Non-timber Forest Products, Their Vulnerability and Conservation in a Designated UNESCO Heritage Site of Arunanchal Pradesh, India

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Abstract

The Apatani, non-nomadic tribe, have evolved an ecologically sustainable system of rural forestry in Ziro Valley, a proposed heritage site of UNESCO. They have been using non-timber forest products (NTFPs) grown in homestead and nearby forests for a very long period. The present study was aimed at identification of priority NTFPs and uses, their availability status and availability trend, conservation need, and sustainability interventions. Qualitative methods of research like, exploratory survey, questionnaire survey, focus group discussion, semi-structured interview of key informants, etc. were employed for data collection. The Apatani used 112 priority NTFPs for food supplement, herbal medicine, house building material and other purposes. However, on the basis of ecological importance such NTFPs were categorized as very low, low, moderate, high, and very high vulnerable species. Twenty vulnerable species like Antitauri ayi (Actinidia callosa), Biling (Choerospondias axillaris), Henchi (Rubus niveus), Jojaru ayi (Cocinea grandis), Ngifying Khisho (Centella asiatica) etc. should be conserved and seventeen not vulnerable species at this stage like, Padu hamang (Cardamum lourate), Sankhe (Quercus griffithii), Bge (Phyllloschrys mnni), Hugu hamang (Ounathie javanica), Kiira (Quercus dealbata), etc. could be commercialized. However, a balance needed to be struck between commercialization and conservation by adopting a comprehensive policy based on scientific and traditional Apatani knowledge for harvesting and regeneration of NTFPs. Homegardening or community farming is recommended for sustainable supply of commercially important species to be domesticated.

Keywords: availability status, availability trend, conservation need, homegardening, priority NTFPs, sustainable intervention, vulnerability index

Introduction

A majority of tribal communities in Arunanchal Pradesh depend on forest resources, in the form of non-timber forest products (NTFPs), for their livelihood and daily need. One such community, the Apatani, confined to the Ziro Valley of the Lower Subansiri district, is still entirely dependent on forest resources and products for their daily requirement of food supplements (like fruits and vegetables), herbal medicines, dyes, firewood, other household and religious needs (Yakang et al., 2013). The Apatani have created one of the most intensively cultivated and ecologically sustainable economies in Ziro Valley achieved anywhere in the world (Taylor, 2009). Over the centuries, Apatani socio-cultural forms have grown in intricacy, structure and mutual interdependence, as population density, prosperity and intensity of land utilization has grown (Furer-Haimendorf, 1980). They have also evolved an ecologically sustainable system of rural forestry, which not only supports their livelihood by meeting the need for food, fuelwood, timber, fodder and medicine but has also helped in protecting biodiversity (Barua and Slowik, 2000).

The Apatani are subsisting on bioreresources produced in the Valley and are independent of the outside world for their need of food, medicine, housing material, etc. This self-reliance is the result of a rich traditional ecological knowledge system practiced for the maintenance of a sustainable livelihood (Barua and Slowik, 2000). Their culture, tradition, knowledge about agriculture, forest management system and conservation techniques are so unique and valued that the Valley is proposed as UNESCO heritage site (Dollo et al., 2009; Rahman, 2015; Yakang, 2015). However, increasing population, increased exposure to life outside the Valley and adoption of a modern lifestyle may influence the status of NTFPs for financial gain with an inherent risk of commercial exploitation followed by sustainability issue.

Since Apatani history developed during several centuries now is getting influenced by the spread of cosmopolitan culture (Rechlin and Varuni, 2006) with suspected impact on self-reliant traditional knowledge and practices of wild resource use, the present study was aimed at gathering information on the NTFPs and their current management practices. The focus was on the identification of priority NTFPs and uses, their availability status and trend, conservation need, and sustainability intervention.

Materials and Methods

Study site

This was an exploratory and qualitative study on collection, consumption and conservation of NTFPs in Ziro (27°33'59"N and 93°49'53"E) Valley in Lower Subansiri district of...
Methodology

The study was conducted between August 2014 and October 2015. A reconnaissance survey in the new and old villages of Ziro Valley revealed that the younger generation had only superficial knowledge about NTFPs, their use, commercialization, conservation, etc. as compared to older people and some middle-aged professionals who were directly or indirectly involved in NTFP harvesting and utilization. Therefore, the latter category of informants was targeted to collect information about collection, consumption, conservation, etc. of the most important NTFPs. Rechlin and Varuni (2006) had also observed that younger generations were spending less and less time in the forests and forest based activities had become less important for survival. As is often the case with traditional societies, the older generations had more intimate knowledge of their plantations, the uses of various trees and herbs, and of the hunting trails through clan forests. A lot of traditional knowledge was being forgotten or discarded by younger generations, mainly due to scarce communication between young and old people (DAL, 2009).

Altogether 17 sites, old and new villages, were included in this study. Fourteen villages (Andong-Tage, Bami, Bamin-Mich, Biila, Bolya, Hari, Hija, Hong, Kalung, Lempia, Posumla, Retu, Suliya and Tajang) and one urban centre (Hapoli) were examined through survey. The key informants contacted for semi-structured interview represented five villages (Dutta, Hari, Hong, Kalung and Old Ziro). Since older people were more comfortable interacting in their dialect, local interpreters were engaged for the questionnaire and semi-structured interview. The questionnaire was mainly used for village dwellers whose main profession was farming but a few vendors were also included. The selection of respondents as well as villages were random. The semi-structured interview was done with those who were engaged in professions other than farming. The selection of key informants was based on the information provided by the village dwellers during interaction. The interaction was slow and also limited in terms of productivity as the targeted people were engaged in work during the day and were only available in the evening, able to spare little time from their busy evening schedule. However, 45 village residents and nine experts from the Apatani community were contacted for questionnaire and semi-structured interview, respectively.

Almost all the respondents provided the vernacular name of the NTFPs. A taxonomist (Dr. P. Gajurel, NERIST, Nirjuli, Arunachal Pradesh) was consulted for scientific identification of these species. Based on this interaction it was found out that very little work had been done on the taxonomy of plants in the Apatani area or Ziro Valley. Inconsistencies were noticed in the transcription of Apatani names by the various respondents-interviewees, interviewer and interpreters. This was a result of the absence of a standardized written script for the Apatani language. In order to counter the inconsistencies in transcription a recently published Apatani language dictionary in the Roman script was consulted. However, some of the vernacular names were converted to scientific names using the literature (DAL, 2009; Srivastava et al., 2010; Yakang et al., 2013) and by contacting the local Forest Officers (Rinya K. And Tachang N.) and the Chairman, Biodiversity Management Committees of Ziro Valley (Hibu Tatu, Mudang Challyang and Taru Palo).

While assessing the availability status of the same NTFP in Ziro Valley, the respondents gave different opinions. Based on this qualitative assessment (solely perception of the respondents)
they could be divided into Abundant, Limited and Scarce categories. It was perceived by the author during the interaction that the villagers’ assessment was based on the availability of the NTFPs in their area (community forest or home gardens) not the whole Valley. Therefore, these assessments were quantified into 3, 2 and 1, respectively. The values were averaged out and rounded off to find out actual category of availability status of a particular NTFP (for e.g. >2.5 was Abundant, >1.5 to <2.5 was Limited and = or <1.5 was Scarce). A similar method was adopted for the availability trend with respect to the past 10-15 years, and they were classified in the following categories: Increase, Stable and Decrease. Since availability status and availability trend both influenced the priority of conservation of a species, a “Vulnerability Index” was developed by combining these two parameters into nine different sets and giving them total scores (e.g. 3+3=6 to Abundant-Increase; 1+1=2 to Scarce-Decrease). These sets were further grouped on the basis of total scores: 6, 5, 4, 3, and 2 and presented in the form of a matrix as depicted in Fig. 2.

Results and Discussion

The questionnaire survey revealed that 96% of the respondents were using NTFPs produced in Ziro Valley. Information from some of the key informants and village elders (Gaonhwa) revealed that NTFPs grew in and were collected from kitchen gardens, Bamboo (Bije) groves, bunds of paddy fields (Lengo Aji and Ado Aji), homesteads (Yorite), and individual/clan/village/community forests (Morye). These parcels of land were found in an almost definite pattern with reference to the settlement (Fig 3) and at a tentative distance (pers. comm. Tasso Sira). While kitchen gardens were currently maintained for growing mostly exotic vegetables and fruits, barrng a few indigenous species, community forests were the main source of indigenous NTFPs. Altogether 112 products of non-timber nature were reported to be used by the Apatani community for different purposes like food supplement, medicine, house construction materials, etc. (Table 1). Many other NTFPs used by them during social customs and rituals were excluded from the text except of those with high emphasis. However, out of all the prioritized NTFP species only 89 could be identified with scientific names. They were of different categories like food plants, medicinal plants, construction material yielding plants and others. Some of them were found common in earlier reported researches like Yakang et al. (2013) where 61 common traditional species were used by Apatani. Also Srivastava et al. (2010) declared 33 species of indigenous biodiversity from Apatani plateau and last but not the least Kala (2005) found 27 ethnomedicinal plants of the Apatani. Literature review also suggested that these species were distributed beyond Ziro Valley, even in the same (Subansiri) or more districts (Changlang, Dibang, Kameng, Lohit, Siang, Tawang, Tirap) of Arunachal Pradesh (BSL, 1996; 2008; 2009) and some of them were used by other tribes for food or medicinal purposes (Kagyung et al., 2010; Rethy et al., 2010; Doley et al., 2015). These plants were classified among Dicotyledons (Acanthaceae, Aconitaceae, Actinidiaceae, Amaranthaceae, Anacardiaceae, Apiaceae, Araliaceae, Asteraceae, Begoniaceae, Berberidaceae, Brassicaceae, Cappripoliaceae, Cucurbitaceae, Elaeagnaceae, Euphorbiaceae, Fagaceae, Lamiales, Lauraceae, Magnoliaceae, Moraceae, Myricaceae, Oleaceae, Oxalidaceae, Piperaceae, Plantaginaceae, Polygonaceae, Rhamnaceae, Rosaceae, Rubiaceae, Rutaceae, Saururaceae, Solanaceae, Symprocneaceae, Theaceae, Urticaceae, Verbenaceae), Monocot (Arecaceae, Dioscoreaceae, Poaceae, Liliaceae ), Gymnosperm (Pinaceae, Taxaceae) and Psoridophyte (Athyraceae, Gleicheniaceae) families. Kala (2005) working on ethnomedicinal plants of Apatani also reported some of these as dominant families of medicinal plants (Acanthaceae,Asteraceae, Lamiaceae, Rosaceae, Rutaceae, Solanaceae, Urticaceae, and Verbenaceae). Other dominant families in the same area reported by Yakang (2015) are Lauraceae, Magnoliaceae, Rubiaceae, Poaceae, Arecaceae etc.

Priority NTFPs

The staple food of the Apatani was rice and fish produced in the Valley which was supplemented by wild fruits and vegetables. Wild plant materials were used for health care. Traditional homes were also constructed by materials produced in the community/clan/individual forests and homegardens. The Apatani tribe used a large number of wild NTFPs to meet their diverse requirement and this was possible largely due to the prevalence of a diversity of vegetation in that area (Katewa, 2003). Priority-NTFPs used and identified by them during the present study were 61 species of food supplement, 27 species of medicine, 15 species of construction materials and 9 species of other uses (Table 1). However, all the priority NTFPs identified during the present study were coming either from the forests or homesteads for consumption of the products by the producers directly in the form of green fruits/vegetables/other plant parts or semi-processed/dry form after storage. They were also sold in the market in both fresh and dry form for the consumption of non-producers. Details of the flow of the NTFPs like, production and collection, and disposal through sale are presented in Fig. 4. It was apparent that majority of the products were collected from the forests as compared to home gardens. It was also evident that large number of products was consumed fresh probably day by day. This indicated that the Apatani managed their forests and homegardens aiming directly at NTFP collection and indirectly achieving environmental functions like carbon storage, nutrient cycling, erosion control and hydrological regulation (Myers, 1988; Gillis, 1992).

In Ziro Valley, more than 270 NTFPs of plant origins, mostly wild, have been recorded earlier by different researches (Kala, 2005; Srivastava et al., 2010; Yakang et al., 2013). However, priority NTFPs identified for the purpose of food supplement, medicine, house construction material and few others during this study stood at only 112, which is much lower in number. These plants were frequently used by the Valley people because of their low cost and local availability. In addition
| No. | Vernacular name* | Scientific name | Category |
|-----|------------------|-----------------|----------|
| 1   | Ausitani ayi     | Aristolochia calustra | Food supplement (Wild Kiwi, fruits eaten raw) |
| 2   | Baching ayi      | Myrcia caesia     | Food supplement (Fruits eaten raw) / Medicine |
| 3   | Biing            | Choridodendron accolae | Food supplement (Fruits eaten raw) |
| 4   | Biya             | Pseudolysitthus mandolineae | Construction material (Mainly in house construction) |
| 5   | Byako (Poro & Amu) | Selaginum myricanthum, S. kurzii | Food supplement (Fruits used as vegetable) |
| 6   | Byguu            | Pseudolysitthus mania | Food supplement (Young bamboo shoots eaten) |
| 7   | Bykhu            | Rubia serpentina    | Other (Tuber used with Rubia serpentina produce dye) |
| 8   | Byng (Engin)     | Dioscorea hamanii   | Food supplement (Edible tuber) |
| 9   | Genda hamanu (Hadyu hamanu) | Zanthoxylum rhesa | Food supplement (Vegetable) |
| 10  | Gisangh hamanu (Gisun hamanu) | Buxus japonica var. rugosa | Food supplement (Vegetable) |
| 11  | Gisun**          | Panax pseudoginseng | Medicine (Plant extract) |
| 12  | Hari ayi         | Elaeagnus latifoliis | Food supplement (Fruits eaten raw) |
| 13  | Hantu ayi        | Aristolochia chinensis | Food supplement (Juicy edible fruits) |
| 14  | Hechi            | Rubus vernus       | Food supplement (Fruits eaten raw) |
| 15  | Hulho hamanu     | Hydroneuris jambu    | Food supplement (Leaves as vegetable) |
| 16  | Hulho lama       | Hydroneuris jambu    | Medicine (Medicinal root) |
| 17  | Hulho hamanu (Hulu hamanu) | Osmanthus grandiflora | Food supplement (Medicinal & Vegetable) |
| 18  | Hulwater hamanu (Huku hamanu) | Diplazium radiziatum | Food supplement (Vegetable) |
| 19  | Hulpe            | Elaeagnus platycladus | Food supplement (Vegetable) |
| 20  | Hulpe hamanu     | Gonostegia birta    | Food supplement (Vegetable) |
| 21  | Huopo hamanu     | Solanum nigrum     | Food supplement (Vegetable) |
| 22  | Impo (Impo)      | Zanthoxylum jamaicen | Medicine / Animal poison (Smoke used in arrows for hunting) |
| 23  | Impo (Impo)      | A. heterophylla     | Medicine / Animal poison |
| 24  | Jingay / Jyuan   | Rubus disciphius    | Food supplement (Fruits eaten raw) |
| 25  | Jorou ayi        | Cinnamomum zeylanicum | Food supplement (Fruits eaten raw) |
| 26  | Khisi            | Cinnamomum zeylanicum | Food supplement (Spice) |
| 27  | Kur a            | Quercus dealbata    | Construction material |
| 28  | Kuray eji        | Castanopsis byntxic | Food supplement (Fruit) |
| 29  | Kukodh hamanu (Kukudh hamanu) | Artemisia indica | Medicine (Leaf smell inhaling, also eaten as vegetable) |
| 30  | Lamy hamanu (Lamy hamanu) | Croton rhupehii | Food supplement / Medicine |
| 31  | Lai               | Dioscorea bulbifera | Food supplement (Tuber as vegetable) |
| 32  | Lahy            | Dioscorea interjunctum | Others (used for local salt making) |
| 33  | Ladi (Ladi hamanu) | Pterocarya stenoptera | Food supplement (Vegetable) |
| 34  | Magi hamanu      | Plantago sericea    | Food supplement (Vegetable) |
| 35  | Majo             | Sagrista filiformis | Medicine (Smoke of Bark and stem) |
| 36  | Ngweyeg hako hamanu (Ngweyeg hako) | Cinnamomum zeylanicum | Medicine (Whole plant, also used as vegetable) |
| 37  | Ngweyeg hako hamanu (Ngweyeg hako) | Cinnamomum zeylanicum | Medicine (Spice) |
| 38  | Oldho hamanu (Oldhy hamanu) | Ocicid carunculata | Medicine (Leaves and stem) |
| 39  | Paday hamanu     | Cardaminus hirata   | Medicine |
| 40  | Paton hamanu     | Clerodendrum colebrookiaum | Food supplement (Vegetable) |
| 41  | Paton hamanu     | Clerodendrum glandulosum | Food supplement (Leaves, also used as vegetable) |
| 42  | Payu             | Kulaoponcus dioica | Others (Gar used for trapping birds, rain) |
| 43  | Pecha            | Pyrus padus        | Food supplement / medicine (Fruits eaten raw) |
| 44  | Peppu            | Phragmites karka   | Construction material |
| 45  | Puri             | Lepisia cornicola   | Medicine |
| 46  | Piuta ayi (Pita ayi) | Pyrus calleyana | Food supplement (Fruits eaten raw) |
| 47  | Raro hamanu (Raray, Ravi, Rave) | Piper piperitatum | Food supplement / Medicine (Vegetable) |
| 48  | Riko              | Gynostegia pedata   | Medicine (Dried stem powder) |
| 49  | Satil (Pine seedlings) | Pinus soelbicantia | Other |
| 50  | Saba (Branches of pine) | Pinus soelbicantia | Other |
| 51  | Sajio            | Magnolia champaca   | Medicine / Constructional Material (Fruits eaten raw, timber for construction) |
| 52  | Sajio ayi       | Morus okпрофессионаl | Food supplement (Fruits used to make local "chumney", yields firewood) |
| 53  | Samper ayi       | Phoebe genitarsii | Food supplement (Fruits used as vegetable) |
| 54  | Sauty tero       | Zanthoxylum rheta    | Food supplement |
| 55  | Sadi              | Quercus grifftisli | Food supplement (Cooked fruits are eaten) |
| 56  | Sadiho (Sankum melji) | Ligusticum stiulakum | Construction material (Used as fence material) |
| Page | Item                                                                 | Description                                                                 |
|------|----------------------------------------------------------------------|----------------------------------------------------------------------------|
| 448  | Sankhii/Nausakhii                                                     | *Eurya acuminata*, Others (Leaves used along with *Rubia manjith* as dye) |
| 449  | Sankhii                                                              | *Symphena paniculata*                                                      | Construction material (Stem used for fencing) |
| 450  | Santoro                                                              | *Lithospermum*                                                            | Medicine (Ripe fruits eaten, also used as spice) |
| 451  | Sandi                                                                | *Quercus*                                                                 | Construction material / Firewood                |
| 452  | Santitero (Santitero)                                                | *Lithospermum*                                                            | Medicine (Fruits used as spice)                |
| 57   | Sankhii                                                              | *Pinus wallichiana*                                                       | Medicine (Resin, firewood)                     |
| 58   | Sankhii                                                              | *Cinnamomum verum*                                                        | Construction material (Fruits used in making chumey, timber used for fencing) |
| 59   | Sankhii                                                              | *Dillenia indica*                                                         | Food supplement                                |
| 60   | Sankhii                                                              | *Litsea cubeba*                                                           | Construction material                         |
| 61   | Sanko ayi                                                            | *Symplocos paniculata*                                                    | Stem used for fencing                          |
| 62   | Sanko ayi                                                            | *Zanthoxylum*                                                             | Food supplement                                |
| 63   | Santero                                                              | *Litsea cubeba*                                                           | Medicine (Ripe fruits eaten, also used as spice) |
| 64   | Santero                                                              | *Litsea cubeba*                                                           | Construction material                         |
| 65   | Sapotay                                                              | *Rubia manjith*                                                           | Construction material (Fruits used in making chumey, timber used for fencing) |
| 66   | Sapoay                                                               | *Dillenia indica*                                                         | Food supplement                                |
| 67   | Taaming                                                              | *Malonias nepaulensis*                                                    | Food supplement (Fruits eaten raw, bark used for obtaining deep yellow dye) |
| 68   | Taaming                                                              | *Rubia cordifolia* or *R. manjith*                                       | Medicine (roots), Stem used as dye             |
| 69   | Tagginghamang                                                        | *Strobilanthes helictus*                                                  | Food supplement (Young leaves used as vegetable) |
| 70   | Tajer/Tajri                                                          | *Nemomichorum manii*                                                      | Construction material (Generally in roof making) |
| 71   | Takho                                                                | *Diospyros kaki*                                                          | Construction material (Used in fences)          |
| 72   | Takho ayi (wild cucumber)                                           | *Cucumis sativa*                                                          | Food supplement                                |
| 73   | Takho                                                                | *Punica*                                                                  | Food supplement (Fruits eaten raw)              |
| 74   | Tali/Talle hamang                                                    | *Allium tuberosum*                                                        | Medicine / Food supplement (Leaves as salad and tuber as medicine) |
| 75   | Tamen, Taming                                                        | *Malonia arnica*                                                          | Food supplement                                |
| 76   | Tamo ayi                                                             | *Bhau chinensis*                                                          | Medicine (Fruits eaten raw)                     |
| 77   | Tape (Tep), hamang                                                   | *Cuscuta microsperma*                                                     | Food supplement                                |
| 78   | Taygo                                                                | *Cyathalonimus cinerrensis*                                               | Food supplement (also used in salt making)     |
| 79   | Tarko                                                                | *Phyllanthus*                                                             | Medicine (Antiseptic)                          |
| 80   | Taro ayi                                                             | *Ficus auriculata*                                                        | Food supplement (Fruits eaten raw)              |
| 81   | Taxan**                                                              | *Taxus bacatta*                                                           | Medicine                                       |
| 82   | Teji hamang                                                          | *Amaranthus tricolor*                                                      | Food supplement (Leaves and stem used as vegetable) |
| 83   | Tibe                                                                  | *Saccharum sp.*                                                           | Construction material                          |
| 84   | Tieve (Tieve, Tehyo Tieve)                                          | *Berberis willdiana*                                                      | Medicine (Thorns used for tattooing/Bark medicinal) |
| 85   | Tahog (Tahog)                                                        | *Eremocaulon capitatum*                                                   | Medicine (Young shoot edible)                   |
| 86   | Yadey                                                                | *Plectranthus japonicus*                                                   | Medicine (Leaf juice used for wound)            |
| 87   | Yokhing (Yokhing)                                                    | *Zanthoxylum armatum*                                                     | Medicine (Dried fruits used as medicine, also as spice) |
| 88   | Yayo (Yayo)                                                          | *Viburnum flexilum*                                                       | Food supplement (Fruits eaten raw)              |
| 89   | Yanso (cane)                                                         | *Calamus floribunda*                                                      | Construction material                          |
| 90   | Ayapakhe/Ayapake hamang = *Ayapake hamang* (Pumpkin)                 | Unidentified                                                               | Food supplement (Fruits and leaves eaten as vegetable) |
| 91   | Doraworkhbu                                                          | Unidentified                                                               | Other (Gums)                                   |
| 92   | Hohin                                                                | Unidentified                                                               | Construction material (Thorny bamboo variety)   |
| 93   | Hilang Tai hamang = Tai hamang                                       | Unidentified                                                               | Food supplement                                |
| 94   | Hulja hamang                                                         | Unidentified                                                               | Other (Gums)                                   |
| 95   | Huljabu hamang (Type of Hilja hamang)                                | Unidentified                                                               | Food supplement                                |
| 96   | Kungki (Khuqi)                                                       | Unidentified                                                               | Food supplement (Fruit)                        |
| 97   | More Tale (= Puyo)                                                   | Unidentified                                                               | Other (Gums)                                   |
| 98   | Ngerti pissa                                                        | Unidentified                                                               | Construction material                          |
| 99   | Nungin                                                               | Unidentified                                                               | Other                                          |
| 100  | Pahkarma ayi                                                        | Unidentified                                                               | Food supplement                                |
| 101  | Pachtu koyu hamang                                                   | Unidentified                                                               | Food supplement (Leafy vegetable)              |
| 102  | Pantai ayi (Gourd variety)                                           | Unidentified                                                               | Food supplement                                |
| 103  | Phol (Phol)                                                          | Unidentified                                                               | Medicine (Wild aromatic grass)                  |
| 104  | Pinhu su ayi                                                        | Unidentified                                                               | Construction                                   |
| 105  | Puing                                                               | Unidentified                                                               | Others (used for local salt making)            |
| 106  | Pudditaru                                                            | Unidentified                                                               | Medicine                                       |
| 107  | Pumai haman                                                          | Unidentified                                                               | Food supplement                                |
| 108  | Reiyung/Reihui/Reching                                             | Unidentified                                                               | Construction material                          |
| 109  | Sanochu                                                             | Unidentified                                                               | Food supplement                                |
| 110  | Siwoh liuka                                                         | Unidentified                                                               | Food supplement                                |
| 111  | Tai hilang San                                                      | Unidentified                                                               | Other (Wood used as axe handle/tool)           |
| 112  | Tagang                                                              | Unidentified                                                               | Other                                          |

*Names differ from one village to another; **Non-Apatani names*
were consumed by the Valley dwellers after direct collection and many (46) of them were sold to cater to the need of market dependent people (Table 2). However, some of the commercially important species identified by the key informants were Antiitari ayi (Actinidia callous), Baching ayi, Billing (Cheropodias avellanator), Diiransankhan, Hari ayi (Elagiaus latifolia), Hunchu, Hiilhua lima (Hydrocotyle javanica), Hiagu hamang (Onoente javanica), Hiipoy hamang (Gonostegia birta), Kung ayi, Ngililhay khiko, Taro (Ficus auriculata), Padii hamang, Kiiki (Ficus auriculata), Siya hamang, Subutute, Saloay ayi (Magnolia champaca, M. oblonga), Samper ayi (Pohoe goalparensis), etc.

However, the respondents could assess 79 ecologically important NTFP species on the basis of availability status and placed 21 species in Abundant, 44 species in Limited and 14 species in Scarce category (Table 3). Similarly, the availability trend of 58 NTFPs was also assessed by them in the following classification-12 species in Increasing, 24 species in Stable and 22 species in Decreasing category. These species, have been evaluated for bot parameters and were grouped according to the "Vulnerability Matrix" (Fig. 2) and presented in Fig. 5. After regrouping as per the vulnerability index, these species could be categorized as follows: (i) Very low vulnerability: Padii hamang, Sankhe (Quercus griffithii); (ii) Low vulnerability: Bije, Hiilhay hamang, Kiika, Kiiku ayi (Castanopsis hystricos), Mepi hamang, Sankho (Ligustrum ovalifolium), Seno ayi (Cerasus cerasoides), Siya hamang, Byako (Solanum myricanthum and S. kurzii), Engg (Dioscora hamiltonii), Lase (Dioscora bulbifera), Ngerii, Pinchi sai ahi, Tamo ayi, Yabin-bije (Cephalostachium capitatum); (iii) Moderate vulnerability: Kukuuyu hamang (Artemisia indica), Padii kouy hamang, Salo ayi, Sarke ayi (Zanthoxylum sp.), Tatang, Baching ayi, Hiipoy hamang, Hiika hamang, Peda (Pyraeopsis), Rikko, Santeror (Litsa edulis), Taaming, Taging hamang (Strobilanthes belitus), Tale hamang, Tamin, Taro ayi, Yorjum, Bukhe, Babo korno ayi, Pami haman (iv) High vulnerability: Antiitari ayi, Ayapakhe hamang, Billing, Dirsanankhan, Henchi (Rubus niveus), Hiilha hamang, Ngiilhay khiko, Raru hamang (Piper pedicelatum), Samper ayi, Suni (Quercus spp.), Tsai hamang, Yao-cane, Sandi, Sanutakute, Tabu ayi (Cucumis sativus) and (v) Very high vulnerability: Hiibin, Imyo (Aconitum ferox and A. heterophylla), Jofuri ayi, Khuong, More taka, Payu. The total number of species according to these categories were arranged as per the "vulnerability index" and presented in Fig. 6. Some of these important non-timber products along with others are presented in Fig. 7, Fig. 8 and Fig. 9.

Above NTFPs, along with others, were exploited in the past and their availability status was altered due to harvesting. Currently they were at varying states of vulnerability in terms of need for conservation. This may be due to different intensity of exploitation and methods of extraction and also because of the ability of the species to respond to the extraction. The exploitation of forest resources has a differing effect, depending on the type of species and parts being harvested. Unless harvesting is controlled, some species may become genetically impoverished much more rapidly than others (Arnold and Perez, 2001). Neumann and Hirsch (2000) also concur that large scale harvesting may have ecological effects on NTFPs in the form of negative, positive and even neutral growth. Therefore, looking at the distribution of the species (Fig. 6) it
Table 2. List of NTFPs sold in the market as food supplement, medicine and construction material

| SN | Food supplement | Food supplement | Medicine | Construction material |
|----|----------------|----------------|----------|-----------------------|
| 1  | Antiitari ayi   | Kra ayi        | Hiluyo lima | Kiira                |
| 2  | Baching ayi     | Lase           | Mitji    | Riiying               |
| 3  | Biling          | Padii hamang   | Ngelyang kbiiko | Santi               |
| 4  | Diriiruankhan    | Pechi          | Padii hamang | Sembo    |
| 5  | Enging          | Rare haman     | Pechi    |                      |
| 6  | Giiyang hamang  | Sankhi         | Riiko    |                      |
| 7  | Hari ayi        | Salyo ayi      | Santero  |                      |
| 8  | Hi/Hiyi         | Samper ayi     | Siya hamang |                    |
| 9  | Hencihi         | Sankho ayi     | Tarko    |                      |
| 10 | Hiigu hamang    | Siya hamang    | Tamin    |                      |
| 11 | Hiika hamang    | Subutute       | Yalbing yazi |                    |
| 12 | Hiito hamang    | Takang         | Yorkhum  |                      |
| 13 | Hiipey hamang   | Tape hamang    |          |                      |
| 14 | Khoi/yi         | Tapyo          |          |                      |
| 15 | Kung ayi        | Taro ayi       |          |                      |

Table 3. Category wise list of ecologically important NTFPs based on 10-15 years experience of the respondents

| No | Abundance | Availability status | Availability trend |
|----|-----------|---------------------|--------------------|
| 1  | Bije      | Abundant            | Increase           |
| 2  | Byapo     | Limited             | Stable             |
| 3  | Byapu     | Scarce              | Decrease           |
| 4  | Byapi     | Increase            |                    |
| 5  | Byara     | Stable              |                    |
| 6  | Kiira     | Scarce              |                    |
| 7  | Kiiro     | Increase            |                    |
| 8  | Luki      | Stable              |                    |
| 9  | Mepi      | Limited             |                    |
| 10 | Padu      | Abundant            |                    |
| 11 | Padu      | Limited             |                    |
| 12 | Padii     | Scarce              |                    |
| 13 | Sando     | Abundant            |                    |
| 14 | Sando     | Limited             |                    |
| 15 | Sando     | Scarce              |                    |
| 16 | Sando     | Increase            |                    |
| 17 | Sando     | Stable              |                    |
| 18 | Sando     | Decrease            |                    |
| 19 | Sando     | Stable              |                    |
| 20 | Sando     | Decrease            |                    |
| 21 | Sando     | Stable              |                    |
| 22 | Sando     | Decrease            |                    |
| 23 | Sando     | Stable              |                    |
| 24 | Sando     | Decrease            |                    |
| 25 | Sando     | Stable              |                    |
| 26 | Sando     | Decrease            |                    |
| 27 | Sando     | Stable              |                    |
| 28 | Sando     | Decrease            |                    |
| 29 | Sando     | Stable              |                    |
| 30 | Sando     | Decrease            |                    |
| 31 | Sando     | Stable              |                    |
| 32 | Sando     | Decrease            |                    |
| 33 | Sando     | Stable              |                    |
| 34 | Sando     | Decrease            |                    |
| 35 | Sando     | Stable              |                    |
| 36 | Sando     | Decrease            |                    |
| 37 | Sando     | Stable              |                    |
| 38 | Sando     | Decrease            |                    |
| 39 | Sando     | Stable              |                    |
| 40 | Sando     | Decrease            |                    |
| 41 | Sando     | Stable              |                    |
| 42 | Sando     | Decrease            |                    |
| 43 | Sando     | Stable              |                    |
| 44 | Sando     | Decrease            |                    |
could be speculated that with continued exploitation and in the absence of conservation measures this distribution may swing towards vulnerability at least in the case of species in the negative impact category. Currently non-vulnerable species may not be a concern for the villagers but if the NTFP sector is promoted and the demand increases then species-specific management would become critical. The issue of regeneration, cultivation or domestication, sustainable long term supply and harvesting, etc. will need to be addressed simultaneously (Ingram and Tieguhong, 2013).

Conservation need

The NTFPs classified using the vulnerability index (Table 3), need conservation efforts of different levels as they are currently assessed at varying levels of vulnerability. The group of scarcely available plants was Bakhe, Pabo korma ayi, Payinglanu hamang, Pumi hamang, Sanchi, Santutaki, Santutaki and Taku ayi. The group of plants which showed decreasing trend of availability was Antitari ayi, Ayopakhe hamang, Billing, Diiransankhan, Henchi, Hibya hamang, Kukulyu, Ngilyang khiko, Pachu kayu hamang, Raru hamang, Salyo ayi, Samper ayi, Sango ayi, Santi, Tayi hamang, Tapang and Yaso-cane. The most important group of plants which had scarce availability status as well as decreasing (availability) trend were Hibin, Imyo, Jiju ayi, Khung, More taku and Payu. These needed utmost care so that they could be saved from disappearance from the Valley in the near future.

The economic benefits of NTFP extraction are viable over time only if collection of the species or groups of species is ecologically sustainable. A maximum sustainable harvest limit implies that the rate at which these parts are taken from a plant or at which individual plants are culled from the population will not exceed the natural/artificial rate of regeneration in a given time period (Stanley et al., 2012). Therefore, harvesting without regeneration and the increased marketing of such wild plants may result in decline and reach near-extinction (Ticktin, 2004). Species with great cultural value and economic significance that are at risk of overexploitation and population decline should thus be given top most conservation priority (Hamilton, 2004). Based on their studies on agriculture diversity and conservation of wild plants Norfolk et al. (2013) have advocated that smallholder farms and homegardens can be valuable tools in conservation, preserving local species and maintaining ecosystem functioning.

Sustainability intervention

The Apatani grew several important species (32) in their homegardens. Some such prominent species were classifed on the basis of ecological importance in the following order: Abundant-Increasing: Padii hamang (6); Abundant-Stable: Bije, Kiira, Mepi hamang, Siya hamang (5); Abundant-Decreasing: Pachu kayu hamang, Salyo (4); Limited-Increasing: Taku ayi

Fig 5 Group of species as per conservation vulnerability matrix (Abundant-Increase --------> Scarce-Decrease) and index value (6------>2)

Fig 6 Species distribution assessed for availability status and availability trend converted to conservation status.
Table 4. NTFP matrix indicating management options for different NTFPs based on qualitative evaluation by the Ziro Valley residents

| Vulnerability status | Ecologically important NTFPs | Commercially important NTFPs | Domesticated NTFPs | Promotion priority NTFPs | Management option |
|----------------------|-------------------------------|-----------------------------|-------------------|-------------------------|-------------------|
| Very low             | Padi hamang, Sankhe           | Padi hamang                 | Padi hamang       | Padi hamang             | Commercialization |
| Low                  | Bije, Hijii hamang, Kiria, Kiria ayi, Mepi hamang, Sankhe, Semo, Sya hamang, Byuko, Enging, Lay, Ngerii, Pachi sai abu, Tamau ayi, Yahin-biye | Sya hamang, Hijii hamang | Sya hamang, Mepi hamang, Bije, Tamo ayi, Kiria, Hijii hamang, Karya ayi, Padi hamang | Padi hamang | Intermediate |
| Moderate             | Kikuluty, Pabtu kyo, Sato ayi, Sankho ayi, Baching ayi, Hijiiyay hamang, Hikka hamang, Pechu, Riku, Santu, Tammang, Toting hamang, Talle hamang, Tamia, Taro ayi, Yorkham, Bubbo, Palai hemo ayi, Pani haman | Sato ayi, Hijii ayi, Hikka hamang, Baching ayi, Riku, Kung ayi, Biling, Taro, Antariya, Hari ayi, Suthutata, Hikka lima | Sato ayi, Sato ayi, Baching ayi, Taro, Tamin, Yorkham | Padi hamang | Intermediate |
| High                 | Antiitari ayi, Ayapakhe hamang, Biiling, Ditingan, Hensi, Hikka hamang, Ngiiyang khiiko, Raru hamang, Nonper ayi, Santi, Tai hamang, Yaw-cane, Sankhe, Santu, Taka ayi | Ditingan, Nonper ayi, Santi, Yaw-cane, Hensi, Ngiiyang khiiko | Tai hamang, Ngiiyang khiiko, Hikka, Hikka lima | Antiitari ayi, Rare hamang | Conservation |
| Very high            | Hikka, Impo, Jofaru ayi, Khung, More taku, Pwu | | | | |

(3); Limited- Stable: Baching ayi, Hikka hamang, Tale hamang, Tamin (4); Limited-Decreasing: Hikka hamang, Ngiiyang khiiko, Tsai hamang (3); Scarc-Decreasing: Jofaru ayi (2). Other homegardens species were categorized into the Limited category (Padi hamang, Poh/Phoh, Sabutute) because their availability trend was not indicated by the respondents. There were some more species of homegarden origin (Giyang hamang, Hiibyo hamang, Hikka hamang, Miiti, Ohlin, Panta ayi, Penu, Pudtara, Sate (Resin), Tame hamang, Tarko, etc.) whose availability status or trend was not perceived during survey.

Plant species with local importance and multiple functions have been maintained in traditional homegardens in North-East of India as part of survival over generations with a complex vegetation structure (Tangiang and Arunachalam, 2009). The species grown in homegardens were meant for bulk production and also for reducing the pressure on the community forest. This could be construed as management intervention aimed at keeping the community forest resources as the growing reserve. The productivity could be enhanced further by combining the ecological experience of the villagers with scientific knowledge. An additional benefit of this system was its contribution towards ex situ conservation of local plant diversity serving as gene pools of eroding indigenous plant species (Das and Das, 2005; Tangiang and Arunachalam, 2009). Aghojoghi and Adolor (2013) have also reviewed the importance of homegardens as conservation units which contain the highest population of some underutilized fruit species. They are in situ conservation sites for indigenous varieties of crops. They are also sites for the domestication of wild varieties of some species. They can be used as trial sites for new varieties of some crops and hence can be considered as an entry point for new varieties of crops into the conservation system.

Recently, some community forest areas have been declared as community reserves as part of a government initiative and are managed by the villagers in order to achieve conservation of medicinal plants growing in them. This is one of the measures to protect and harvest NTFPs on a sustainable basis as suggested by Manuel (2005). One such initiative in the Ziro Valley is Medicinal Plant Conservation Area, Harkhe Tari of 200 ha established in 2012. This is intended to conserve very important medicinal plants like, Panax pseudo-ginseng, Paris polyfolia, Cinnamomum tamala, C. zeelanican, Embelia ribes, Berberis aristata and Rhus marjith.

Based on the perception of local stakeholders about the categories of NTFPs matrix was prepared and presented in Table 4. There are some species (Padi hamang, Sankhe, Bije, Hijii hamang, Kiria, Kuria ayi, Mepi hamang, Sankhe, Semo ayi, Sya hamang, Byuko, Enging, Lay, Ngerii, Pinchi sai abu, Tamo ayi, and Yabim-biye) which can be commercialized since their conservation need/priority is very low or low. Out of these Padi hamang, Mepi hamang, Hijii hamang, Sya hamang, and Kuria ayi are the priority choice to be promoted on a commercial scale. Further, Padi hamang, Sya hamang, and Hijii hamang are commercially important species and Padi hamang, Bije, Mepi hamang, Sya hamang, Tamo ayi, Kiria have the added advantage of being cultivated in homegardens providing extra security against the negative effects of commercialization. Padi hamang, Sya hamang, Mepi hamang and Hijii hamang can be safely recommended for further enhancing the market potential outside the Apatani Valley.

In contrast, Antiitari ayi, Ayapakhe hamang, Biiling, Ditingan, Hensi, Hikka hamang, Ngiiyang khiiko, Raru hamang, Nonper ayi, Santi, Tai hamang, Yaw-cane, Sankhe, Santu, Taka ayi should be conserved since they have high or very high vulnerability status. Although Antiitari ayi, Rare hamang, Ditingan can be promotion-priority-choice species, Ditingan, Nonper ayi, Hensi, Ngiiyang khiiko, are commercially important species and Taki hamang, Ngiiyang khiiko, Hikka hamang, Jofaru ayi are homegarden grown species, they should not be promoted for commercialization based on current status. Nevertheless, Antiitari ayi, Rare hamang, Ditingan can...
being commercially important and priority choice species should be managed for recovery first and could be commercialized afterwards.

Conclusions

There are a lot of host plant species used by the Apatani as NTFPs with plenty of options in the case of medicine and food supplement. They are locally consumed along with a few, edible and medicinal herbs which have marketing potential as well. NTFP utilization had existed for centuries but it has intensified in the past few decades due to an increase in awareness and demand of the products. Increasing demand can lead people to disregard traditional harvesting techniques. The management of NTFPs must not ignore the local indigenous knowledge, the ecological impact of NTFP extraction, the development of appropriate small scale enterprises and cooperatives for collecting, processing, marketing, monitoring and sharing rights and benefits (Uprety et al., 2010).

Natural resources have seen a decrease in availability status and availability trend due to increased exploitation. The increasing demand for natural products in the sectors of food and medicinal ingredients poses major ecological and social challenges. High pressure on wild resources is threatening the survival of populations and species while also endangering local ecosystems. Overharvesting of selected plants for commercialization, premature collection along with habitat destruction, open grazing, forest fire and soil erosion are major threats to the sustainability of NTFP conservation (Famuyide et al., 2013). Unrestrained and unmanaged harvesting is known to have a negative impact on the
structure and dynamics of the population and this can lead to the decline or even disappearance of a plant species (Muraleedharan et al., 2005; Jircoh et al., 2013; Dattagupta et al., 2014).

Conservation measures are to be taken to ensure sustainability in production and supply. An appropriate policy framework for a sustainable promotion of NTFPs, domestication of NTFPs, improving harvesting, and processing techniques is necessary to facilitate food security, reduction of poverty, and improved livelihoods (Ahenkan and Boon, 2011). Therefore, domestication or homegardening needs to be encouraged. It is widely accepted that the indigenous knowledge is a powerful resource in its own right and complementary to the knowledge available from western scientific sources. By combining the ecological wisdom of the villagers with scientific knowledge higher productivity of homegardens may be achieved without causing substantial environmental degradation (Denevan, 1995; Milate-Mustafa, 2000).

The selection of potential species can be done based on local priority as most of the wild edible species have high nutritional value. Therefore, it seems imperative to carry out studies on the nutritional values of these plants (Angami et al., 2006). Based on the current status of conservation Padii hamang, Siya hamang, Mepi hamang and Hagu hamang is recommended for marketing. Antiitari ayi, Rare hamang, Dieransankhan, Sampooy ayi, Hembi, Ngyiyang khiko could also be marketed but only after improvement in their current very low or low conservation status.

The literature survey pointed to gaps in literature, which necessitate further studies to assess the importance of wild plants in the daily life of households, market potential of the wild plants, their contribution to the local people’s livelihood (Barirega et al., 2012) and the response to harvesting. It is recommended that future research should focus on gathering detailed information about selected NTFP species, describing habitats, growth requirement, production level and response to harvesting so that a roadmap could be developed for a sustainable management strategy (Ehlers et al., 2003). Simultaneously, a balance needs to be struck between human development and environmental degradation. Further, to address the conflicting demand of commercialization and conservation a comprehensive policy should be adopted (Dattagupta et al., 2014). This should be based on scientific and traditional Apatani knowledge for harvesting and regeneration of NTFPs keeping in mind a minimal impact on the heritage.

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