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 acanthosphatus* 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 show 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*, *Ranunculus*, *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, Ranunculaceae, 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
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 temperate 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 Nyili 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 acanthosphatus*, *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 acanthosphatus* 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 acanthosphatus* 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 oxyphillum* 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, materials, energy and rituals. Because of the temperate climate the other common species of Bamboo such as *Bambusa tulda, B. pallida, B. zygent eus* 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 hookeri, Angiopteris evecta, Artemisia indica, Berberis wallichiana, Castanopsis hystrix, Cyathea gigantea, Dicranopteris linearis, Eremocaulon capitatum, Kavalama uren, 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 acantosphatus* 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, Viburnum 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 griffithii* 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*, *Sachcharum* 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 individual 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, Phragmite s 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.