

Status, Utilization and Economic Valuation of Non-timber Forest Products of Arunachal Pradesh, India

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Abstract

Non-timber forest products are important component of subsistence and livelihood of tribal communities living in and near forests. This is of particular significance in the state of Arunachal Pradesh having more than 80% of geographical area under forest cover and predominantly inhabited by tribal people. Purpose of this study was to document the status and utilization pattern and to assess the economic value of NTFPs of the state. Present study was carried out in eight districts of Arunachal Pradesh viz., Changlang, East Kameng, Lower Subansiri, Tawang, Tirap, Upper Siang, West Kameng and West Siang covering 34 villages and 350 households. Altogether, 135 plant based and 36 animal based non-timber forest products were recorded. Among plant based NTFPs, 54 species were collected for leaves, 30 for stem and 22 for fruits. Most of the animal based NTFPs (93%) were collected/hunted for food. Average 20~40 kg of NTFPs was collected annually per household. Maximum plant based NTFP collection was recorded from West Siang followed by West Kameng and Tawang. Similarly, highest collection of animal based NTFPs was recorded from West Siang followed by Tirap and Lower Subansiri. NTFP contributed more than 50% of annual income of the people of East Kameng, Tirap, Lower Subansiri and Upper Siang districts. An illiterate and unemployed person with minimum agricultural land was more dependent on forests for his livelihood than a literate jobholder. The study concludes that a large section of people of Arunachal Pradesh are dependent on NTFPs for their livelihood however due to its unscientific harvesting, the availability of NTFPs is receding with time. There is an urgent need to promote cultivation and scientific harvesting of NTFPs in order to conserve the plant and animal diversity of this global biodiversity hotspot and for ensuring livelihood security of the people living in this area.

Key Words: NTFPs, forests, tribal communities, livelihoods, economic valuation

Introduction

Forests provide significant social and economic benefits to the people in forest rich countries. Since early 1990s the role of non-timber forest products (NTFPs) for sustainable forest use and poverty alleviation has received worldwide attention (Peters et al. 1989). NTFPs play a vital role in the

life of the tribal people and provide a source of cash income and support subsistence living (Peters et al. 1989; Hegde et al. 1996). In almost all the tropical countries, NTFP collection is a major economic activity (Chopra 1993; Sharma 1995; Alexander et al. 2001; Ambrose 2003) and about 500 million people living in or near forests depend upon them for meeting their livelihood needs (Alexander et al. 2002).

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The NTFPs often termed as minor forest products are integral part of day-to-day livelihood activities of the tribal people of India (Saxena and Farrington 2003; Sarmah 2006; Saha and Sundriyal 2013).

There is a growing consciousness about NTFP species playing a prominent role in increasing the income of farm households in the mountains (Dhyani and Khali 1993). A careful screening and prioritization of most potential species and detailed information on their structure, regeneration, stand productivity, harvest level and possibility of harvest adjustment would help devise maximum income generation and help develop long-term management plan for the species at large (Panayotou and Ashton 1992). There exists a huge potential of utilizing traditional ecological knowledge that tribal communities possess about wild plant resources, their use and management for achieving sustainable NTFP production (Gangwar and Ramakrishnan 1990; Phillips 1993; Maikhuri et al. 1994).

Arunachal Pradesh is part of Eastern Himalayas global biodiversity hotspot and supports very high species richness (Myers et al. 2000). The forests of Arunachal Pradesh harbour rich diversity of both timber and non-timber yielding species. The forests are also rich in drug yielding plants, including many species of aromatic plants and spices (Haridasan and Beniwal 1994; Pandey 1998; Sarmah

2010). Due to lack of sufficient agricultural land for crop cultivation and inaccessibility in high mountain areas, people of this part of India are highly dependent on forest products. Forest and forest products are integrated in the traditional life style of the people of Arunachal Pradesh (Sarmah et al. 2008). Traditional knowledge about utilization of natural resources is still prevalent in many parts of the state (Rethy et al. 2010). Against such a backdrop, the present study was undertaken to document the status and utilization pattern and to assess the economic value of NTFPs of the state. The study also documents the traditional methods of collection and utilization of NTFPs by major tribes of Arunachal Pradesh.

Study area

The study was carried out in eight districts of Arunachal Pradesh namely, Changlang, East Kameng, Lower Subansiri, Tawang, Tirap, Upper Siang, West Kameng and West Siang (Fig. 1). The study area encompasses tropical, sub-tropical, temperate and alpine climates. The lower belts of Arunachal Pradesh experience hot and humid climate. The maximum temperature that marks the climate of the foothills is 40°C. The winter temperature usually falls below freezing point in Tawang and West Kameng districts. The relative humidity remains high throughout the year and

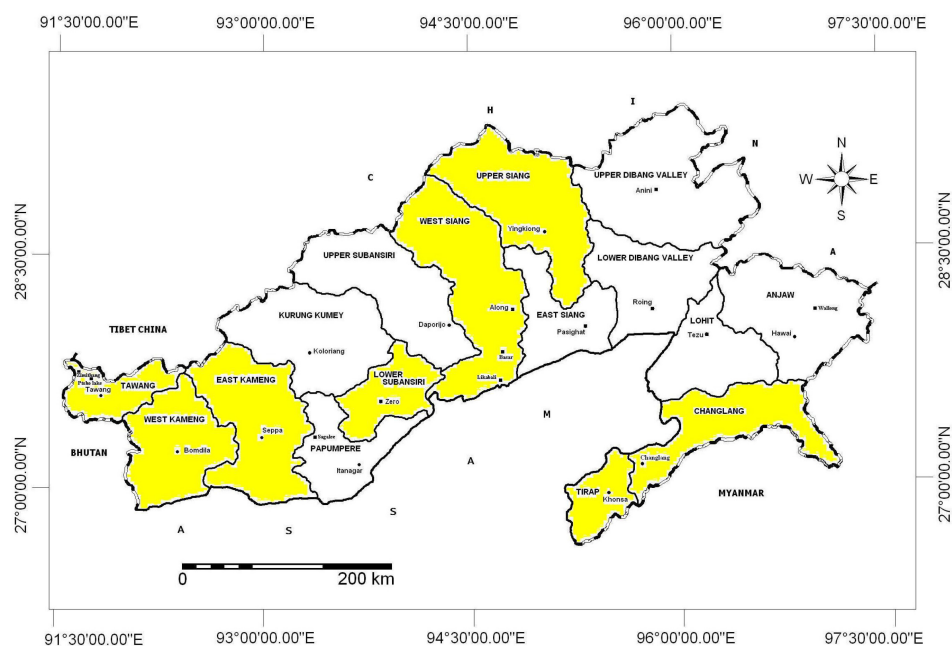


Fig. 1. Map of Arunachal Pradesh showing study districts.

Table 1. Total geographical and recorded forest area in selected districts of Arunachal Pradesh

Districts	Geographical area (sq km)	Recorded forest area (sq km)	Percentage of geographical area (sq km)	Total population (census 2011)	Forest types
Changlang	4,662.0	4,132.24	88.66	147,951	Evergreen
East Kameng	4,134.0	3,133.82	75.81	78,413	Evergreen, Deciduous
Lower Subansiri	3,460.0	2,748.73	81.1	82,839	Evergreen
Tawang	2,172.0	1,085.80	49.95	49,950	Evergreen
Tirap	2,362.0	1,511.0	63.97	111,997	Tropical, Evergreen, Scrub
Upper Siang	6,188.0	1,169.0	18.89	35,289	Evergreen, Deciduous
West Kameng	7,422.0	3,952.4	53.25	87,013	Evergreen
West Siang	7,643.0	3,400.4	44.39	112,272	Evergreen

Source: Forest Statistics of Arunachal Pradesh (2007 ~ 2008).

varies between 40% and 95%. The total geographical area and area under forests are given in Table 1.

The inhabitants of Changlang district belong to Tangsas, Singphos and Tutsas tribes. The Tangsa tribe comprise a number of Sub-Tribes, namely, Muklom, Havi, Longchang, Mossang, Jugli, Kimsing, Ronrang, Mungrey, Longphi, Longri, Ponthai, Sangwal, Tikhak, Yungkuk, Sakieng and Thamphang. Principal occupation of these people is farming. A good number of people are also employed as agricultural labourer, government contractors and traders. The major tribes inhabiting East Kameng district are: Bangnis (Nyishi), Akas, Mijis and Puroiks (Sulung). The Bangnis also called Nyishi, Nishang, Nissi or Dafla and Sullungs, inhabit the area contiguous to the North-Eastern Kameng extending upto Lower Subansiri district. Agriculture is the main occupation of the people of East Kameng district. Though Jhum is prevalent in the district, it is being gradually replaced by permanent cultivation.

The Apatani, or Tanii, are the dominant tribal group in the Ziro valley in the Lower Subansiri district. They practice permanent cultivation and their paddy fields are well developed and irrigated. The Nyishi tribe inhabits western part of the district. They are agriculturists by profession and mostly practice shifting cultivation. Tawang, the western most district of Arunachal Pradesh, is the home of Monpa tribe. It is a thinly populated mountainous tract. Monpa tribe of Tawang and Dirang follow an old tradition of conserving community and private forests. Tirap district is on the southern bank of Brahmaputra. The major tribes inhabiting in the district are the Nocte, Wancho and Tutsa. They occupy a distinct geographical area and have their dis-

tinct social norms, customs, beliefs and practices. Jhum is common form of agriculture though during recent years people have started adopting terrace farming. Upper Siang district is inhabited by Adi, Memba, Khamba and Idu Mishmi tribes. The Adi practice wet rice cultivation which serves as the staple food for them. Trapping and hunting, increasingly with firearms, supplement their diet. The inhabitants of the West Kameng district comprise mainly Monpa, Miji, Sherdukpen, Aka, and Bugun. The Monpas belong to the Tibeto-Mongoloid stock and are the largest tribe of the district. The Mijis are settled in Nafra and Akas in Thrizino villages. The Sherdukpens are mainly settled in Rupa, Jigaon, Shergaon, Thongre and Doimara. Most inhabitants are Buddhists. Most Akas, Bugun and Mijis follow indigenous religion. West Siang district is the homeland of tribes like Galo, Minyong, Bori, Bokar, Pailibo, Ramos and Memba. Wet rice cultivation now accounts for the majority of production in the Galo area, however shifting cultivation is also still practiced, especially in remote villages.

Most tribal households in rural Arunachal Pradesh own small plot of lands (0.5 ~ 1 ha/family) on which they practice shifting cultivation. Agriculture sector is therefore unable to produce sufficient food and cash income, as a result their dependence on the forest resources especially fuelwood, timber, wild edibles, medicinal plants and wild animal poaching is very high.

Materials and Methods

Household information was collected through interview using a semi-structured questionnaire during 2010 ~ 2011

covering 34 villages inhabited by seven tribes namely, Adi, Apatani, Galo, Monpa, Nocte, Nyshi and Tangsa under eight districts of Arunachal Pradesh. Villages were selected on the basis of their road accessibility and field survey was carried out throughout the year. During rainy season only those villages having good road connectivity could be reached. Key informants survey was carried out with village headmen and traditional healers belonging to different age group and sex. Data pertaining to NTFPs, their harvesting, processing, marketing as well as utilization pattern were collected through personal interview with people engaged in such activities. Per district, 4~5 villages were selected and from each village, heads of 10 households were interviewed. Data on total land holding, annual income from NTFPs, duration of NTFP collection, season of NTFP collection, NTFP collection area, types of NTFP collected/used/sale, parts of NTFP collected/utilized, uses of NTFPs collected, female participation in NTFP collection/sale, distance travelled to collect NTFP, quantity of NTFP collection etc were collected from the heads of households and key informants. The data gathered through above methods were crosschecked and validated with the other villagers belonging to the same tribe using the technique of triangulation. Secondary data was collected from the State Forest Department as well as from the State Forest Research Institute, Itanagar. The monetary value of each NTFP was calculated comparing the market price of NTFPs prevailing at the nearest local market with the price value at various district headquarters as well as state capital. Market surveys were conducted by undertaking periodic visits to the local markets in all the selected village/district headquarters as well as in the state capital market. Quantity of the NTFPs supplied/sold to the local market and their sale price was recorded through personal interview with the sellers and buyers in the market.

Quantification of the extracted forest products was done by weighing the head load; and per capita per day consumption was calculated by following formula: Per capita per day consumption = Quantity consumed per household per day / No. of persons per household. Statistical analysis was done using MS Excel.

Results

People of Arunachal Pradesh collect NTFPs from government forests, community forests private forests, agricultural fallow lands and homestead lands. People use on an average 20~30 ha of forest land surrounding their village for NTFPs collection. All types of plants like trees, shrubs, herbs and climbers are collected for food, firewood, medicine, spices for their self consumption and also for sale in market. Animals are hunted mainly for their food and medicinal value (Table 2 and 3). Community hunting of wild animal is done for self consumption however, individual hunting is done for self consumption as well as sale in the local market. Hunting is done mostly during the period of land clearing for shifting cultivation, in private and community forests. Hunting is intensive during the months of April-May and September-December. September and October are the suitable months for group hunting. However, hunting time and seasons also depends on the species of animal being hunted. Capturing and killing of large animals are mostly carried out during nights.

The amount of NTFPs collected per household depends on occupation, literacy and land holding of household. Less educated, landless persons and unemployed people depend more on NTFPs for their sustenance. Analysis of data showed a negative correlation ($r = -0.206$, $p > 0.05$) between annual income from NTFP sale and land holding capacity. On an average 20~40 kg of NTFPs are collected annually per household. Quantity of NTFP collection is high for those who collect both plant and animal and trade NTFPs to nearby states. District-wise, maximum plant based NTFP collection was recorded from Tawang (76.0 kg/household) followed by West Siang (54.2 kg/household) and West Kameng (53.8 kg/household). NTFP collection on per hectare basis was found to be the highest in Lower Subansiri (175.6 kg/ha) followed by Changlang (147.4 kg/ha) and the lowest was in Tirap district (10 kg/ha) (Table 4).

Tirap district recorded the highest collection of animal based NTFPs (2.3 kg/household) closely followed by West Siang (2.0 kg/household) and Lower Subansiri (1.27 kg/household) while it was least in Tawang and West Kameng districts (Table 4).

In East Kameng district 65~70% of the annual income

Table 2. Plant based NTFPs collected by the local tribes for commercial uses

Plant species	Plant part used	Uses	Plant species	Plant part used	Uses
<i>Acorus calamus</i>	Rhizome	Medicine	<i>Livistona jenkinsiana</i>	Leaves	Construction material, Edible
<i>Agaricularia</i> sp.	Fruiting body	Edible	Local black salt	Whole plant	Edible
<i>Alnus nepalensis</i>	Stem	Fuelwood, fodder	<i>Mangifera indica</i>	Leaves	Medicine
<i>Alocasia macrorrhiza</i>	Root	Edible	<i>Michelia champaca</i>	Seed	Edible, Medicine
<i>Alpinia malaccensis</i>	Fruits	Edible	<i>Musa</i> spp.	Flower, fruit, stem core	Edible
<i>Angiopteris evecta</i>	Rhizome	Medicine	<i>Musa velutina</i>	Stem	Edible, Medicine
<i>Agaricus</i> sp.	Fruiting body	Edible	Mushrooms	Fruiting body	Edible
<i>Bambusa pallida</i>	Stem	Construction material, Edible	<i>Ocimum sanctum</i>	Whole plant	Medicine
<i>Bambusa</i> spp.	Stem	Construction material, firewood, Edible	<i>Oroxylum indicum</i>	Stem and leaves	Medicine
<i>Bambusa tulda</i>	Shoot	Construction material, Edible	<i>Panax</i> sp.	Stem, leaves	Medicine
<i>Bidens pilosa</i>	Leaves	Medicine	<i>Phoenix sylvestris</i>	Root	Edible
<i>Calamus acanthospathus</i>	Stem	Construction material	<i>Phyllostachys bambusoides</i>	Shoot	Edible
<i>Calamus flagellum</i>	Stem	Construction material	<i>Pinus roxburghii</i>	Stem	Fuelwood
<i>Calamus floribunda</i>	Fruits and stem	Edible, Construction material	<i>Pinus wallichiana</i>	Whole plant	Fuelwood, Medicine
<i>Calamus gracilis</i>	Stem	Construction material	<i>Piper betel</i>	Leaves	Edible
<i>Calamus</i> spp.	Bark, stem, shoot	Weaving, Construction material, Edible	<i>Piper brachystachyum</i>	Leaves	Edible
<i>Carica papaya</i>	Seeds	Medicine	<i>Piper longum</i>	Whole plant	Medicine
<i>Cassia obtusifolia</i>	Fruit	Medicine	<i>Piper pedicellatum</i>	Leaves	Edible
<i>Centella asiatica</i>	Whole plant	Edible, Medicine	<i>Polygonum hydropiper</i>	Whole plant	Fish poison, Medicine
<i>Citrus aurantifolia</i>	Leaves	Medicine	<i>Pouzolzia hirta</i>	Leaves	Edible
<i>Citrus aurantium</i>	Fruits	Edible	<i>Prunus avium</i>	Fruit	Edible
<i>Citrus lemon</i>	Fruits	Edible	<i>Prunus rufa</i>	Fruit	Edible
<i>Clerodendrum colebrookianum</i>	Leaves	Edible, Medicine	<i>Psidium guajava</i>	Leaves	Medicine
<i>Clerodendrum infortunatum</i>	Leaves	Edible	<i>Pteris wallichiana</i>	Leaves	Fish poison, Medicine
<i>Clerodendrum japonicum</i>	Leaves	Edible, Medicine	<i>Quercus dealbata</i>	Leaves	Construction material
<i>Coptis teeta</i>	Root/rhizome	Medicine	<i>Quercus incana</i>	Stem	Fuelwood
<i>Coriandrum sativum</i>	Leaves	Edible	<i>Rhododendron arboreum</i>	Stem, flower	Fuelwood, Edible
<i>Cupressus torulosa</i>	Stem	Firewood	<i>Rubia cordifolia</i>	Stem and leaves	Medicine
<i>Curcuma aromatica</i>	Rhizome	Medicine	<i>Solanum indicum</i>	Fruit	Edible
<i>Cyclosorus</i> sp.	Leaves, stem	Edible, Insecticides	<i>Solanum nigrum</i>	Leaves	Edible
<i>Dillenia indica</i>	Stem, fruits	Edible, Construction material	<i>Solanum torvum</i>	Fruit	Edible
<i>Dioscorea hamiltonii</i>	Tubers	Edible	<i>Spilanthes calva</i>	Flower	Edible
<i>Gymnocladus assamica</i>	Fruits, seed, leaves	As soap	<i>Taxus wallichiana</i>	Stem, leaves	Fuelwood, Fodder, Edible, Fish poison
<i>Houttuynia cordata</i>	Leaves, root	Edible, Medicine	<i>Termitomyces</i> sp.	Fruiting body	Edible
<i>Illicium griffithii</i>	Seed	Edible, Medicine	<i>Thuja occidentalis</i>	Stem, leaves	Fuelwood
<i>Imperata</i> sp.	Whole body	Construction material	<i>Zanthoxylum acanthopodium</i>	Leaves	Edible
<i>Juglans regia</i>	Stem	Construction material	<i>Zanthoxylum armatum</i>	Seed	Medicine
<i>Juniperus squamata</i>	Stem, leaves	Ritual	<i>Zanthoxylum rhetsa</i>	Leaves	Edible
<i>Litchi chinensis</i>	Fruit	Edible			
<i>Litsea cubeba</i>	Leaves	Medicine			

Table 3. Animal based NTFPs collected by the local tribes for commercial uses

Plant species	Uses
<i>Anas platatea</i>	Edible
<i>Aspongopus nepalensis</i>	Edible
<i>Bombyx mori</i>	Edible
<i>Bothroponera</i> sp.	Edible
<i>Bothroponera rufipes</i>	Edible
<i>Chrysalis</i> sp.	Edible
<i>Dicrurus bracteatus</i>	Edible
<i>Funambulus</i> sp.	Edible, Ritual works
<i>Hoolock leuconedys</i>	Edible
Honey	Edible, Medicine
<i>Hystrix cristata</i>	Edible
<i>Lepidocephalus</i> sp.	Edible
<i>Nomacheilus</i> sp.	Edible
<i>Garra</i> sp.	Edible
<i>Chaugunius</i> sp.	Edible
<i>Lepidocephalus</i> sp., <i>Nomacheilus</i> sp., <i>Garra</i> sp., <i>Chaugunius</i> sp.	Edible
<i>Macaca</i> sp.	Edible
<i>Macropygia unchall</i>	Edible
<i>Manis pentadactyla</i>	Edible, Medicine
<i>Milvus migrans</i>	Edible
<i>Monomorium pharaonis</i>	Edible
<i>Motacilla alba</i>	Edible
<i>Muntiacus muntjak</i>	Edible
<i>Paradoxurus</i> sp.	Edible
<i>Pardofelis</i> sp.	Edible
<i>Pavo cristatus</i>	Edible
<i>Plectia nearctica</i>	Edible
<i>Pyrrhocorax pyrrhocorax</i>	Edible
<i>Sus scrofa</i>	Edible
<i>Ictinactus malayensis</i>	Edible
<i>Tragopan</i> sp.	Edible
<i>Ursus thibetanus</i>	Edible
<i>Varanus</i> sp.	Edible
<i>Xylorhiza</i> sp.	Edible

of the villagers comes from NTFP sale. In Lower Subansiri, Tirap, West Kameng and Tawang districts, 50 ~ 60% of the annual income comes from NTFP sale. Contribution of NTFPs to the total annual income was lowest in West Siang district (14 ~ 18%) (Fig. 2). Few villagers could earn handsome amount (Rs. 1 ~ 2 lacs) annually from the commercial trading of *Taxus* leaf and Ginseng root. The commercial trading of *Taxus* leaf from wild has been banned in India since 1996 but illegal trading still continues in certain parts of Arunachal Pradesh. In West

Kameng and Tawang, firewood is the most important NTFP.

Edible plants (e.g. *Acorus calamus*, *Alpinia malaccensis*, Bamboo shoots, *Clerodendrum colebrookianum*, *Cucurbita* sp., *Houttuynia cordata*, *Piper pedicellatum*) and animals (e.g. *Antelope cervicapra*, *Aspongopus nepalensis*, *Gallus gallus*, *Hystrix cristata*, *Macropygia unchall*, *Muntiacus muntjak*, *Rattus ratus*, *Xylorhiza* sp.) are the most important NTFPs collected by Galo, Nocte and Adi tribes and average annual collection of edible NTFPs by each household of Galo, Nocte and Adi involved in collection and sale of NTFPs are 2576 kg, 211kg and 334 kg respectively. Bamboo is the major NTFP for Nyshi, Apatani and Tangsa tribes and its average collection ranges from 800 to 1400 nos per household per annum. In areas dominated by Monpa tribe, firewood contributes more than 50% of total NTFP collection. Maximum cane collection is done by Nocte, Apatani and Tangsa tribes (Fig. 3).

The degree of women participation in NTFP collection and sale was significant in most districts except in Changlang where mostly men are involved in NTFP collection and sale. Tribal people of East Kameng, Lower Subansiri, Tawang, Tirap and West Siang travel on an average 5 km distance for NTFP collection and the distance travelled to collect NTFPs is guided by the types and availability of the forest products (Table 5).

Average annual income from NTFP sale was highest among Adi tribes (Rs. 38750/household) and most of the income comes from the sale of firewood, medicinal plants and animal products. People belonging to Nyshi, Apatani and Monpa tribes earn on an average Rs. 36000, Rs. 33300 and Rs. 31400/household per annum mostly by selling fuel, bamboo/bamboo products and animals hunted from wild. For Monpa tribes, the majority of the income comes from the sale of firewood and medicinal plants. Galo and Nocte tribes earn Rs. 10700/household and Rs. 20000/household per annum by selling bamboo, cane and hunted animals. Annual income from NTFP is lowest among Tangsa tribes (Rs. 2800/household per annum) and most of their earning comes from the sale of bamboo, cane and medicinal plants.

Utilisation of NTFPs

Altogether, 135 plant based and 36 animal based NTFPs were recorded to be used by the people of the eight

Table 4. Quantity of NTFPs collected from the study villages

District	Villages surveyed	Number of households surveyed	Total population surveyed	Quantity of plant based NTFPs (kg)	Quantity of animal based NTFPs (kg)	Quantity of plant based NTFPs (kg ha ⁻¹ forest)
Changlang	Jungmeisung, Rangkutu, Choktok, Kengkhu, Old Changlang	50	200	1,475	45	147.4
East Kameng	Tajo, Samchu, Wada Bagang, Yangfo, Jayang Bagang	50	250	1,595	55	45.57
Lower Subansiri	Tajang, Reru, Kalung, Dutta, Mudong Tagi	50	250	1,756	63.5	175.6
Tawang	Jang, Sela, Tawang monestry	30	120	2,280	0	114.0
Tirap	Khoma, Khela, Khonsa	30	120	225	70	15
Upper Siang	Geete, Jenging, Pugging, Maryang	40	160	504	35	20.16
West Kameng	Dirang, Aka, Miji, Rupa, Morshing	50	200	2,690	0	130.45
West Siang	Bene, Kugi, Page, Poboli, Eyi	50	200	2,709	100	93.41

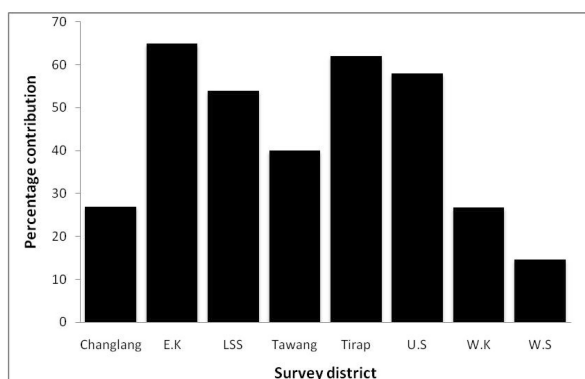


Fig. 2. Contribution of NTFPs in the annual income of the people of Arunachal Pradesh.

districts of Arunachal Pradesh. Out of which 54 species were collected for leaves, 30 for stems, 22 for fruits, 13 for rhizomes/root/tuber, 8 for seeds, 5 for flowers, 4 for shoots and 3 for barks (Fig. 2). 41% plant based NTFPs were collected for their medicinal value, while 35% were collected for food besides 10% for construction purposes and 6% for use as firewood (Fig. 4). NTFPs are grouped in following categories based on their uses:

Edible

Among the plant based NTFPs, 39 are edible including fruits, vegetables, nuts and out of this, 34 species are reported to be having multiple uses (food, fodder, firewood,

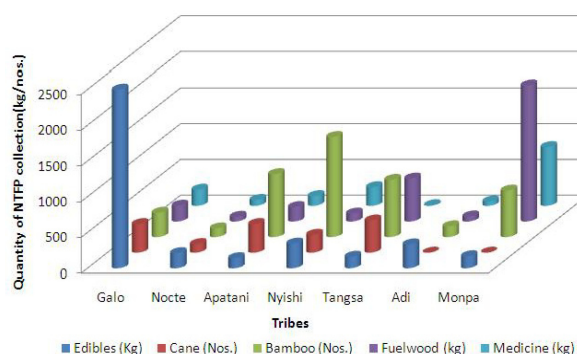


Fig. 3. Tribe wise collection pattern of major NTFPs.

medicine, spices etc) (Fig. 4A). As regards 39 edible plant species, 14 species are used as leafy vegetables and salad, 20 are used for fruits and 8 for seeds (Fig. 4B). Categorisation of plant based NTFPs on the basis of its edible parts revealed that 16 species are useful for their leaves followed by 14 for fruits, 5 for fruiting body, 4 for whole plant body, 3 for seeds, 3 for shoots and 2 are used for flower and stem (Fig. 4C). In case of animal based NTFPs, 36 species are either hunted or collected only for meat while 3 species showed both medicinal as well as food value. Twenty seven out of 29 animal based NTFPs are edible.

Medicinal

A total of 50 plant and 6 animal species are collected for

Table 5. Types of NTFPs and their usage in Arunachal Pradesh

District	Factors accountable				
	Type of NTFP collected	Parts used	Utility	Frequency of women participation	Distance travelled to collect NTFP
Changlang	Tree, Herbs, Shrubs, bamboo, climbers, mushroom & animals	Leaves, fruits, shoot, bark, flower, nuts, Meat/ flesh, skin & honey	Food items construction materials, local medicine & food	Rare	1 ~ 2 km
East Kameng	Tree, shrubs, herbs, insects and bamboo	Stem, Root, leaves, fruits, meat/flesh	Local Medicine, food items, firewood and construction materials	Regular	> 5 km
Lower Subansiri	Tree, herbs, shrubs, climbers, Stem, bamboo, animal and insects	Leaves, root, stem, Fruits, honey and Meat/ flesh	Local medicine, food items, spices & construction material, firewood	Regular	> 5 km
Tawang	Tree, shrubs, herbs, climbers	Leaves, stem, root, fur, skin	Food items, fodder, medicine, ritual purposes, firewood	Frequently	> 5km
Tirap	Tree, herbs, climbers, animal parts, bamboo and animals	Leaves, bark, root, fruits, honey, meat/flesh and	Local medicine, food items, pesticides and spices	Frequent	> 5 km
Upper Siang	Tree, herbs, shrubs, climbers, bamboo, animal parts and insects	Leaves, roots, meat/flesh, skin, honey and fruit	Food items, medicine, construction purposes, decorative materials, firewood	Frequently	2 ~ 5 km
West Kameng	Tree, climbers, herbs, shrubs, bamboo	Leaves, root, skin, honey & fruits	Local medicine, food items, firewood & construction materials	Frequently	2 ~ 5 km
West Siang	Tree, climbers, herbs, shrubs, bamboo, animal parts and insects	Leaves, root, meat/flesh, skin, honey & fruits	Local medicine, food items, salad, fertilizers, pesticides & construction materials	Regular	> 5 km

use as medicine. Different plant parts found its usage in the traditional medicine system. Leaves are collected from 30 plant varieties while roots/tubers are collected from 9 plant species, stems are collected from 8 plant species while whole plant body is used for medicine in case of 7 species. Seeds of 6 species, fruits of 5 plant species and flowers of 3 plant species are used for medicine formulations (Fig. 4D). Some of the common medicinal plants collected from the forests of the state are: *Acorus calamus*, *Angiopteris evecta*, *Biden pilosa*, *Bouhinia vahlii*, *Carica papaya*, *Coptis teeta*, *Litsea cubeba*, *Ocimum sanctum*, *Piper longum*, *Rubia cordifolia*, *Solanum torvum* and *Zanthoxylum armatum* (Table 6).

Fuelwood

Eleven plant species found its usage as firewood. Apart from cooking, firewood is required for burning in Bhukhari (A kind of stove made of iron sheet) and in other types of

stoves to keep the interiors of dwellings warm during winter months. Maximum consumption of firewood was found in sub-tropical and temperate areas of West Kameng, Tawang, East Kameng, Upper Siang and Lower Subansiri. A household of five members needs on an average about a truckload of firewood annually for this purpose. The firewood species preferred by the people are: *Cupressus torulosa*, *Pinus roxburghii*, *Quercus incana*, *Rhododendron* spp., *Alder* sp., and *Salix* sp (Table 6).

Fodder

Plant leaves are collected from the forest as a supplement to the conventional fodder for domestic animals. In the present study, 3 plant species namely *Alnus nepalensis*, *Salix alba* and *Taxus* sp. were found to be collected for fodder (Table 6).

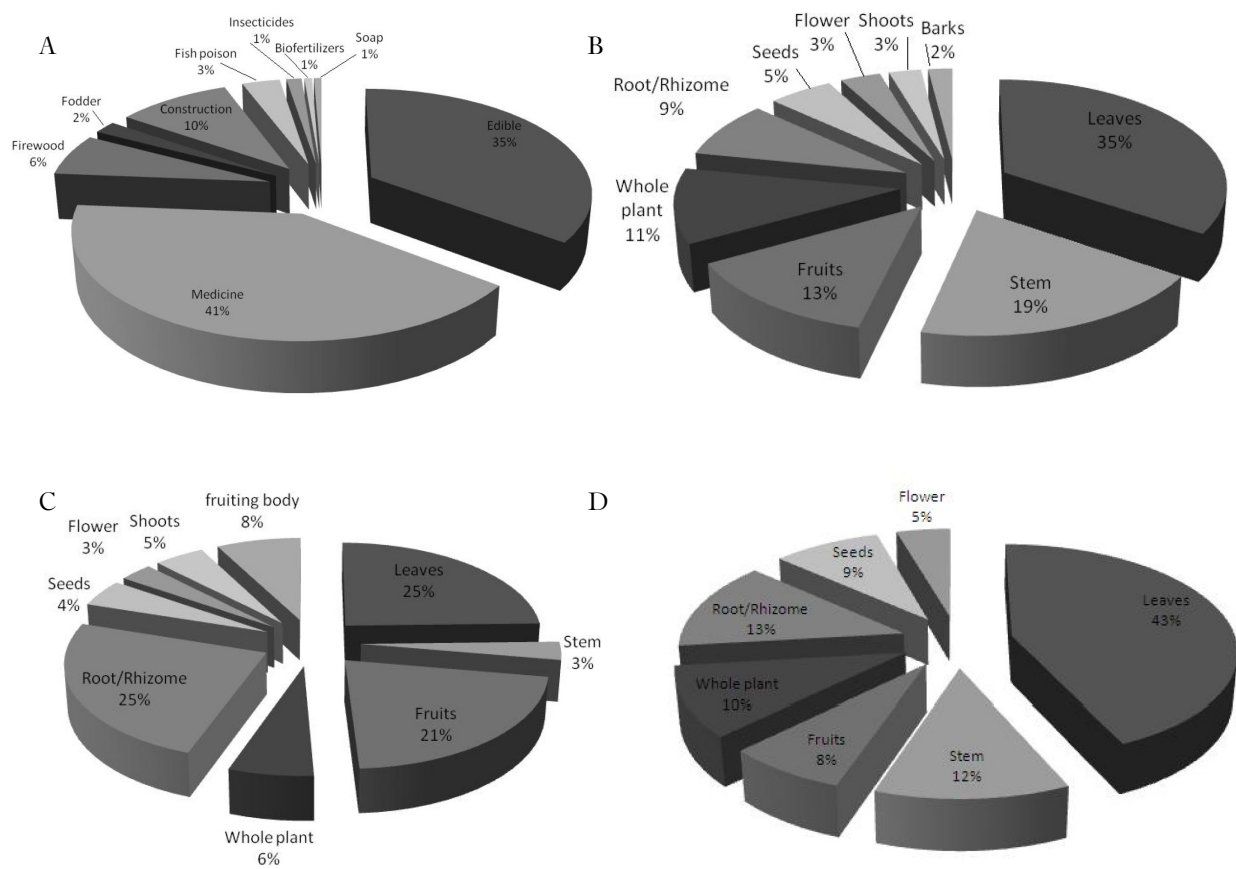


Fig. 4. Various uses of plant based NTFPs collected by prople of Arunachal Pradesh. (A) Various uses of plant based NTFPs collected. (B) Contribution of different plant parts to total NTFPs collected. (C) Contribution of different plant parts to the edible NTFPs. (D) Contribution of different plants based NTFPs in traditional medicinal use.

Craft making

Craft making is an old tradition among Khamti, Apatani, Adi, Galo and Monpa community. Various utensils, container vessels, hand tools, etc. are made from different trees/shrubs besides bamboos for household use as well as for sale. Sixteen different cane, bamboo and tree species are used for craft making. Some of the common plant species collected for this purpose are: *Bambusa tulda*, *B. gigantia*, *Calamus acanthospathus*, *C. floribunda* and *Michelia champaca* (Table 6).

House construction

Materials collected for house construction included the tree trunk for pillar, bamboo for fencing, leaves for roofing and cane for binding purposes. Fourteen plant species are collected by the people in the study areas for house con-

struction purposes. *Alnus nepalensis*, *Arundinaria maling*, *Bambusa pallida*, *Calamus acanthospathus*, *C. gracilis*, *C. flagellum*, *Dellinia indica* and *Livistona jenkinsiana* are most widely used in house construction (Table 6).

Religious uses

Junipers and *Cupressus*, locally known as ‘Shukpa’ are regarded as sacred species and its parts such as leaves, branches form an integral part of the religious ceremony and are used for burning during the ‘ritual of sacrifice’ by the Monpas. Leaves of *Junipers*, *Cupressus* and *Thuja* are burnt and fumigated in a small rock or brick/mud structure known as ‘Sungyung’ in front of the household to keep off the evil spirit and diseases. The Apatani tribe uses squirrel flesh during rituals and marriage ceremonies. Three species of plant (*Juniperus squamata*, *Cupressus torulosa* and *Thuja oc-*

Table 6. Plant based NTFPs collected in Arunachal Pradesh

Uses	Plant species
Medicinal	<i>Acorus calamus</i> , <i>Ageratum conyzoides</i> , <i>Angiopteris evecta</i> , <i>Anisomeles ovate</i> , <i>Bouhinia vahlii</i> , <i>Bidens pilosa</i> , <i>Campylandra aurantiaca</i> , <i>Canarium strictum</i> , <i>Carica papaya</i> , <i>Cassia obtusifolia</i> , <i>Centella asiatica</i> , <i>Citrus aurantifolia</i> , <i>Clerodendrum colebrookianum</i> , <i>Clerodendrum japonicum</i> , <i>Coptis teeta</i> , <i>Curcuma aromatic</i> , <i>Cyperus brevifolius</i> , <i>Dipsacus inermis</i> , <i>Drymaria cordata</i> , <i>Elaeagnus parvifolia</i> , <i>Erythrina arborescens</i> , <i>Garcinia pedunculata</i> , <i>Gaultheria</i> sp., <i>Houttuynia cordata</i> , <i>Hydrocotyle sibthorpioides</i> , <i>Illicium griffithii</i> , <i>Litsea cubebam</i> , <i>Mangifera indica</i> , <i>Melodinus khasianus</i> , <i>Melastoma malabothricum</i> , <i>Michelia champaca</i> , <i>Mikania micrantha</i> , <i>Musa velutina</i> , <i>Ocimum sanctum</i> , <i>Oroxylum indicum</i> , <i>Oxalis corniculata</i> , <i>Paederia foetida</i> , <i>Panax</i> sp., <i>Perilla frutescens</i> , <i>Picrorhiza kurroa</i> , <i>Picrorhiza scrophulariiflora</i> , <i>Pinus wallichiana</i> , <i>Piper longum</i> , <i>Plantago erosa</i> , <i>Pogostemon benghalensis</i> , <i>Polygonum hydropiper</i> , <i>Polygonum</i> sp., <i>Psidium guajava</i> , <i>Pteris wallichiana</i> , <i>Rhus hookeri</i> , <i>Rubia cordifolia</i> , <i>Rumex acetosella</i> , <i>Solanum torvum</i> , <i>Spilanthes calva</i> , <i>Swertia hookeri</i> , <i>Swertia chirayita</i> , <i>Taxus wallichiana</i> , <i>Thalictrum foliolosum</i> , <i>Woodfordia fruticosa</i> , <i>Zanthoxylum armatum</i> .
Edible	<i>Agaricularia</i> sp., <i>Alpinia malaccensis</i> , <i>Agaricus</i> sp., <i>Artemisia indica</i> , Shoot of <i>Bambusa pallid</i> and <i>Bambusa tulda</i> , <i>Calamus floribunda</i> , <i>Cantharellus</i> sp., <i>Chlorophytum arundinaceum</i> , <i>Citrus aurantium</i> , <i>Citrus lemon</i> , <i>Coriandrum sativum</i> , <i>Dillenia indica</i> , <i>Dioscorea hamiltonii</i> , <i>Diospyros</i> sp., <i>Hodgsonia macrocarpa</i> , <i>Duabanga grandiflora</i> , <i>Garcinia</i> sp., <i>Illicium griffithii</i> , <i>Litchi chinensis</i> , <i>Livistona jenkinsiana</i> , <i>Mahonia</i> sp., <i>Michelia champaca</i> , <i>Manihot esculenta</i> , <i>Musa</i> spp., <i>Musa velutina</i> , <i>Myrica esculenta</i> , <i>Phoenix sylvestris</i> , <i>Phyllostachys bambusoides</i> , <i>Prunus avium</i> , <i>Prunus rufa</i> , <i>Rhododendron arboretum</i> , <i>Silene heterophylla</i> , <i>Solanum indicum</i> , <i>Termitomyces</i> sp., <i>Zanthoxylum acanthopodium</i> .
Fuelwood	<i>Alnus nepalensis</i> , <i>Arundinaria maling</i> , <i>Bambusa</i> spp., <i>Cupressus torulosa</i> , <i>Pinus roxburghii</i> , <i>Pinus wallichiana</i> , <i>Quercus incana</i> , <i>Rhododendron arboretum</i> , <i>Salix alba</i> , <i>Taxus wallichiana</i> , <i>Thuja occidentalis</i> .
Fodder	<i>Alnus nepalensis</i> , <i>Salix alba</i> , <i>Taxus wallichiana</i> .
Fish poison	<i>Amphineura opulentus</i> , <i>Croton tiglium</i> , <i>Derris elliptica</i> , <i>Polygonum hydropiper</i> , <i>Polygonum</i> sp., <i>Pteridium aquilinum</i> , <i>Pteris wallichiana</i> , <i>Taxus wallichiana</i> .
Construction	<i>Arundinaria callosa</i> , <i>Aspidopterys indica</i> , <i>Bambusa pallid</i> , <i>Bambusa</i> spp., <i>Bambusa tulda</i> , <i>Calamus acanthospathus</i> , <i>Calamus flagellum</i> , <i>Calamus floribunda</i> , <i>Calamus gracilis</i> , <i>Calamus</i> sp., <i>Dillenia indica</i> , <i>Imperata species</i> , <i>Juglans regia</i> , <i>Livistona jenkinsiana</i> , <i>Milletia cinerea</i> , <i>Plectocomia himalayana</i> , <i>Villebrunea integrifolia</i> .
Weaving and handicraft	<i>Calamus</i> spp. and <i>Bamboo</i> spp.
Insecticides	<i>Cyclosorus</i> sp. and <i>Pteris</i> sp.
Soap	<i>Gymnocladus assamicus</i>
Ritual works	<i>Juniperus squamata</i>
Packing	<i>Phrynium capitatum</i>
Bio-fertilizer	<i>Quercus</i> sp.

occidentalis) and 1 species of animal (*Funambulus* sp.) were found to be used by the tribes for rituals.

Fish poison

Eight (8) plant species are used for fishing purposes. Galo tribes were reported to use maximum number of such species as fish poison (7) followed by Adi and Apatani tribe. The common plant species used as fish poison are: *Croton tiglium*, *Amphineura opulentus*, *Derris elliptica* and *Polygonum hydropiper* (Table 7).

Monpa collect the pine needles and oak leaves (*Paisang*) which are rich sources of organic manure for indigenous agriculture system. The leaves are collected and kept beneath the floor of a local hut. The local hut is a double stor-

ied structure in which the first story is used for habitation, whereas in the ground floor a mixture of pine needle and *Paisang* leaves along with the excreta of pig are allowed to decompose and the manure thus formed is called "Permang". Most of the Monpas live in temperate zone where water is a scare commodity. In order to minimise the wastage of water in toilet, they use the green leaves of *Paisang* as a substitute for tissue paper. It is on this consideration that Monpas do not cut or pluck the leaves of *Paisang* trees. Only the fallen leaves are collected and utilized for mulching and the dry wood is used as firewood.

Economic valuation

An estimation of the economic value of the NTFPs col-

lected for sale and self consumption was done using its price value in the local market. The major NTFPs collected for sale and self consumption are:

Cane

On an average 200 ~ 300 kg of cane is collected per year by a group of 3 ~ 5 persons from the forests of Lower Subansiri, Changlang and Tirap districts. Group members could be either from the same family or same community. Annual income of each group from cane ranges between Rs. 5,000 ~ 10,000.

Bamboo

Bamboo is one of the major NTFPs collected for sale in Lower Subansiri, East Kameng and Changlang districts. By selling raw bamboo, each household on an average earned Rs. 3,000 ~ 5,000 annually depending upon the type of bamboo collected and their market demand.

Green vegetables

Several varieties of green vegetables are collected from the forest either for sale by women members in the local market or for self consumption. Maximum harvesting of green vegetables from wild is done during winter and income from green vegetables was found highest during November to March. The sales of vegetables fetch them an earning between Rs. 3,000 ~ 6,000 per household/annum.

Fruits

Wild fruits of *Litsea cubeba*, *Prunus* sp., *Litsea chinensis*, *Myrica* sp., *Citrus* sp., and *Artocarpus heterophyllus* are collected from the forest for self consumption as well as for sale in the local market. On an average, each household collect fruits worth Rs. 500 ~ 1,000 per annum from the forests.

Pine wood

Stick of resinous pinewood is used both as candle for lighting and as firewood. It is sold in the market at Rs.10 per bundle. Households involved in the collection and sale of *Pinus wallichiana* wood-sticks in Lower Subansiri district earned between Rs. 1,000 ~ 2,000 annually.

Animal products

Besides plant products, many local people also engage

themselves in hunting of wild animals. Villagers do community hunting mostly in community land or in community conserved area. Many tribes of the state including Apatani, Galo, Nyshi, Mishmi have hunting festivals and major hunting is done during these festivals. Illegal hunting of Wild Deer, Wild Boar, Squirrel, birds though banned by Law was reported from Zero, Pasighat, Papum Pare, Bomdila, Rupa and Shergaon. Villagers are permitted to go for community hunting during festival time. Each household involved in hunting of animals from wild sell bush meet and other animal parts worth Rs. 5,000 ~ 20,000 per annum depending upon the number and types of animal hunted. Animal based products like bush meet and bird's bills (e.g. hornbills) are sold mostly in local markets.

Insects

Both mature insects and caterpillars are collected from the forests for self consumption and sale in the local market. Insects like beetle, moth and larvae are also collected and sold. On an average, each household involved in this business earned Rs. 2,000 ~ 3,000 per annum.

Honey bee

A few households are also engaged in collecting honey from the forests, which is sold in the market at the rate of Rs. 200 ~ 300 per litre. Annually, each household involved in this business earned on an average Rs. 500 ~ 1,000.

As the annual income from NTFP is not constant, the amount listed above is therefore an average value. Some of the common NTFPs having potential of producing high economic return include: *Acorus calamus*, *Bambusa pallida*, *Bambusa tulda*, *Calamus acanthospathus*, *Calamus flagellum*, *Calamus floribunda*, *Clerodendrum colebrookianum*, *Coptis teeta*, *Diplazium esculentum*, *Illicium griffithii*, *Litsea cubeba*, *Livistona jenkinsiana*, *Musa* sp., *Pinus* sp., *Piper longum*, *Piper nigrum*, *Quercus dealbata*, *Rhododendron* sp., *Zanthoxylum* sp. and honey.

Discussion

NTFP collection is an important source of income for forest dwellers and rural poor. It varies from state to state ranging from 5.4 to 55 percent (Prasad 1985). Rural populace especially forest dwellers depend on the forests not

only to supplement their domestic requirements for foods, fodder, fibre and medicines but also to supplement their income by selling part or all of their collection in local markets. In India, more than 41 million tribals and forest dwellers derive their earnings from these products after consuming about 60% of collected NTFPs for personal use (Prasad 1985). NTFP is potentially obtainable from about 3000 species found in the forests of India. Among all NTFPs, medicinal plants form the biggest but underutilized NTFPs. Tiwari (2002) reported 129 types of NTFPs from northeast India which includes 39 types of food, vegetable, fruits and tuber species; 46 types of medicinal plants and brewing herbs; 24 types of building material and other commercial items and 13 types of animal based NTFPs. In a technical report on NTFPs of North East India by GBPIHED (2007), highest number of NTFPs were reported from Manipur (31 nos.), followed by Arunachal Pradesh (26 nos.), Assam (9 nos.), Nagaland (5 nos.), Meghalaya (4 nos.), Tripura (3 nos.) and Mizoram (2 nos.) which is gross underestimate and suggest on the lack of in-depth study. In Manipur NTFP contributes to 40% of their total income, while for marginal, small and large farmers the share of NTFP in total income is 34%, 14% and 4% respectively (GBPIHED 2007). Supporting the present study, Tiwari (2000) also reported 106 plant based NTFP species from Arunachal Pradesh including 6 bamboo species used for house construction, 60 wild species for fruits and other plant parts and about 40 species for use in worship. Chetri et al. (2005) reported 94 NTFPs from Sikkim. Similarly, Bhardwaj and Gakhar (2008) and Lalfakzuala (2007) reported 172 NTFPs (39 for making furniture, 44 wild edible fruits and 89 herbal species) from Mizoram. In Tripura, medicinal plants contributed highest percentage of NTFP and generate maximum income for the rural people followed by bamboo based handicraft (Das et al. 2009). Majority of the people living in rural areas especially in the vicinity of the forests solely rely on the collection and trading of fuel wood and many other non-timber forest products for their livelihood. A household survey around Midnapur forests revealed that of the 122 uses of plants or their parts listed by the people, the maximum were for food (44), followed by fuel (39) and medicinal purposes (18) (Malhotra et al. 1991). In the present study 135 plant based and 36 animal based NTFPs have been reported

from Arunachal Pradesh. About 60% of NTFPs are consumed as food or as a dietary supplement especially during the lean season. Saha and Sundriyal (2013) have recently reported as many as 343 plant species used by five tribal communities of Arunachal Pradesh.

GBPIHED (2007) reported that a total of 55 NTFPs species were marketed in Arunachal Pradesh out of which the plant parts collected were: whole plant (12.73%), stem (9.09%), bark (9.09%), leaves (30.91%), flowers (5.45%), seeds/ fruits (16.36%), roots (3.64 %), rhizome (1.82%), resin (3.64%) and others (7.27%). In the present study, 79 plant based and 32 animal based NTFPs were found to be marketed species. Out of the total plant based NTFPs reported, 40% were collected for leaves, 22% for stem, 16% fruits, 9.5% for root/rhizomes, 6% for seeds, 3.7% for flowers. Saha and Sundriyal (2013) also reported 76 plant species being sold by tribal communities in Arunachal Pradesh to earn cash.

In Manipur, nearly 90% population depends on forest products as a major source of livelihood and about 25 thousand women were reported to be involved in collecting forest products (FAO 1992). Similar trends were recorded in Arunachal Pradesh where women were involved in NTFP collection and sale in 70% cases.

In the present study, poor people were found to be more dependent on forest products for their livelihood than the rich. Several researchers have reported that it is the poorest households with minimum agricultural lands, livestock, adult males that are predominant collectors of forest products (Malhotra et al. 1991; Hegde and Daniel 1992). NTFPs are estimated to generate 70% of all employment in the Indian forestry sector (Das 2005). Commercial NTFPs alone are estimated to generate Rs.3 billion annually. According to a study, NTFP collection generates over 2 million person years of work annually (Shiva 1995). In addition, millions of individuals are employed in NTFP processing and marketing. With the promulgation of Wildlife Protection Act (1972), access to collection of NTFP and fishing has been prohibited in some states causing deteriorating relationship between forest department and forest user group. However, some states have accorded permission for NTFP collection and fishing. These primarily include fodder grasses, dry and fallen twigs, branches, leaves, leaf litter apart from mushrooms, edible tubers, flowers,

fruits and medicinal herbs. But free access to more valuable NTFP like cashew nuts, bamboo and fibrous grasses are denied (Sarin et al. 1998). Bharadwaj and Gakhar (2008) reported that the income of landless was higher in absolute terms in Manipur. The return per person per day from NTFP collection turned out to be almost double the return from wage earning in the village in Manipur. In a study on 33 sample households in four villages of the Karbi-Anglong, Assam, average income from NTFP collection was Rs. 4649.57 per family per year (Tiwari et al. 1997). On an average, each family earned an additional amount of Rs. 15,069 per year by way of selling the hand-craft items made of bamboo collected from the forest. On the other hand, present study showed that annual income from NTFP sale varied from district to district and on an average each household earned Rs.10,000~20,000 per annum. In some cases, villagers involved in selling of NTFPs like Pseudo-Ginseng, *Taxus wallichiana* leaves, *Coptis teeta* leaves and *Piper longum* could earn three to four times more than the villagers involved in daily wage earning.

Buddhism has been playing a very significant role among the Monpas in preserving ecologically sensitive and biologically diverse areas by associating such areas with certain deity and declaring them as sacred sites. Monpa tribe of Tawang follows an old tradition in which both community forest and private forest are conserved on community as well as private lands. Three species of local pine are conserved for performing the rituals, worship and customs of Buddhist religion. The leaves of these varieties are also used for making *Dhup* (incense).

Due to geographical inaccessibility of the region, the local communities in Arunachal Pradesh fail to get the desired return from NTFP sale. They often get only collection charges for products that have a very high market value. Most of the profit from products goes to middleman, contractors, traders and industry. There are at times products which lack proper price mechanism and marketing channels as a result of which the NTFP collectors are deprived of a fair price for their products. The state government should take necessary steps to make the market work for the poor. The NTFPs with high market demand may be introduced in agroforestry systems for commercial cultivation. This will help in enhancing livelihood of the tribal communities and in conserving biodiversity of the state.

Unscientific harvesting of NTFPs and trade to nearby states is an issue of concern because overexploitations of resources pose pressure on its sustainability. Majority of villagers have reported that the availability of several NTFP species viz., *Taxus wallichiana*, *Pseudo-Ginseng*, *Coptis teeta*, *Gymnocladus assamicus*, *Rubia cordifolia* has declined over the past few years due to overexploitation and illegal trading to other parts of the country.

Open access forests are prone to unsustainable harvest by collectors for commercial purposes (Tiwari et al. 2008). The common and economically viable NTFPs need to be adopted in the traditional tribal agricultural system based on people's perception and knowledge. Prioritization of selected species that are capable of giving high economic return to local inhabitants and gathering information on their status in nature can go a long way in the management of such species. NTFP certification, intensive management, marketing support, popularization of sustainable harvesting techniques and ensuring economic and social equity can assure sustainable production.

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