60 NTFP species are found socio culturally strongly attached to the Apatanis as these species are preferred and used in various common and daily needs besides the economic gain. Moreover species like *Allium hookerii, Angiopteris evecta, Artemisia indica, Berberis wallichiana, Castanopsis hystrix, Cyathea gigantea, Dicranopteris linearis, Eremocaulon capitatum, Kavalama urens, Prunus persica, Phyllostachys bambusoides, Molineria capitulata, Saccharum arundinaceum* etc. are some of such

traditionally preferred plants. Except a few, almost all the species are collected by the communities in the wild form from the forests areas of Ziro and adjacent region.

The market survey undertaken in the study site has clearly revealed that the NTFPs also provide a good sustenance to the local communities. Although only a limited population of the community is engaged in the marketing of the forest products in the local market it has been found that many others are engaged in selling the product directly, after collection, to the vendors. The main market in Hapoli (Gandhi market) town area and market in Ziro (old Ziro) are the main market to sell the produces. Local Apatani women as well as the women's from the nearby areas play an active role in marketing and commercialization of NTFPs as well as the other horticultural products. Most of the NTFPs that are used as vegetables, fruits etc. are brought from the forest areas mainly for self consumption by the local people of Ziro. Some of the species were brought from the forest lands, home gardens and some from the jhum lands of neigbouring areas. Many of the marketed NTFPs were purchased from the neighboring areas like Joram, Yachuli and Raga villages. The people from the nearby areas collect the forest products from the wild and sell it in the main market on whole sale basis. The local ladies also transport the same forest products available to other markets outside Ziro mostly to capital complex markets in Naharlagun and Itanagar.

About 25 species have been found to be of high marketing and socioeconomic value. The bamboo particularly the *Phyllostachys bambusoides* and the cane *Calamus acantospathus* and *Plectocomia himalayana* have high utility and market potentiality. The other species having good market value constitutes the fruits and vegetable plants. Majority of the vegetable are sold in Rs. 40-60 Kg^{-1} in average prices but in heavy quantity. A vendor may earn Rs 400-600 per day from the marketing of 2 to 3 vegetable species. While the vendor selling the vegetable fruits like *Phoebe goalparensis, Magnolia* sp. earn higher amount upto Rs.800 per day. This indicates the landless class of people may take such opportunity for revenue generation using such valuable forest resources. Among all the marketed products about 15 species used for vegetable, spices and medicine and fruits are having higher preferences among other people and communities and accordingly marketed to capital markets as per their availabilities. The vegetable plants namely *Allium hookerii*, *Houttuynia*

cordata, Centella asiatica, Piper pedicellatum, Pouzolzia spp. and *Zanthoxylum* spp. believed to be more nutritious and medicinal and are the mostly demanded not only in the Ziro but in markets of capital complex that can be exploited for higher economic earning as their leafy parts can easily be harvested in sustainable way and also found along the bamboo growth and plantation.

The prices of the products are found to be varying according to the season, use, preference and demand of the people. The profit from the source of income varies according to the demand and selling of these forest products. There are some products which were available in plenty in the forests but were not sold in the market because of reasons like the forest being far and the female members who do not always go to forests for collection of these forest products as they have to go to the fields besides being involved in other household works.

It is interesting to note that the local people generally do not go for wide commercialization of these products, even though these products are locally preferred and can fetch good response when bought to the local market or outside market but they collect such products only for their own consumption. Wild edible fruits such as *Cissus repens, Vibernum foetidum, Choerospondias axillaris, Rhus chinensis, Mahonia napaulensis, Pyrus pashia, Rubus* etc. are highly preffered but rarely sold in the local markets. Such species can be commercialized and sold in the local markets as well as markets outside and can fetch a good market price. Besides some of the species like *Litsea cubeba*, they prefer buying it from the nearby Nyishi areas in whole sale and then sell it in the market. The reason for this being that they hardly get time for collection of such forests products, as they are mostly engaged in agricultural lands. The male members or the daily jungle goers collect such products but only for their own consumption sometimes because they mainly visit the jungle either for collection of firewood, or in search of their animals.

The adjacent forest areas of the Apatani plateau harbor some very high priced NTFP yielding plants mostly the medicinal which can play crucial role in economic development of the communities. Although these species are not found associated with the Apatani tradition and IKS, they are highly priced and used outside. Hence can be managed and marketed. Among these *Paris Polyphylla, Taxus wallichiana,*

Panax pseudoginseng, Illicium grifithii are the major ones and included in the list of globally significant medicinal plants (Gajurel, 2012).

Non-timber Forest Products (NTFPs) play a crucial role in alleviation of poverty and in promotion of economic development for forest dependent communities by contributing to livelihoods, including food security, income, health and sustainable development (FAO, 1995; Falconer, 1997). The management and conservation of the useful species in the area applying modern technology may really help the poor communities in reducing the poverty. Both conservation and development strategies should take into consideration in the socio-economic context of different beneficiaries in order to apply appropriate measures to poverty reduction (Katja *et al*., 2011).

5.5. Indigenous Knowledge Systems associated with NTFPs.

Traditional celebrations of fairs and festivals are keeping intact the cultural heritage of the Himalayan region and have remarkable contribution in conservation of forest and landscape (Pala *et al*., 2014). The north eastern region of India particularly the state of Arunachal Pradesh is a home of rich tradition and culture of many tribal communities (Elwin, 1957). The communities of the region are closely associated with the forests and many ritual celebrations and festivals are directly attached to the forest species and their conservation. The present study clearly revealed that the Apatanis, known for their rich culture and tradition, are intermingled with the forest resources for fulfillment of various cultural and traditional requirements. They are very observant of their rituals and festivals and their belief on these rites and rituals is very deeply connected with their everyday life. Among the various selected forest species used by the communities it has been found that *Calamus acanthospathus, Castanopsis hystrix, Castanopsis tribuloides* and *Phyllostachys bambusoides* are mostly utilized one and strongly attached to the culture and tradition of Apatanis. Because of the faiths and taboos they are being used in almost all the occasions. Every rituals or festivals whether at individual homes, or for festivals like ‘Myoko’, ‘Murung’ and ‘Dree’ begins with the preparation of ‘Agyang’ (sacred altar) where the main offering and sacrificial are done and almost 90% requirements are fulfilled by these species for making the sacred altar. The other species which are selectively used in one or two specific occasions particularly in ‘Myoko’ and ‘Murung’ are *Prunus persica, Machilus*

vilosa, Kavalama urens. It has been found that the *Saccharum arundinaceum* is a must use for Dree festival and have strong belief for protection of crop from insect. Although the uses of the species like *Saccharum arundinaceum, Prunus persica, Molineria capitulata, Exbucklandia populnea* are selectively used in one or two specific occasion but are essential and cannot be avoided. Species such as *Lagenaria siceraria and Zingiber officinalis* are of importance to the Apatanis in every rituals, ceremonies and festivals. Though this plant species are mostly cultivated and found in home gardens yet it has a lot of significance in carrying forward the rich culture and traditions of Apatanis. The study revealed that without all these species, it would be difficult to perform and continue the rich cultural practices of Apatanis. From importance and dependency point of view, bamboo and *Castanopsis* spp forests are most significant for Apatanis. The forests are maintained not only for meeting the requirements of fuel wood, wild edible fruits, fodder and timber but are also used for other socio-cultural activities and rituals (Dollo *et al.,* 2009).

As they recognize the value of each plant they also follow traditional conservation practices, which by and large found important in protection and conservation of natural heritage of the Apatani plateau. Plantation of all the useful species in home garden and, community forests as well as sustainable harvesting of these species have been commonly practiced by the communities. Plantation of species of Bamboo, *Magnolia, Pine, Castanopsis, Prunus*, etc. and caring and conservation of species of *Calamus*, *Sachharum* spp., *Mahonia* spp., etc in forests have got high priority because of their ritual and cultural value. On the other hand some forest species are marked as a sacred tree and are never being destroyed or felled. For instance the species of *Ficus* 'Saro sanii' is considered to be one of the most sacred trees by the Apatanis. There are certain restrictions in the felling of this tree for using as firewood or any other uses. There is a belief that attending natures call or spitting in front of the 'Saro sanii' is a bad omen and it may either bring bad health to the person concerned or may affect any member in his family or bring bad luck, as they believe that evil spirits resides in such trees as a resting place.

Though no important taboos are associated with the use of some plant species for religious purposes yet certain taboos known as 'Anyodu' are followed along with every rituals or festivals where there is certain restrictions implied in the form of not consuming certain food items or not going to jungles, fields etc. depending on the

type of rituals performed by the indiviual or community. Apart from the uses of plant species, animals like Hen, Dog, Mithun, Monkey etc. also play important role for the completion of rituals depending on the demands and types of festival or rituals being performed. Squirrel called as *Dremomys lokriah* 'Takhii' is also one of the most important animal species that is used by Apatanis for various social ceremonies like 'Murung', 'Myoko' etc. The flora and fauna associated with socio-cultural and other ritualistic importance are protected by a mechanism called 'Dapo'. A system managed by the 'Bulyang' (traditional councils) for protection and over extraction of forest resources (Dollo *et al*, 2010).

The earlier studies (Habung, 2008, Sundriyal *et al.*, 2004, Srivastava *et al.*, 2010) have also focused on the rich indigenous knowledge system of Apatanis in relation to forest resource utilization and conservation practices. The community is also very rich in ethobotanical knowledge that helps them to selectively use many forest resources for fulfillment of various requirement and healthcare practices (Kala, 2005, Bamin *et al*., 2013). Overall the rich traditional knowledge of the Apatanis particularly the fair and festivals are found very useful in conservation of forests. Apatanis are considered as efficient resource managers with rich traditional ecological knowledge and conservationists by nature, thereby attracting the attention of UNESCO for the Ziro valley being considered for declaration as World Heritage Site (Chaudhry *et al.*, 2011) The spiritual and cultural values of indigenous communities, would be of immense value in conserving biodiversity (Rudd,1960).

The Apatanis rituals and culture is truly harmonized with the forest and forest species. The unique traditional knowledge system of the community is found very supportive in conservation and management of forests species and other natural resources. The traditional and cultural ethics linked with specific forest species not only found as supportive to the community but also nature friendly as all the resources used are given due importance in their cultivation and management.

CONCLUSIONS

The following conclusions are drawn from the present study:

- A total of 147 species of plants under 118 genera and 65 families are found utilised by Apatanis as various NTFPs yielding species. The species are represented by 138 Angiosperms, 1 Gymnosperm, 6 Pteridophytes and 2 fungal species.

- Most dominant families are Asteraceae, Poaceae, Rosaceae, Arecaceae, Fagaceae, Lamiaceae, Lauraceae, Araceae, Moraceae and Solanaceae.

- Based on utilization pattern, 12 distinct categories of NTFPs are documented having maximum species under food category with 88 species and minimum species under gums and dyes with 4 species each.

- On the basis of plant parts used they are categorized into 16 different classes. Leaves are used predominantly (61 spp.) mostly in vegetables and medicines followed by fruits and seeds (43 spp.), stems (26 spp.), and whole plant (24 spp.).

- The present study on phytosociological analysis in the selected community forest stands reveals the occurrence of 138 species with various population density and distribution that indicates a good floristic diversity of the forests supporting the NTFPs and other requirements.

- More than 50 important NTFP yielding species composed of all the habitat forms i. e. herbs, shrubs, trees and climbing species are reported in the selected sites.

- Many commercially high value and socio-culturally preferred species like *Calamus acanthospathus, Phyllostachys bambusoides, Castanopsis* spp, *Pinus wallichiana, Magnolia champaca, Piper pedicellatum, Gonostegia hirta, Oenanthe javanica, Diplazium esculentum, Podophyllum hexandrum, Houttuynia cordata, Elatostema platyphyllum,* etc. were recorded with different population density and frequency.

- The species like *Alnus nepalensis, Magnolia champaca, Rubia manjith, Calamus acanthospathus, Castanopsis hystrix,* etc. found with good population densities. In contrast the populations of a few other important species like *Piper*

pedicellatum, Podophyllum hexandrum, Gonostegia hirta, Wallichia oblongifolia etc. are found very low indicating the need of their proper management.

- The analysis of market reveals that 25 species of food plants are commonly marketed from the area. The fruits of *Castanopsis hystrix*, *Phoebe goalparensis* and *Magnolia champaca,* fruits of *Zanthoxylum armatum* and *Solanum kurzii*, leafy shoots of *Acmella paniculata*, *Houttuynia cordata* and young shoots of *Phyllostachys bambusoides* are found to have high market value.

- Sixty species are found socio-culturally closely attached to the Apatanis and are being used by almost all the household to fulfil their common needs. *Phyllostachys bambusoides, Calamus acanthospathus, Castanopsis hystrix, C. tribuloides, C. armata, and Quercus lamellosa,* are found as most important NTFPs having multipurpose uses and also inevitably associated in the religious festivals and ceremonies.

- The herbal salt preparation using six different species namely *Cirsium interpositum, Cyatula prostrate, Pogostemon yatabeanus, Phragmites karka, Vernonia cineria, Typhonium trilobatum* by the community is found very unique tradition and is found to be associated with the rich culture of the communities.

- Various non wood forest products are found associated with the various cultural events where the selection and uses of specific products is made based on some religious beliefs and faiths. Besides the bamboos and cane, the species like *Kavalama urens, Saccharum arundinaceum, Molineria capitulata, Machilus villosa, Cyclosorus glandulosus, Mahonia napaulensis* etc. are found associated with specific social attachments unavoidable in the Apatani ritual and festivals.

- The rich Indigenous Knowledge Systems associated with utilization of various NTFPs is well reflected through their rituals and religious performances and celebrations.

Future Prospects of the study:

- Selection and phytochemical analysis of important edible and medicinal plant species.
- Phytochemical investigations on the properties of the species used in preparation of Apatani herbal salt.
- Selection and cultivation of high value market potential species.
- Promotion of marketing and value additions of numerous products.
- Conservation of rare and thinly populated species having higher utility rate.
- Regeneration studies of high value NTFPs found in the community forests.
- Promotion and protection of Indigenous Knowledge Systems of Apatanis.

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APPENDIX- I

Questionnaire for Data Collection on NTFP:

1. Person(s) interviewed:
   i. Name:
   ii. Sex:
   iii. Age:
   iv. Profession:
2. Details on species recorded:
   i. Scientific Name:

   ii. Common Name:

   iii. Local name:

   iv. Family:

   v. Habit:

   vi. Part Used:

   vii. Method of preparation:

   viii. Cultivated or wild:

   ix. Method of harvesting:

   x. Season of collection:

3. Market Survey:
   Name of Market:
   Type of market: Daily/weekly
   No. of vendors:
   Demand: Low/moderate/high

Sl. no.	NTFPs sold	Species name	Kg day/ week	Sale value per kg (Rs.)	Who goes for collection?
1	Vegetables				
2	Bamboo				
3	Cane				
4	Fruit				
5	Others				

4. Traditional Knowledge Systems:

i. Why do Apatanis use or prefer using forest resources? Any special belief or taboos associated for using the forest resources?

ii. Any belief of the Apatani's in regard to their forest and its resources?

iii. How do they conserve their forests? Do they follow or observe any special rituals or beliefs for conserving forests? What steps are followed traditionally?

5. Selection of Resources:

i. Is there any special or particular method/time/season for collection of any plants or any forests resources by Apatanis? Or any particular location for collection of a particular plants like fruits, vegetables, firewood or any forest resources used in day to day basis?

ii. Do they perform any rituals or taboos before collection of resources from forests like firewood, vegetables, canes, fruits etc?

iii. Is there any particular area or place from which resources used in performing rituals or festivals are collected or preferred collecting? Any taboos or totems associated with it?

Ceremonies:

Name of ceremony	**Details of ceremony**	**Duration of ceremony**	**Taboos**	**Participants**
Birth				
Death				
Marriage				
Any others				

Plants used in festivals and rituals:

Name of festival/ rituals	**Name of plant**	**Plant part used**	**Who and from where it collect?**	**Significance in festival/rituals**	**Alternative used**

Animals used in rituals and festivals:

Name of festival/ rituals	**Name of animal sacrifice in festival /rituals**	**Name of animal/parts used**	**Source of collection**	**Alternative used**

APPENDIX- II

List of Publications:

- Bamin Y., Gajurel, P. R., Potsangbam, S. and Bhuyan. L. R. (2013) Account of common and traditional non-timber forest products used by Apatani Tribe of Arunachal Pradesh, India. *Pleione,* 7(2): 514 - 529.

- Chaudhry P, Dollo, M., and Bamin, Y. (2011) Traditional biodiversity conservation and natural resource management system of some tribes of Arunachal Pradesh, India. *Interdisciplinary Environmental Review*, 12(4): 338–348.

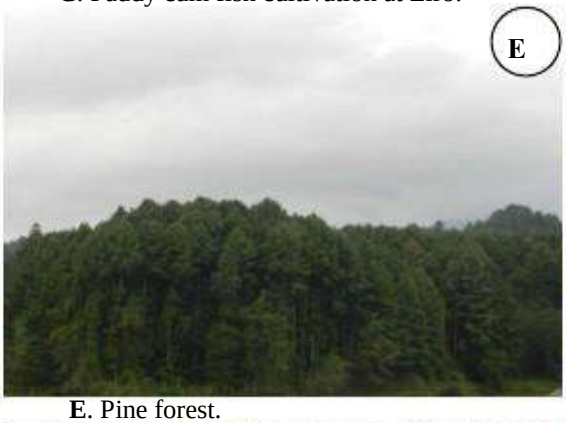
- Bamin Y and Gajurel P. R. (2014). Traditional utilization of plants in festivals, rituals and their conservation by Apatani Tribe of Arunachal Pradesh, North East India. *International Journal of Conservation Science* (under review).

A. Bird's eye view of study area Ziro.

B. Traditional Apatani village at Hong.

C. Paddy cum fish cultivation at Ziro.

D. Bamboo forest.



E. Pine forest.

F. Castanopsis forest.

G. Community forest at Bulla.

H. Community forest at Hija.

Plate 1

A. *Acmella paniculata* (Wallich. ex. DC.) R.K. Jansen

Family: Asteraceae

Local name: Yorkhung

Uses: Leafy shoots taken as vegetable, consumed raw against constipation.

B. *Acorus calamus* Linn.

Family: Asteraceae

Local name: Kile tolyo

Uses: Paste of rhizome applied on cuts, wounds and bone fracture.

C. *Artemisia indica* Willd.

Family: Asteraceae

Local name: Kukulyu

Uses: Vegetable, leaves used as insecticides and used for relief against headache and nose blockade.

D. *Balanophora dioica* R. Br. ex Royle

Family: Belanophoraceae

Local name: Kiidi payu

Uses: Paste of rhizome is used as gum.

Plate 2

A. *Berberis wallichiana* DC.

Family: Berberidaceae

Local name: Tiipe tiire

Uses: Spines used for tattoing, paste of the bark gives relief from wounds and swellings.

B. *Calamus acantospathus* Griff.

Family: Arecaceae

Local name: Taser

Uses: Fiber used in house building, household items and for making accessories in rituals.

C. *Cardamine hirsuta* Linn.

Family: Brassicaceae

Local name: Padii hamang

Uses: Young shoots taken as salad.

D. *Choerospondias axillaris* (Roxb.) B. L. Burtt & A. W. Hill

Family: Anacardiaceae

Local name: Biiling

Uses: Fruits edible.

Plate 3

A. *Cinnamomum bejolghota* (Buch.- Ham.) Sweet.

Family: Lauraceae

Local name: Yatti/ Sangin

Uses: Leaves used for making rain shield 'Yatti'.

B. *Cinnamomum verum* J. Presl.

Family: Lauraceae

Local name: Salley

Uses: Bark and roots used as spices.

C. *Cirsium interpositum* Petr.

Family: Asteraceae

Local name: Lobyo tire/ Tipey tire

Uses: Whole plant used for making local salt, spines used for tattoing.

D. *Cissus repens* Lam.

Family: Vitaceae

Local name: Hulla/Taru beku

Uses: Fruits edible.

Plate 4

A. *Colocasia affinis* Schott.

Family: Araceae

Local name: Yarri

Uses: Leaves used as fodder.

B. *Cyathea gigantea* (wall. ex. Hook.) Holtt.

Family: Cyatheaceae

Local name: Tashe

Uses: Pith used as food, fodder, leaves used for relief against bodyache.

C. *Cyclosorus glandulosus* (Blume) Ching.

Family: Thelypteridaceae

Local name: Milo riji

Uses: Leaves used in religious purposes.

D. *Dendrophthoe falcata* (Linn.f.) Ettingsh.

Family: Loranthaceae

Local name: Sanii payu

Uses: Seeds used as gum.

Plate 5

A. *Duchesnia indica* (Andrew) Focke.

Family: Rosaceae

Local name: Subu tute jilyung

Uses: Fruits edible.

B. *Exbucklandia populnea* (R. Br. ex Griff.) R. W. Br.

Family: Lauraceae

Local name: Dolo/Tapo

Uses: Trunk used for house building, Pod used as spoon by children.

C. *Ficus auriculata* Lour.

Family: Moraceae

Local name: Taro

Uses: Fruits edible.

D. *Ficus sarmentosa* Buch-Ham. ex. J. E. Sm.

Family: Moraceae

Local name: Sireh myarung

Uses: Young fruits edible.

Plate 6

A. *Gnaphalium affine* D. Don

Family: Asteraceae

Local name: Miiyang

Uses: Dry leaves used for making fire.

B. *Gymnostema pentaphyllum* (Thunb.) Makino.

Family: Cucurbitaceae

Local name: Rikko

Uses: Dried stem paste is used for cough and cold.

C. *Houttuynia cordata* Thunb. Kongl.

Family: Saururaceae

Local name: Sia hamang

Uses: leafy shoots taken as vegetable, good appetizer.

D. *Juncus effesus* Linn.

Family: Juncaceae

Local name: Mima

Uses: Whole plant used for tying vegetables, meat etc.

Plate 7

A. *Kavalama urens* (Roxb.) Raf.

Family: Sterculaceae

Local name: Niiji yanii

Uses: Leaves used for wrapping food items, local rice beer during religious ceremonies.

B. *Litsea cubeba* (Lour.) Pers.

Family: Lauraceae

Local name: Santero

Uses: Fruits taken as spices, gives relief from cough and cold.

C. *Loropetalum chinense* (R. Br.) Oliv.

Family: Hamamelidaceae

Local name: Marri ripu

Uses: Leaf branches used in religious ceremonies.

D. *Mahonia nepaulensis* DC.

Family: Berberidaceae

Local name: Taaming

Uses: Fruits edible, bark used as dye, bark and leaves used in religious purposes.

Plate 8

A. *Molineria capitulata* (Lour.) Herb.

Family: Hypoxidaceae

Local name: Loli

Uses: Leaves used in religious ceremonies.

B. *Morus alba* Linn.

Family: Moraceae

Local name: Gende

Uses: Fruits edible.

C. *Myrica esculenta* Buch.-Ham. ex D. Don

Family: Myricaceae

Local name: Baching

Uses: Fruits edible.

D. *Oenanthe javanica* (Blume) DC.

Family: Apiaceae

Local name: hiigu

Uses: Leafy shoots taken as vegetable and gives relief from indigestion.

Plate 9

A. *Phoebe goalparensis* Hutch.

Family: Lauraceae

Local name: Samper

Uses: Fruits used for making chutney.

B. *Phragmites karka* (Retz.) Trin. ex. steud.

Family: Poaceae

Local name: Pepu

Uses: Whole plant used for making local salt, roofing, household item.

C. *Phyllostachys bambusoides* Gamble

Family: Poaceae

Local name: Byapu/Bije

Uses: Young shoots used as vegetables, mature culm used for house building, religious purposes, handicrafts etc.

D. *Physalis angulata* Linn.

Family: Solanaceae

Local name: Apu byayung

Uses: Fruit taken as vegetable and is good for stomach disorders.

Plate 10

A. *Pinus wallichiana* A. B. Jackson

Family: Pinaceae

Local name: Piisa

Uses: Resins, cones and bark used as firewood. Resins also as medicine in cuts, wounds and cracked heels.

B. *Pogostemon yatabeanus* (Makino) Press

Family: Lamiaceae

Local name: Higu hiha

Uses: Whole plant is dried and used for making local salt.

C. *Rubus ellipticus* Sm.

Family: Rosaceae

Local name: Jilyung

Uses: Fruits edible.

D. *Vibernum foetidum* Wall.

Family: Caprifoliaceae

Local name: Yoyu

Uses: Fruits edible.

Plate 11

A. Daily market at Hapoli.

B. Interaction with the local vendor.

C. Tubers of *Colocasia esculenta.*

D. Fruits of *Solanum nigrum.*

E. Leaves of *Allium hookeri* & *Litsea cubeba.*

F. Fruit of *Lagneria siceraria.*

G. Leaves of *Piper pedicellatum.*

H. Dry fruits of *Magnolia champaca.*

Plate 12

A. Bamboo basket.

B. Fresh Bamboo shoot.

C. Bamboo floor.

D. Fermented bamboo shoot.

E. Bamboo container.

G. Basket for storing rice.

F. Rain shield.

Plate 13

A. An Apatani priest ‘Nyibu’ chanting rituals.

B. Stacks of *Machilus vilosa* ‘Sama Yasang’ readied for performing rituals during the start of ‘Myoko’ festival known as ‘Sama pining’.

C. Procession ‘Penii’ carried out during Myoko‘. Only the male members participate holding leaf branches of *Calamus acanthospathus* called ‘Tazer’.

D. Traditional altar ‘Agyang’ made of *Phyllostachys bambusoides, Calamus acanthospathus, Castanopsis* spp.during ‘Murung’ festival.

Plate 14

A. Sacred altar 'Nago' of Myoko made of *Phyllostachys bambusoides, Calamus acanthospathus, Castanopsis* spp.

B. Sacred altar 'Dree agyang' prepared for Dree festival made of *Phyllostachys bambusoides, Calamus acanthospathus, Cyclosorus glandulosus, Saccharum arundinaceum.*

C. Ladle 'Yaju' made of *Lageneria siceraria,* basket 'Supung liha' and container 'Supung Pinta' made of bamboo and cane species used during festivals. Leaves of *Kavalama urens* used for offering rice powder during religious ceremonies like 'Myoko', 'Murung' etc.

D. Women were performing rituals'Ayi Supung' offering rice powder' Yatang' and rice beer 'O' on the main altar Yugiyang' placed for 'Myoko'. *Prunus persica* is used as the main altar.

Plate 15

A. The ash 'Piyu' obtained after burning the different plants called 'piyu hubiyu'.

B. Filtration of 'piyu' on bamboo funnel.

C. 'Pila' filtrate obtained after filtration.

D. 'Tapyo' wrapped and ready for use.

E. 'Tero Pila' made of chilli, pork fat, 'tapiyo', and 'pila' taken with leafy shoots of *Houttuynia cordata.*

F. Local chutney 'Pikey' made of bamboo shoot, 'pila', 'tapiyo', chilli and pork fat.

Plate 16