

Bamboo and cane resource utilisation and conservation in the Apatani plateau, Arunachal Pradesh, India: implications for management

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Abstract—The north-eastern states of India account for nearly 50 percent of the total bamboo resource of the country. Arunachal Pradesh State has more bamboo and cane diversity than any other state of India. There are over 26 major and 105 sub-tribes in the state and all of them possess huge indigenous knowledge about use and management of bamboo and canes, which are owned, protected and grown by the local people. This study (carried out in 1998–2000) has been focussed on the Apatani community of Arunachal Pradesh, which is famous for managing bamboo-plantations for several decades, and possesses a wealth of knowledge for using and managing bamboo and cane resources. The study reveals that a total of 9 bamboo and 3 cane species are being used for house construction, fencing, firewood, and for edible shoot purposes. Nearly 90% bamboo demand is met by just one species, *Phyllostachys bambusoides*, popularly known as *bije* bamboo that is maintained by each household in their gardens. Canes are collected either from the natural habitats or from the markets; therefore their plantations are highly desirable. The study explored the uses to which bamboo and cane are put. An absolutely new house requires 2500–3000 bamboo culms, and total annual requirement for the purpose was estimated at 391 400 culms in the study area. Furthermore 472 204 bamboo culms were recorded as used annually for fencing, while 112 681 culms were used for diversified craft works in the seven main rural settlements of the Apatani plateau. The total annual cane twine requirement was estimated at 7 464 716 m of *Plectocomia himalayana* (*tarpi*) and 73 975 m of *Calamus acanthospathus* (*tasurr*) for diverse purposes. The Apatani community has a rich natural resource base combined with the traditionally conservationist attitude which, if directed still further, can have a tremendous impact on the local resource development of the area. Once the economic potential of these resources is recognised, the bamboo and cane should receive due priority for planned development for the area. It is emphasised that a part of the total well managed bamboo resource should be diverted towards income generation, such as bamboo ply production and upgraded bamboo craft products with improved technologies to increase income to rural people. There is also a strong need for opening of a research centre and common facility centres at the district level, which would be able to carry out practical research and technology transfer in the use of bamboo related to its traditional status in the area.

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1. INTRODUCTION

World-wide, bamboo is slowly but steadily gaining importance as a material for the future and susceptible to sustainable development. India is the second largest producer of bamboo in the world next to China and also has the richest diversity of bamboo in the world with 136 species in 30 genera [1]. In spite of having such a rich resource base and a widespread living tradition of bamboo use, the tremendous potential of bamboo lies dormant and largely untapped in comparison with countries like China, Japan and Taiwan whose names are synonymous with bamboo in the world [2]. In north-eastern India a strong base and culture of use of bamboo and cane resources exist with over 58 and 40 species, respectively [3]. There exists a wealth of indigenous knowledge on utilisation and management of bamboo and cane resources, which go side by side in traditional use. The housing design and patterns vary between the different tribes, but bamboo is one of the most important components [4]. Arunachal Pradesh, which comprises 60% of the total area of northeast India, harbours 14 genera and 34 species of bamboo [5] and 4 genera and 17 species of cane [6], which is the highest diversity for any state in India. Not owning a bamboo grove is unthinkable in this part of India, and it is managed and grown by the local people. All the traditional shelters and structures of the state use a combination of bamboo, cane and timber. Traditional construction techniques that use bamboo in flooring, roofing, as post and beam, and also in the false ceiling and fencing remain largely undocumented. The Monpa community of Tawang and West Kameng districts builds bamboo suspension bridges of twisted split bamboo cables and woven walkway. Bamboo twine is used by the Adi community to tie palm thatch leaf roofing to the roofing under-structure, which also is largely of bamboo poles and splits. The Adi and the Apatani both use flattened bamboo culm lengths as floor planks over bamboo floor joints [7]. The long houses of the Nyishi tribe are cross-braced with bamboo poles and have strong walls of interwoven bamboo culm-planks. The bamboo tile roofing of the Apatani of Ziro area lasts from 10 to 12 years without treatment and is preferred as it catches fire less readily than a thatch roof. Besides use in housing, bamboo and cane are also used for fencing, craft, rituals and edible shoot purposes. Unfortunately, in spite of their traditionally important role in different sectors, and the fact that these products are so readily and cheaply available, documentation of uses of cane and bamboo have received little attention, which otherwise could make an encyclopedia of information, and if improved could provide employment to hundreds of thousands of people [7, 8]. Such an indigenous knowledge base has high implications for utilisation and management of these resources, which may become an important driving force for economic upliftment of the region. Therefore, the present study focuses on documenting the diversity of bamboo and cane resources with relation to its management, propagation practices, the present and past utilisation, and

possibility of development and introduction of bamboo and cane based livelihoods or small-scale craft based industry in Arunachal Pradesh. Such a study would also provide a basis for future planning for housing and sanitation development using the natural resources available in the region. This documentation is pertinent not only for planning further development in the area but also to serve as an example for the rest of the country.

2. STUDY AREA

The north-eastern region of India comprises seven states: Arunachal Pradesh, Assam, Meghalaya, Manipur, Nagaland, Mizoram, and Tripura, which are collectively considered as a major 'Hotspot of Biodiversity' [9]. Arunachal Pradesh constitutes 60% of the total area of the Northeast regions and the state has strategic importance as the whole of the northern side is occupied by China, the north-eastern side by Myanmar, the south-western side by Bhutan, the western side by the state boundary of the Assam and on the southern side by Nagaland state (Fig. 1). Arunachal Pradesh has an area of 83 743 sq km with an elevation range of 100–7089 m; the population of the state is 1 091 117 made up of 26 major and over 110 sub-tribes.

The study area falls in Ziro valley (Ziro-I circle) also known as the Apatani plateau situated in the Lower Subansiri district of Arunachal Pradesh, situated at an altitude of 1564 m above sea level (Fig. 1). This scenic valley is the home of the Apatani tribe whose unique land use pattern and culture of conservation have made them a focal point of attention [10, 11]. The blue pine and bamboo plantations on the fringes of a wide mosaic of wet rice fields surrounded by thickly forested mountains on all sides form a picturesque landscape. The elevation of the surrounding mountains lies between 1830 and 2900 m. Though famed for their agricultural practices, high rice yields and forest and bamboo plantations, quantification of this land and plantation based economy has received little attention. The surrounding area of Ziro-I is inhabited by the Nishing tribal community of Ziro-II circle, who supply many items to the Apatanis.

The Apatani are a close knit society with a total population of about 30 000, which is mainly concentrated in the tightly packed seven settlements of Bulla, Dutta, Hari, Hija, Hong, Michi Bamin and Modang Tage (Fig. 1). Bulla comprises the four settlements of Lempia, Reru, Tajang and Kalong. The community follows a settled pattern of life and is basically an agrarian community. The community is skilled for rice–fish cultivation and unlike most other tribal communities they do not practice shifting cultivation (Jhum). Apatanis are keen managers of land and depend mostly on their well-kept plantations rather than on the forest for their basic needs. This practice distinguishes them from most of the other tribes of the state and defines their distinctive lifestyle and social system [11]. In recent years, there have been attempts by the state government to resettle a part of the village population in new model villages like Siro and Manipolyang, Dilopolyang — mainly people from Hong village. The centre of administration (district headquarters) has shifted from

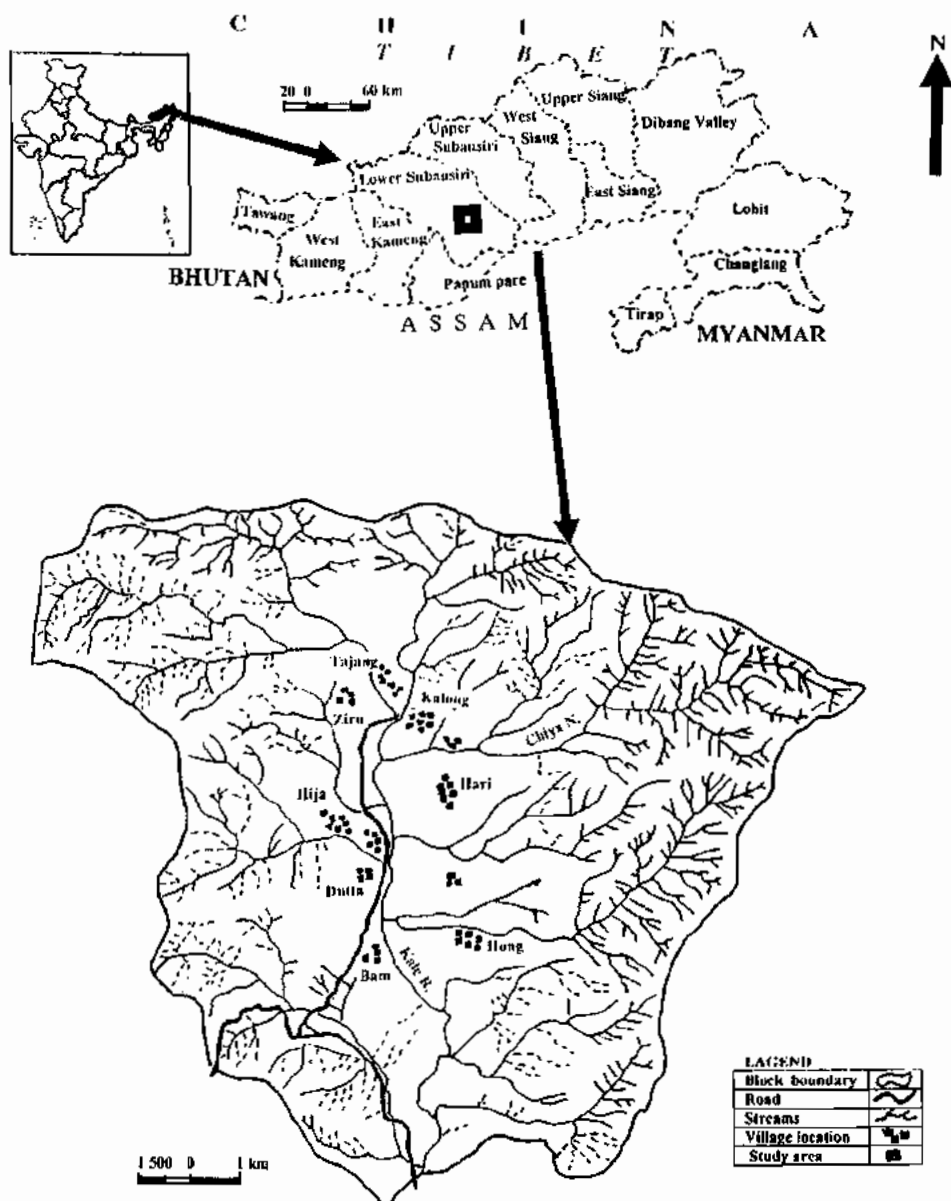


Figure 1. Location map of the study area in Apatani plateau in Lower Subasiri district.

Old Ziro to the new Hapoli township which is about 7 km away from Old Ziro town. The majority of people in Hapoli are from Hari village, which boasts of having produced the largest number of government officers in the plateau. Hong village on the other hand owns most of the forest area in the Apatani belt.

Apatani society is divided into a large number of clans (*nahi*) each of which resides together in a cluster in the village (*lemba*). The clan is the main social unit,

which acts in solidarity. Earlier there were two distinct classes, the *mite* or the higher class and the *mura* or the lower class, between which marriage was prohibited. In recent years, these distinctions have almost disappeared, along with the practice of child marriage, which was also common in the past. Governance is done through a system of *gaonburas* (Village headmen), and a local village council, which settles disputes at the village level according to customary law.

The area harbours a temperate climate with the summer temperatures ranging from 12°C to 25°C, and in winter from -0.6°C to 15°C. The average annual rainfall of the area is 1200 mm. Frost is common in the winter season. The soil is dark brown, sandy loam and of lateritic origin. A single small mountain stream called the Kley with low alluvial banks runs through the valley, from which man made mud channels irrigate the rice fields on either side.

3. METHODS

The analysis was based on primary data collected in the field with the help of structured questionnaires by randomly selecting the households in the Apatani plateau ($n = 182$). Households were chosen on the basis of clan and house type to determine the average or typical utilisation pattern of bamboo and cane. All the seven major settlements (Bulla, Dutta, Hari, Hija, Hong, Michi Bamin and Modang Tage) were surveyed to give an idea of the trend in the entire plateau. The questions asked covered a wide array of subjects related to land-use pattern, craft, agriculture, house construction, fencing and ritual needs in all the settlements [7]. Information was gathered on different land-use types including bamboo plantations, sources of bamboo and cane supply, important species collected and their utilization, traditional bamboo and cane crafts, durability and requirement of raw material, type of damage to the products, and ethical perspectives on cane and bamboos [8]. All the observations and points raised by interviewees were noted. Extensive interviews were conducted and informal discussions were also held with older farmers to ascertain the past history of bamboo and cane, and the extent of the availability of different species. Information was collected on a farmer's preferences in taking up a species for plantation, and methods used to propagate and conserve their bamboo and cane resources. Field observations and actual measurement, drawing, sample collection and mapping of selected bamboo plantations, typical houses and fields were carried out. Records were also made with reference to the number of bamboo species used for edible shoots and quantities collected annually. Sources of bamboo and cane supply were identified and records were made on extent of collection for different species. Local markets were surveyed to find out the cost and demand of the bamboo-based products. An inventory was made for different crafts made, their durability, market value, if any, and local demand. Local artisans were interviewed to get an idea about the demand and supply of the durability of each of the items.

The forests were visited and studied for wild bamboo and cane species, sampled for measuring their associations and density. All species were collected and

identified with the help of experts. The important forest stands were *Puut more* (a clan forest area of the Nending clan of Hija village), *Talle valley* (a bio-reserve and wildlife sanctuary and clan forest area of Hong Village), and *Michi Sansung* (an individual low altitude forest of Michi clan of Michi Bamin village). On the basis of preliminary visits a rough map of each area was prepared to show the various bamboo communities and characteristics of various sites were identified. Bamboo plantations and natural habitats were randomly sampled with the help of 10×10 size quadrates ($n = 20$) for each species. A total of six bamboo plantations were mapped and studied in detail. Primary observation revealed the six types of bamboo plantation in the valley, which includes an average sized typical steeply sloping plot with both blue pine and hardwood tree species (oak varieties); small sized gently sloping plot with only two blue pines, an average sized almost flat plot with wild apple and hardwood species; a small plot with fruit trees, blue pine, oak varieties and other hardwood species; a very small plot with only bamboo and some very young pine; and small sized gently sloping plot with some blue pines at one end of the plot. The bamboo species falling under each quadrates were listed, no. of culms/clumps were counted and cbh (circumference at breast height) was noted. Unfortunately such sampling was not done to cane areas due to inaccessibility. All these results were compiled and combined for both, bamboo and cane resources.

4. RESULTS

4.1. Demography, land use pattern and bamboo plantations

Among the seven studied villages, Dutta had a minimum of 40 and Bulla a maximum of 564 households; however, the population of Hong was highest of all (Table 1). Altogether there were 2007 households with a population of 8199 in the 7 studied villages. The community is confined within a 1058 sq km area and the majority of the population is dependent on agriculture. The social status of a man in Apatani society is largely determined by the size of his land holding. Of the total land area, 32 sq km is cultivated area, while the rest is under forest, plantations and settlement. Since the cadastral surveys are not done for rural areas in Arunachal Pradesh, data for exact distribution of land area under different category are not available. The scarcity of land has led to the development of an admirably efficient and well managed system of land use for which the Apatani community is famous. Land is the most precious commodity in the Ziro plateau and has a very high value in the local system. The people depend on a large variety of landuses for their sustenance, and each is identified for a specific need (Fig. 2). There is a typical pattern in the topographical relationship of a settlement to the surrounding plantations, forest and agricultural land so that there is barely any difference from one settlement to the next. The most common indigenous land use systems are rice fields, home gardens, clan forest and bamboo plantations, and 24–33%, 2–9%,

Table 1.
Demographic profile in Apatani plateau in Arunachal Pradesh

Village	No. of house holds in the village	Population	Literate		Occupation		Cultivators	Agri. labourers	Livestock, fishing and orchard	Service	Others	Non-workers
			Male	Female	Male	Female						
Bulla	564	2061	998	1063	358	282	799	34	14	66	78	1066
Bamin-Michi	107	450	221	229	96	79	110	—	5	23	17	295
Mudang-Taga	174	721	344	377	158	126	313	—	—	10	17	376
Hari	268	827	380	447	425	379	721	—	10	35	4	358
Hija	372	1532	730	802	247	220	650	—	4	54	9	814
Dutta	40	512	251	261	122	91	185	—	—	32	23	272
Hong	472	2096	1026	1070	425	379	721	—	3	78	11	1263

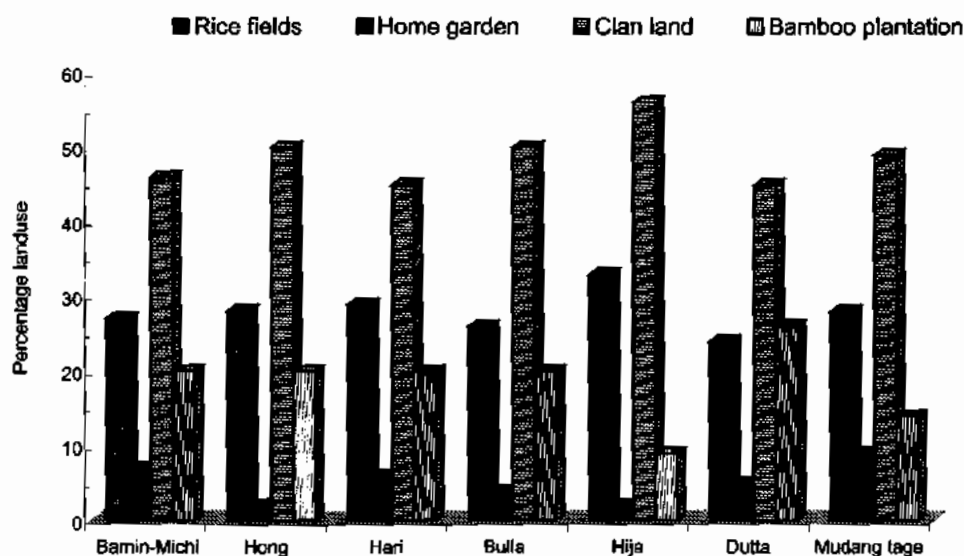


Figure 2. Major land uses in the study villages of Apatani plateau, Arunachal Pradesh.

45–56% and 9–16% area, respectively, was recorded in different villages under these categories (Fig. 2). Land ownership is mostly individual or belongs to the clan as a whole. All cultivated land, bamboo gardens, home gardens, granaries and forest plantations (*sansung/saale/sadi*) are privately owned. Clan land consists of some forest tracts (*more*), burial grounds and the sites for assembly platforms (*lapangs*) within the settlement (Fig. 2). Common village land is now minimal and is confined to a few pasture lands on the outskirts of the village. Unlike other tribes who rely to a large extent on forest produce, the Apatani depend mostly on their extensive bamboo and pine plantations and their permanent needs, and irrigated rice fields for their food and housing needs. A few important land uses are described below.

4.1.1. Rice fields (*Aji*). Rice is the staple crop of the Apatani and was earlier the major item of trade or barter with their neighbours. Therefore the rice fields (locally called *Aji*) had high value in the local system. The average area for rice cultivation was recorded as 0.36 ha per family in the studied villages. Both early and late ripening rice varieties were cultivated. Rice seedlings are first planted in a nursery (*miding*) in late February or early March and transplantation was done by the end of April. Though labour intensive, the agricultural tradition of the Apatani stands out not only because of its exceptionally high organically produced rice yields but also on account of a well developed irrigated rice terrace cultivation technique. The valley flatland is fed by the only small river or mountain stream (*Kley*) that runs through the region. The terraces are smaller and steeper at the entrance of the valley and, as it widens, the terraces become larger with level differences of barely one foot between successive terraces. In a year only a single crop is sown and harvested. *Mepia*, *pyapin* and *emo* are the main varieties grown, of which the first two are

harvested in the last week of August and early September (early varieties) while *emo* is late ripening and is harvested in October. *Emo* is the most commonly grown variety and grows on less fertilised land, with lower per hectare yields. *Mepia* and *pyapin* have higher per hectare yields and are cultivated only in nutrient-rich soil. The productivities of rice were high: from 8 to 10 t ha⁻¹, which can be correlated with the post green revolution in the Punjab state of India.

4.1.2. Vegetable and maize gardens (Yorlu) and millet gardens (Yapyo). The *yorlu* is primarily a distant vegetable garden patch where other crops like tobacco, millet and maize are grown along with some fruit trees of peach, plum, apple and pear. Most of these crops are grown for home consumption. Plots where only millet was grown are called *yapyo*. The *yorlu* and *yapyo* are fenced plots, located in those areas that are rain-fed only. Millet was also planted on mounds of rice fields or uneven sloping land at the fringes of the valley bowl. Millet was used solely for the brewing of millet-beer, which was mainly consumed at home or sold. The Apatani cultivate two varieties of millet — an early ripening one called *mipa* and the late one *sarse*. The seedlings of both these varieties were transplanted from the home garden (*balu*) or *yorlu* in the last part of April or early May, respectively. *Mipa* was harvested in August while *sarse* was gathered in early November after the *emo* rice crop.

4.1.3. Home garden (Balu). Adjoining the homestead land to the side or at its rear was a small vegetable patch called the *balu*. This land was usually planted with vegetables or with a cane like reed (*pepu*) used for making floor mats. These were commonly used in every household and sold at Rs¹ 50–70 per mat locally. The common vegetables and cereals cultivated were cucumber (*Taku*), millet (*Sarse*), pumpkin (*Tape*), maize (*Tani*), tomato (*Byayung*), Lai saag (*Gya hamang*), ginger (*Taki*), soyabean (*Potung perung*), onion (*Byaku*), and french bean (*Obyo perung*). Vegetables were grown mainly for home consumption, though some surplus was sold in the Hapoli and Old Ziro market. The most commonly sold vegetables were potato, cabbage, *lai saag* (mustard leaves) and chillies. Potato, cauliflower, cabbage and tomato were more recent introductions to the Apatani plateau. Home gardens were as meticulously tended as the rice fields, fenced every year with bamboo and fertilised with local home-made manure.

4.1.4. Clan forest land (More). Forest tracts (locally called *More*) were dispersed throughout the Apatani plateau covering the surrounding hills. They were either owned by a particular clan or jointly by two to three clans that inhabit a section of a village. In this area only members belonging to the owner clan may hunt or collect cane, timber, firewood or any other forest produce. Wild fruit and nuts and some jungle leaves used in traditional rituals (*niji leaves*) were collected at intervals.

¹Note: Rs 45 = \$ US 1.

4.1.5. Bamboo plantations (Bije). Apatani believe that there is no life without bamboo. This resource was jealously guarded and meticulously tended by every villager in the Apatani plateau. The community manages bamboo plantations mainly with single bamboo species, which is probably unparalleled in any traditional society in the world. Almost every household (about 98%) had at least one bamboo garden locally called *bije* after *Phyllostachys bambusoides*. These individually owned, carefully tended and beautifully fenced, gardens were 2–3 acres in area, the largest plots measuring up to 5 acres. The plantations were maintained primarily for house construction, craft and fencing. They were typically interspersed with a few blue pine or oak (*kra*) trees that were also used for housing. Wild apple (*pecha*) trees tend to grow with the bamboo but were put to no commercial use. Earlier trees, like the *Sankhe* (*Camelia cordata*) and the *Timin* (*Rubia cordifolia*) shrub used for making dye, were also planted in this area. This practice has been discontinued since the introduction of synthetically dyed yarn.

4.1.6. Individual forest plantation (Sansung). Closer to the settlement, at the beginning of the hill slopes, were private forest plantations of blue pine (*pusa* or *Pinus wallichiana*) and oak species, primarily used for house construction and firewood purposes. Wild bamboo species *Tabyo* was sometimes planted for their use in fencing as it is found in far-off areas. These plantations were fenced and carefully tended to ensure optimum growth and stocking. Young saplings of pine and oak were planted in the last part of winter in February. The characteristic blue pine (*Pinus wallichiana*) variety was not indigenous to the area. Though the economy of the people was largely agrarian, there has been a shift towards services, particularly for the young educated group members.

4.2. Bamboo and cane resource base in the Apatani valley

A total of 9 bamboo and 3 cane species were recorded used by the community in different study villages. Among all the species, *bije* bamboo (*Phyllostachys bambusoides*) was most extensively used, and almost all farmers maintain their own plantation of this species. Density of this species was maintained between 4000–5100 culm/ha. This was the only bamboo species planted by the Apatani, with the exception of *Dendrocalamus hamiltonii* (*yayi*), though in small numbers. In addition to the species of plantation bamboo, all other species were collected from wild habitats for different uses. Canes were collected from the forest areas or purchased in the markets. The characteristics of different species of bamboo and canes are summarised in Table 2 and also described below.

4.2.1. Bamboo species.

Phyllostachys bambusoides (*bije*). This planted species is the monopodial, and most strong, durable and resistant to insect attacks. The tensile strength of this bamboo was recorded to be higher than that of mild steel, and it is considered as

Table 2.
Types and characteristics of bamboo and cane found in the Apatani plateau

Species	Local name	Wild/ planted	Edible	Aver. outer diam. (cm)	Aver. wall thickness (cm)	Internode length (cm)	Local usage
Bamboo species: <i>Arundinaria</i> species	<i>Tador</i>	Wild	—	0.5–0.9	0.2–0.3	40–50	Minor uses
<i>Cephalostachium</i> <i>capitatum</i>	<i>Yabing</i>	Wild	Edible, fermented shoots	2.5–3.5	0.2–0.3	48–53	Loin loom component, bamboo shoot, craft
<i>Chimonobambusa</i> <i>callosa</i>	<i>Tabyo</i>	Wild	—	2–3	0.3–0.4	15–17	Rice field fencing, inner loft floor/ceiling, craft, firewood
<i>Chimonobambusa</i> species	<i>Rijang</i>	Wild	—	1–2.5	0.5–0.6	14–15	Rarely used, fencing
<i>Chimonobambusa</i> species	<i>Tapyu</i>	Wild	Young shoots edible	2–3.5	0.2–0.3	15–18	Not used any more Earlier for driving away birds and rats
<i>Dendrocalamus</i> <i>hamiltonii</i>	<i>Yayi</i>	Bought from Nishi, sometimes planted	Most commonly used for wet and dry shoots	8–10	0.5–0.6	35–40	Mugs, food (wet and dry bamboo shoot)
<i>Phyllostachys</i> <i>bambusoides</i>	<i>Bije</i>	Planted	Young and fresh shoots edible	4–7	0.5–0.6	26–27	Most extensively used for housing, fencing, Craft works; to a lesser extent for firewood, and edible shoots
<i>Pleioblastus</i> <i>simonii</i>	<i>Hebing</i>	Wild	—	3.5–4.5	0.2–0.3	40–50	Minor uses

Table 2.
(Continued)

Species	Local name	Wild/ planted	Edible	Aver. outer diam. (cm)	Aver. wall thickness (cm)	Internode length (cm)	Local usage
Unidentified	<i>Tajar</i>	Wild	—	0.8–1.5	Solid, may have a tiny hole	80–90	For making shrine ornaments for the Mithun sacrifice/puja
Canes: <i>Calamus</i> <i>acanthospathus</i>	<i>Tasurr</i>	Wild	—	1		15	Most important cane for craft. Mainly used in craft and traditional rituals (puja)
<i>Calamus</i> <i>khastanus</i>	<i>Tikhe/ Takhe</i>	Wild	—	1.5–2		32	Rarely used Craft and twine for house interior only
<i>Plectroconia</i> <i>himalayana</i>	<i>Tarpi</i>	Wild	—	2			Most commonly used for housing, fencing, and crafts

the most durable species among all in the study area. The community relied almost entirely on this bamboo to fulfil its basic housing, fencing and craft needs. Its straight length, smooth and even toned skin and medium-length of internode make it a priority species. Almost every household had one or more bamboo plantations. In some cases it was found that vegetable and fruit gardens had been converted into bamboo gardens. Shoots of this species were eaten fresh only as it tends to spoil quickly. It was propagated vegetatively through the rhizome. According to local sources there was no record of *bije* having flowered and it is often referred to as a male bamboo. The present local cost of this bamboo (excluding transport) ranges from Rs 3 to Rs 10 for a mature culm.

Dendrocalamus hamiltonii (Yayi). This sympodial medium diameter bamboo had recently started to be grown by some individuals in their forest plots or bamboo plantations, particularly in Hija and Lempia (Bulla villages). Otherwise, it usually purchased from the Nishi tradesmen, for edible fresh shoots, for edible fermented bamboo shoots, and mature culms for making mugs and arrows. Both these items (arrows and mugs) were now no longer in demand, but samples can still be seen in most houses. The bamboo shoot of this variety was the most commonly eaten in the region.

Chimonobambusa callosa (Tabyo). This was the most commonly used wild bamboo species in the past; however, its uses have gradually declined over the years. The shoots were also eaten by the *Mithun* (*Bos frontalis*) and therefore the species showed a dominance in the interior forest areas where distance and density of vegetation made carriage cumbersome. It is used mostly for fencing farm plots, i.e. rice fields (*aji*), millet gardens (*yapyo*), nurseries (*miding*) and the vegetable and fruit gardens away from the settlement area (*yorlu*). It is also used to make a bent component in the hunting trap (*giiri*). In Bulla it was found to have been planted in some individual forest plantations, and priced at Rs 2–4/- per culm. It has been used sometimes in the construction of the loft floor (*reke*) and for making some minor craft products. The culms of *tabyo* tend to grow in a clump formation. It has a distinctive horny crown at the nodes. It was seen to dominate the forest landscape at points and to grow profusely in the interior forest areas with some cane species and a few scattered huge individual oaks (*shanti*). It was distinguished from the other *Chimonobambusa* species (*rijang*) by its smooth outer skin and lighter reddish colouring. In general it has a larger diameter than the other two *Chimonobambusa* species found in the region (Table 2).

Chimonobambusa sp. (*Rijang*). This bamboo can be distinguished from the *tabyo* by the colour and texture of the outer skin, which is dark and rough in this species. It is found near water, mountain streams or springs and grows along with oak varieties in the forest. It is slightly smaller in diameter and also has smaller internode length as compared to the other two thorny bamboo types found in the area (Table 2). The diameter of this bamboo was found to vary with altitude. At lower elevation, the species was found scattered. This species was used for minor

works only. In a few households, which did not have bamboo plantations, it was used for fencing farm plot areas.

Chimonobambusa sp. (Tapyu). This species is distinguished from the *tabyo* and *rijang* by its distinctive scent and slightly swollen thorny nodes. Earlier this species was split and kept in the granary to keep away rats, and also in rice fields to drive away birds due to its strong scent. The young culms are said to have a stronger smell, which was said to be caused by a white insect that makes its home inside the walls of the bamboo. The leaf and short diameter size were similar to that of the *tabyo*, and shoots were edible. It grew in high humidity conditions at somewhat lower altitudes (near Hapoli and in far-off forest areas, e.g. the *Puut more* of Hija village).

Cephallostachium capitatum (Yabing). This wild bamboo was probably one of the most important of the wild bamboo species in the Apatani plateau and traditionally had some very specific uses. It is used to make the winnowing tray (*yapyo*) and is also a component of the loin loom due to its light weight, long internode distance (average, 72 cm) and smooth texture, which make it extremely suitable for these purposes. Shoots were considered the tastiest (distinctive delicate sweetish flavour), and the fermented shoot may last up to a year without spoiling. The Apatani and neighbouring Nishis most often collected it as food. The latter also sold this at the rate of Rs 10/- per *chunga* (bamboo cylindrical container) to the Apatani. Earlier this species was used in the construction of granaries, but has now been replaced by *bije*, which was considered more durable and accessible. This smooth skinned bamboo was interestingly said to have three subtypes — *yabing-bimbu*, *yabing-binkhe* and *yabing-to*, each of which has different properties. The first two varieties have recently flowered and died and are locally known to have a 45-year-old flowering cycle. The first variety has the largest diameter, while the last kind has the longest internode (72 to 80 cm) and was used to make one of the components of the loin loom. It was also said to be poisonous when split and was used to snare wild animals (in traps), though strangely it was said not to affect humans. The water found inside this bamboo was earlier used by the Apatani to cure ailments like dysentery and diarrhoea. The internode length of this bamboo was 48 to 53 cm. The *bimbu* variety was also used to cut the umbilical cord of the new-born child as it is said to form a sharp cutting edge. The flowering of this bamboo in 1998 has led to its complete absence in the forest at present.

Tajar/Taping. This hard solid, small diameter wild bamboo grows to extremely long lengths, and tends to bend and double over like a creeper. The diameter varies from 8 mm (solid) to 15 mm (tiny hole) with a long internode (Table 2). It is found at lower-mid altitudes around 1400–2000 m near the fringes of individual forest areas and grows along with the *tapyu*. The local people believe that if the culms of this species are smoked, it will last forever and acquire iron-like hardness. However, in its raw state, the culms rot easily if exposed to damp soil. It was considered sacred by the Apatani and collected for traditional rituals and for making the *supung pinta*

or traditional cane covered gourd flask. It was collected from the forest once a year for two of the most important Apatani festivals (*Myoko* and *Morung*). Small pieces of the bamboo were split into a flower just above the node and then tied with dyed wool (to prevent complete splitting). Pieces of ginger (considered sacred by the Apatani) were pierced by the top ends of this bamboo flower. These sticks are used to decorate the post where the sacrificial *mithun* was tied. This bamboo was sometimes though rarely, purchased bought locally from Nishi tradesmen also.

Pleiblastus simoni (Hebing). This variety of clump bamboo is uncommon and can be found only in the wild in parts of Talle valley area, at altitudes of around 2400 m. It was observed that *Hebing* tends to grow only with fir and hemlock tree species and in acidic soil conditions. It was used for minor works. It has a diameter of 2.7 to 3.7 cm, thin walls and long internodes and is very lightweight (Table 2).

Arundinaria sp. (*Tador*). This species is found in the Talle valley and Manipolyang area, where it grows profusely. It seems to prefer medium to high altitudes (around 2000 m), where it grows like a dense hedge about 6 to 8 ft tall and grow along with oak tree species. Its diameter is less than 1 cm and it is very thin walled. It is used for minor purposes.

4.2.2. Management of bamboo plantations. Bamboo plantations were strongly fenced every year with the plantation bamboo itself (*bije*). Traditional knowledge recommended the cutting of three-year-old bamboo from the plantation to ensure proper growth of new culms. An established plantation will regenerate on its own and can be continuously exploited for a number of years. It was recorded that an established bamboo plantation had up to 5000 bamboo culms ha^{-1} . Of this, more than 50% were recorded as mature, which implies that such a garden can yield about 2500 to 3000 mature bamboo in a year. *Bije* attained its full maturity in three years and harvesting was done between the dry months of September and February. Mature bamboo could be recognised by the bright orange fungal growth (*nyanyi*) around the nodal area. The Apatani eat this fungus in raw and boiled form. The multiplication of the *biji* bamboo was done through rhizomes. Rhizomes from an established bamboo garden were dug out and planted at a new place in early February. In a new garden, the planting of bamboo began from the top of the slope downwards. The root growth was said to be both quicker and better in this direction. The root of the planted shoot should be long for larger diameter culm and faster overall growth: the longer the root length, the larger the diameter of the new culm. An entire 1- or 2-year-old bamboo culm along with the rhizome was uprooted and planted at a new place for multiplication. The length of the planted culm was maintained for 3 or 4 internodes after leafing started. A naturally occurring culm of this height was preferred for optimum growth. The culm was cut in the middle of the internode at an angle so that the water did not collect and rot the bamboo. If it was cut too close to the node, the natural drying of the culm will spread to and affect the node adversely. Bamboo rhizomes were laid out at preferred intervals

of between 2.5 to 3 feet to ensure quick coverage of the plantation area. Rigorous pruning of shoots was done to allow only one or two stems to grow from each shoot. It took about five years for a bamboo garden to yield mature bamboo, and coverage of an entire one hectare area takes three years. Once planted, the bamboo requires very little maintenance except constant protection (fencing) from the straying cattle and *mithun* who love to eat both the leaves and shoots of the bamboo.

4.2.3. Cane. Cane has the same importance as bamboo for the Apatani, as they are mostly used together. There were three varieties of cane found and used in the Apatani plateau, locally called *tarpi* (*Plectocomia himalayana*), *tasurr* (*Calamus acanthospathus*) and *takhe* or *tikhe* (*Calamus khasianus*). All these were high altitude canes with varying diameter (Table 2). Of these, the first two species were most commonly used while the last one was scarce and at present rarely collected or used by the community. *Tarpi* was used most frequently for housing and fencing and for making most of the traditional craft products. *Tasurr* cane was used together with *tarpi* cane in craft products. All these canes are found in the wild and collected from the forest or purchased locally from Nishi tradesmen. The *tasurr* (*Calamus acanthospathus*) cane used for the *mithun* sacrifice was usually collected from the forests. More recently a few people have started planting cane saplings of *Plectocomia himalayana* (*tarpi*) in their bamboo gardens (*bije*) with varied success. There were already symptoms of over-exploitation of the cane and timber resources in the peripheral forest areas, which has led to pressure being put on the interior forest areas as well. At present, over 60% of the cane requirement was met from outside of the Apatani area. Most of the cane was purchased locally from visiting Nishi tradesmen at Rs 2/- or 3/- a bundle (*mutti*) or sometimes from fellow Apatani villagers at Rs 4/- or 5/- a bundle, who sold a portion of their collection, if surplus. Very often a welcome gift of cane coil was given to a fellow clan member. Each Nishi bundle typically consists of 5 or 6 pieces of about 2 m length twine as against the Apatani bundle, which has between 12–15 pieces of 2 m length twine of either the *tarpi* or *tasurr* variety. A solid coil of *tasurr* cane of approximately 15 to 20 m lengths was sold within the village for Rs 150/-. It usually represents a complete back-load. Bundles of solid cane were sometimes sold locally and typically have lengths of 2 m each with a varying number of pieces, and cost between Rs 150/- to 170/- a bundle.

The different varieties of cane found in the Apatani plateau are described below.

Plectocomia himalayana (*Tarpi*). *Plectocomia himalayana* was considered most durable among all cane species and was widely used as twine for interior and exterior works in houses, veranda and fencing and for making woven bamboo craft products (Table 2). A slight slope and some shade were required for the proper propagation of this cane which could grow well with pine, oak and bamboo. In the wild it was seen to flourish with *Chimonobambusa callosa* (*tabyo*) and a few large oak (*shanti*) species. The leaf tip of this cane was typically long with thorny stem. It also has the largest diameter of the three varieties found in the area.

Calamus acanthospathus (Tasurr). *Calamus acanthospathus* was used mostly for craftwork and to make the thickly braided rope (*subu-sa*) to tie the sacrificial mithun. Most households make an annual pilgrimage to the forest, particularly between 1200–2200 m elevation, to collect a coil of this cane for use in various ritual sacrifices during the *Myoko* and *Morung* festivals. It has long internodes, a small diameter and a strength and flexibility that make it especially suitable for the rim strengthening elements, feet and side supports of woven products (Table 3). *Tasurr* was said to be suitable for intricate woven cane work as seen in the jungle (forest) backpack (*lera*), the cane covered gourd bottle (*supung pinta*) and the traditional hat (*byopa*). The fruit of this cane was sour tasting and oblong shaped with white jelly-like filling, and an orange coloured textured shell. These fruit grow at the tip of the branches of the lianna.

Calamus khasianus (Takhe-tikhe). This species was collected and used in small quantities due to its low durability in exposed conditions. Sometimes used to tie the loft floor, ceiling (*reke*), and similar interior works and for making the jungle backpack (*lera*). It was also used during the local festivals (*Myoko* and *Morung*) in the ritual altars. Its availability in the wild and local market was very low as compared to the other two canes. In earlier days it was used for making the famous nose plugs worn by the Apatani women. Its present use was so minimal that it has been ignored in data analysis.

4.3. Bamboo and cane utilisation

Bamboos are used for various household courses, house repair, craft products, fencing and ritual practices (Table 3). Canes are also used for the same purposes (Table 4). Spoilt, dead or distorted bamboo culms were usually converted into firewood. The average size of a traditional Apatani home was about 80 m², which was predominantly constructed by bamboo. An average of one or two culms of *tajar* bamboo per household is required every year for ritual practices. Ten culms

Table 3.
Annual bamboo utilisation in the Apatani plateau

Villages	No. of bamboo culms used annually							
	Housing repair		Craft products		Fencing repair		Ritual practices	
	Per HH	Total village	Per HH	Total village	Per HH	Total village	Per HH	Total village
Bulla	100	56 400	69	38 916	250	141 000	3	1692
Dutta	100	4000	59	2360	250	10 000	3	120
Hari	60	16 080	41	10 988	230	61 640	3	804
Hija	100	37 200	62	23 064	150	55 800	3	1116
Hong	145	70 035	46	22 218	318	153 594	3	1449
Michi Bamin	100	10 700	39	4173	290	31 030	3	321
Modang Tage	150	26 100	63	10 962	110	19 140	3	522

HH = Household.

of *yabing* per household are required annually for craft purposes, which are usually collected by individual households from the forest. Nearly 90% of the households purchase *yabing* bamboo shoot locally from Nishi tradesmen and in the remaining 10% households collect it directly from the forests. Though wild bamboo was not commonly used, in Hija and Hong village only 5% of the households use *tabyo* (*Chimonobambusa callosa*) annually for farm fencing and minor craft work. On an annual basis, each household uses 228 culms of bamboo for fencing, 108 for repair, 54 culms for craft products and nearly 3 culms for ritual practices (Table 3). Among different villages studied, Bulla had a maximum requirement of over 238 000 culms annually, while Dutta village had a minimum of 16 480 culms for repair, crafts, fencing and ritual practices, which was a clear reflection of the number of households in these villages. Use of corrugated galvanized tin (CGT) sheet in roofing by a few select households (particularly in Hari) has reduced the requirement of bamboo, particularly for roofing in some villages. Cane is used in house construction, for tying fencing and for making local craft products in daily use (Table 5). *Plectocomia himalayana* or *tarpi* is the species that is used in the largest measure, followed by *Calamus acanthospathus* (*tasurr*), which is an essential component of many traditional craft products and ritual altars. Some cane shoots are also eaten, but the amount is too negligible to be taken into account, since they are very rarely collected from the forest. A huge quantity of cane is used for fencing, house repair and making craft products (Table 4). The total average estimated quantities of cane used every year in the Apatani plateau are 7 464 716 m of *Plectocomia himalayana* (*tarpi*) cane twine and 73 975 m of *Calamus acanthospathus* (*tasurr*) whole cane length.

Table 4.

Cane utilisation in the Apatani plateau

Village	Average quantity of cane used annually									
	Fencing		House repair		Craft products				Rituals * (CA)	
	** (PH)		** (PH)		(in m)				(3 yearly)	
	(twine in m)		(twine in m)						(whole cane in m)	
	Per HH	Total village	Per HH	Total village	Per HH *CA	**PH	Total *CA	**PH	Per HH	Total village
Bulla	2200	1 240 800	400	225 600	18	910	10 152	513 240	50	28 200
Dutta	3220	128 800	400	16 000	21	533	840	21 320	60	2 400
Hari	1660	444 880	300	80 400	13	482	3484	129 176	50	13 400
Hija	2950	1 097 400	400	148 800	16	775	5952	288 300	60	22 320
Hong	2670	1 289 610	630	304 290	18	600	8694	289 800	60	28 980
Michi	3120	333 840	480	51 360	21	512	2247	54 784	60	6420
Bamin										
Modang	3330	579 420	500	87 000	30	804	5220	139 986	60	10 440
Tage										
TOTAL	*2736	5 114 750	*444	913 450	20	659	36 589	1 436 516	*60	112 160

*CA = *Calamus acanthospathus*. **PH = *Plectocomia himalayana*.

4.3.1. Housing. All Apatani houses were of identical design with a simple rectangular plan and an open verandah in front (*byago*) and at the back (*uko*), and both these open bamboo platforms were used as sit-outs and for craft work and weaving as well as for drying paddy and millet on woven bamboo mats (Fig. 3). A narrow room at the entrance was used for rice pounding and also kept an array of bamboo cages for hens. The main long room was a hall with typically two hearths at either end of its length. All activities in the house, such as sleeping, cooking and washing, were centred on this hearth. A three tiered drying shelf of cane and bamboo hung just above the fireplace, where the smoke emanating from the ever-present fire dried meat, paddy grains and cane twine. A loft floor (*reke*) was used to store and dry bamboo and cane articles, and extended throughout this main room. A steep bamboo or timber ladder fitted into openings at either end for access (Fig. 3). This floor structure entirely was made of a series of whole bamboo culms clamped and tied with cane. The main hall had a flooring (*myopu*) of flattened bamboo culms laid together and tied down tightly with a continuous length of cane twine, while that of the verandas and rice pounding room was of half split bamboo lengths laid close together and tied with cane rope. In some rare cases (in Hong village), this floor was made of wild bamboo (*tabyo*). About 50% (1069 culms) of the total bamboo used in house building goes into the construction of the bamboo tiled roof (Fig. 4). The bamboo tiles are made in panels of 40 × 250 cm of half split bamboo lengths that fit inside one another. These tiles are clamped between two small diameter bamboo pieces into a panel and joined together with a cane rope that passes through holes made in the top part of both the interlocking bamboo lengths. The roof structure, predominantly of bamboo, was cross-braced. Large diameter bamboo was required to make these panels. The ridging was made of heat bent flattened culms (*Mampoyamy*) draped over the ridge.

Table 5.

Cane and bamboo utilisation for housing in the Apatani plateau

Village	Av. no. of houses built/year	Maximum no. of houses built/year	Average no. of bamboo culms used per house	Total no. of bamboo used annually (culms)	Average quantity of cane used per house (m)	Total # of cane twine used annually (m)
1. Bulla	50	100	2000	100 000	7200	360 000
2. Dutta	3	8	1800	5400	6000	18 000
3. Hari	8	15	1500	12 000	6000	48 000
4. Hija	50	100	2000	100 000	7200	360 000
5. Hong	60	80	2000	120 000	6000	360 000
6. Michi	15	30	2000	30 000	6000	90 000
Bamin						
7. Modang	6	10	2000	12 000	6000	36 000
Tage						

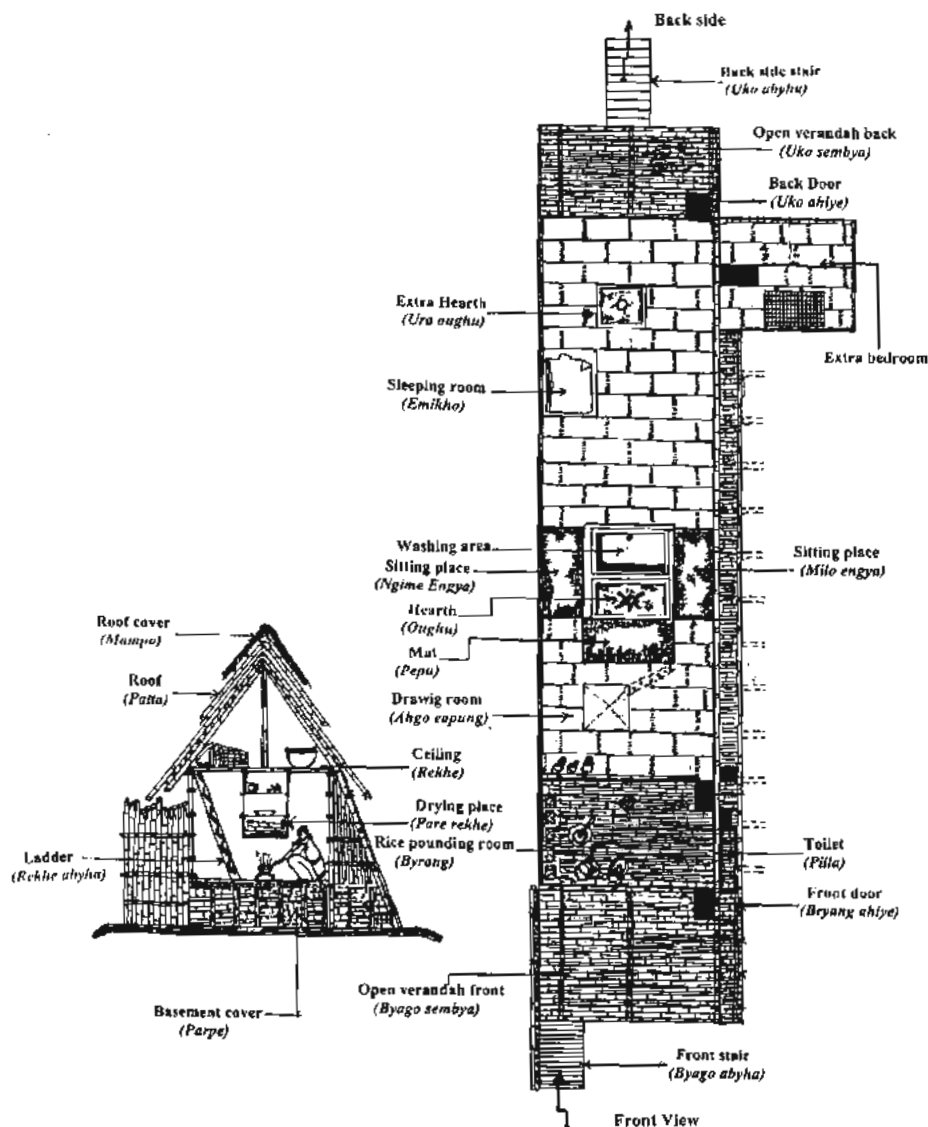


Figure 3.

On average, the Apatani house has a life of between 8 and 12 years. During recent times the upgraded houses with cement concrete post pedestals, bamboo *tarza* walls in a timber framework and CGT sheet roofing has a life of about 30 to 45 years. Such houses did not required complete replacement of their elements, and thus reduced the number of houses being built annually. The bamboo roof tiling has a life span of about 10 years and has become very common in the last twenty years. However, the ridging bamboo planks need to be constantly replaced in pieces. The earlier traditional roofing was of thin pine wood sheets, which is now

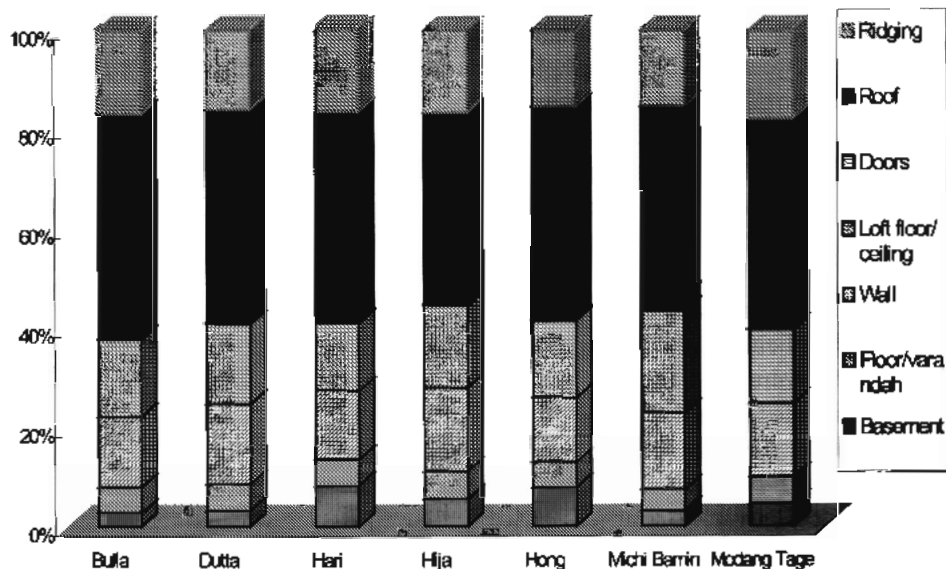


Figure 4. Bamboo requirement for construction of a typical Apatani house (80 m²).

only visible in some houses in Hong village. Hari had almost 90% of its houses with roofing of CGT sheets after the entire village was gutted in a severe fire in June 1997 (the same happened in Hiza in December 1998, damaging many houses). The only species of bamboo used in housing was *Phyllostachys bambusoides*. The wild bamboo *Chimonobambusa callosa* (*tabyo*) was used in isolated cases but its use was so minimal as to be excluded in analysis. An absolutely new house consumes up to 2500 to 3000 bamboo poles, while an average of 1500 to 2000 mature culms are used in rebuilding of a typical 80 sq m Apatani house, as many culms from an old house are used in a re-built house (Table 5).

The only species of cane used in housing was *tarpi* or (*Plectocomia himalayana*). In a typical Apatani house, the loft floor (*reke*) and the flooring consume the highest quantity of cane twine. The amount of cane used in rebuilding a house or in an entirely new one remains the same, as all the cane twine was cut while dismantling the old house and cannot be re-used as was done with some of the bamboo. It was estimated that a total of 600 bundles (*muttis*) or 7200 m of cane twine are used in the construction of a typical 80 sq m Apatani house. The total amount of bamboo used every year for house construction was 391 400 culms (Table 5).

On average, it was found that about 192 houses are built every year while a maximum possible number of 343 houses may be built in a year (Table 5), though the number was steadily decreasing with the recent introduction of some more durable new building materials like the CGI sheet roofing and the cement concrete posts. The total annual requirement of bamboos for housing in the Apatani plateau was 611 915 culms. Similarly, the total requirement of cane twine used for housing every year was 2 185 450 m.

4.3.2. Fencing. All land uses including the homesteads were fenced with bamboo (*bije* or *tabyo*) with the exception of the community or clan forest (*more*) areas. The rice fields (*aji*) were fenced in only those places where there was a possibility of animals entering and destroying the crop. A large number of culms are required in fencing and annually an average of 228 bamboo culms per family was required for repair works in different villages (Table 4). Cane is used to tie the predominantly bamboo or sometimes timber pole structure in all fencing. The only cane used for the purpose is *tarpi* or (*Plectocomia himalayana*). It was found that an average of 2736 m or 274 bundles of cane twine are used annually per household for fencing. Nearly 472 204 culms of *bije* bamboo, and 5 114 750 m or about 500 000 bundles of cane twine were used annually for fencing in the seven main rural settlements of the Apatani plateau (Table 5).

The bamboo gardens were also extensively fenced with the planted bamboo (*Phyllostachys bambusoides*) itself using the upper stem portions of the bamboo culms with leaf cover, so that no part of the bamboo was wasted and the fencing was almost opaque. An average of 303 culms were used for fencing a 1 ha bamboo plantation. The *yorlu* (vegetable and fruit gardens found away from the settlement area) and *sensing* (individual forest plantation) areas were also fenced with wild bamboo (*Chimonobambusa callosa*) but more often with *bije*.

4.3.3. Bamboo and cane crafts. Craft was never an economic activity or a means of livelihood and all products of daily use were made at home. Traditionally the older male members of the household made bamboo and cane articles for home use. Traditional Apatani bamboo and cane work was characterised by unusual shapes and intricately woven patterns in some very attractive designs. The potential of transforming these basic skills into a variety of new products for a larger market is immense. There were many traditional craft products like the rice pouch (*chiba*), the jungle backpack (*lera*), the gourd bottle (*supung pinta*) and the grain storage basket (*yopo*) that can find a ready urban market with only minimal modifications in size and finishing quality. Approximately on an annual basis, each household needed 54 mature bamboo culms for craft works in the study area (Table 3). *Bije* bamboo was used prominently in the craft works. For all studied villages, the total annual requirement of bamboo was recorded to be 112 681 culms, which was highest in Bulla village and minimum in Dutta. Two species of cane, *Plectocomia himalayana* (*Tarpi*) and *Calamus acanthospathus* (*Tasurr*) were used mainly for craft purposes. *Tarpi* was used to make the body of most of the woven products while *tasurr* was used in the rim strengthening and edging or feet elements and to make all the finer and more intricately woven products. During recent years there has been a trend to replace use of cane-twine with white plastic-twine of the same width, woven in an identical manner. A total of 1 436 516 m of *Plectocomia himalayana* (*tarpi*) twine and 36 589 m of *Calamus acanthospathus* (*tasurr*) was used in making traditional craft products every year (Table 4). After every third year, nearly 112 160 m of solid *tasurr* cane was used for making a braided rope to tie the sacrificial mithun

(*subu-sa*). On average, 3839 m of *tarpi* cane twine and 40 m of solid *tasurr* cane was required per household every year in the Apatani belt.

Some bamboo and cane schemes that are currently being run in the area are: (i) UNDP sponsored project to State Forest Research Institute (SFRI), Arunachal Pradesh, which focuses on demonstration, multiplication, and capacity building (mainly on cultivation and craft tool improvement) on cane and bamboo. One instrument for cane curing is already installed, while one more is under progress. (ii) State Government Sponsored schemes run by the Department of Textile and Handloom (earlier it was called the Department of Handloom and Handicraft), and it mainly takes Training courses on cane and bamboo. Qualifying students are also supported for establishing production units if desired by the district concerned. (iii) Planning Commission, Government of India, has also sanctioned a project on cane, bamboo and medicinal plants, which will be run by the Forest Department, Government of Arunachal Pradesh, with the support from the Cooperative Department. This project will aim for cultivation and development of cottage industries on these sectors. The project is yet to be launched.

4.4. Sources of bamboo and cane

Housing and fencing needs of the community for bamboo and timber were met almost entirely from their individual plantations, while for cane they are almost completely dependent on forests and the Nishi tradesmen and to a lesser extent on the clan forest (Fig. 5). Though cane was forest product, it has been considered as a market product since the Nishis collect it from forest areas and sell it in the market. Farmers of Hari and Hija maintain cane reserves in their clan forest areas, while Michi Bamin and Modang Tage had no cane in their community forests. One or two households in Michi Bamin were found to have started plantations of cane in their individual forest areas (*sansung*). In most cases it was found that changing lifestyles, which leave no time or energy for cane collection, has led to this high dependence on market cane. Also due to the better socio-economic status of Apatanis, perhaps purchase of cane from the market was the best and affordable option rather than collecting it from remote forest communities. A few households also buy (*bije*) bamboo from within the village or from a neighbouring village at the time of rebuilding their house. In villages like Modang Tage and Michi Bamin, there were households that bought this bamboo from Hong, which has the largest area under bamboo plantations. The wild *yabing* species of bamboo used for edible shoots and to make the winnowing tray (*yapyo*) is collected mostly from the forest areas. Bamboos and canes are collectively used for housing, fencing, crafts and bamboo shoots.

4.5. Traditional crafts and local requirements

A total of 30 most prominent bamboo and cane craft products were recorded as used by the Apatani community in the study area (Table 6). Almost all of the bamboo

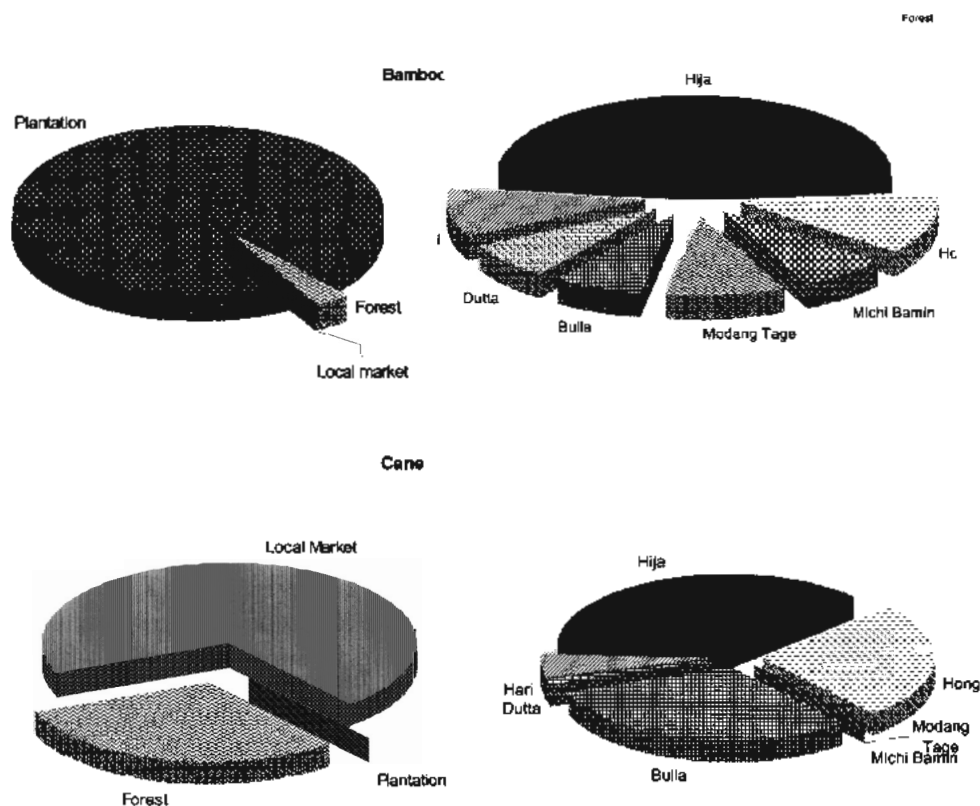


Figure 5. Sources (on left side) and village requirement (right half) of bamboo and cane in the study area.

used for traditional craft work comes from the individual bamboo plantations. The only wild bamboo (*yabing*) or *Cephalostachys* used for making the winnowing tray (*yapyo*) was collected from the individual or clan forest areas or bought locally from forest dwellers. Another wild bamboo (*tabyo*) or *Chimonobambusa callosa* was used for making arrows, which have long since been replaced by the gun. The *Dendrocalamus hamiltonii* (*yayi* bamboo) was purchased from the Nishis to make cups (*turla*) which are now rarely used and replaced by steel or enamel mugs from the market.

A description of traditional Apatani bamboo and cane craft products is summarised in Table 6. A few major traditional items need special mention.

4.5.1. Byopa. The *byopa* is the helmet-like cane hat worn by the Apatani men and was an example of fine craftsmanship. It was said to last a lifetime. Somewhat conical in shape, it has a protruding tail like extension that rises upwards from the base of the hat. The tight cane coiling that makes up the structure of this hat was begun from the top and ends in a tightly knotted stitch. Made exclusively from *tasurr* cane, it usually has an attachment of hornbill beak and feathers. There were

Table 6.
Traditional Apatani bamboo and cane craft products

Product description	Local name	Average life with regular use (in years)	Primary material	Local use	Cost of the item (Rs)
1. Carrying basket	<i>Yaso yagii</i>	2-3	Cane	To carry grain (paddy/millet) from the fields or granary	200-500
2. Carrying basket	<i>Yayi yagii</i>	1-2	Bamboo	To carry grain (paddy/millet) from the fields or granary	70-150
3. Basket with hand cord	<i>Yaso yopo</i>	3-4	Cane	To store rice or rice powder	60-250
4. Basket with hand cord	<i>Bije yopo</i>	3	Bamboo	To store rice or rice powder	60-90
5. Open weave head carrying basket	<i>Rapya/Raju</i>	1	Cane	To carry firewood from the forest	60-100
6. Head carrying basket	<i>Barju</i>	1	Bamboo	To carry vegetables from home gardens	40-60
7. Small open basket	<i>Litiya</i>	5-6	Cane	To store dried meat/chilli	60-150
8. Lidded container	<i>Aji-Pua</i>	1	Bamboo	To store vegetables	20-60
9. Lidded container	<i>Yaso aji pua</i>	2-3	Cane	To store vegetables	50-100
10. Large shallow lidded box	<i>Yo patre</i>	10	Bamboo	To store dried meat	—
11. Large tray	<i>Sarse pakhe</i>	1	Bamboo	To dry millet for making millet beer	30-60
12. Lidded box	<i>Yading</i>	10	Bamboo	To store clothes, personal possessions or rice	—
13. Cane covered gourd bottle	<i>Supung pinta</i>	20-30	Cane /wild bamboo	To store rice beer for distribution during rituals and festivals	100-200
14. Round section, tall lidded container with inner resin coating	<i>Yakhang</i>	20	Cane, bamboo	To store millet for making millet beer	—
15. Winnowing tray	<i>Yapyo</i>	1-2	Wild bamboo	To clean rice	100-120
16. Conical filter	<i>O Sadr</i>	1	Bamboo	To filter millet for making millet beer	30-50
17. Conical filter	<i>O badr</i>	1	Cane	To filter millet for making millet beer	45-90
18. Bamboo mat	<i>Puping</i>	1-2	Bamboo	To dry paddy and other grains	50-100

Table 6.
(Continued)

Product description	Local name	Average life with regular use (in years)	Primary material	Local use	Cost of the item (Rs)
19. Small pouch with flap	<i>Chiba</i>	5	Cane	Tiffin box to carry food during jungle trips/farming	—
19. Cane jungle backpack	<i>Lera</i>	5–7	Cane	To carry provisions during jungle/hunting trips	200–400
20. Hat	<i>Byopa</i>	20–30	Cane	Man's helmet like hat	400–800
21. Rain shield	<i>Yatii</i>	5	Bamboo and cane	Folding rain shield with head cover for farming	—
22. Dao cover	<i>Illyo Hubyu</i>	2–3	Bamboo slats with Cane binding	To carry and shield the dao blade	40–110
23. Fishing trap	<i>Nyie Pakhe</i>	1	Bamboo	To trap fish in the rice fields	50–75
24. Hunting trap	<i>Giiri</i>	1	Wild bamboo and cane	To hunt wild squirrel and other small game	30–50
25. Tongs	<i>Meghe</i>	1	Bamboo	Kitchen tongs for utensils	2–3
26. Spoon	<i>Punyu</i>	2	Bamboo	To cook and serve food	5–15
26. Rope for tying mithun	<i>Subu sa</i>	1	Cane	To tie the sacrificial mithun	20–30
27. Basket straps	<i>Se</i>	1–2	Cane	Attachment for basket to support it on the head	15–20
28. Hen coop	<i>Paro patre</i>	1	Bamboo	To keep domestic chicken	30–50
29. Long cylindrical container	<i>Yormii/pilla sudu</i>	2–3	Bamboo	To keep salt and chilli powder	5–15
30. Cup	<i>Turla</i>	2	Bamboo	To drink millet and rice beer	20–30

Rs 45.00 = 1 US\$.

at present very few people in the plateau who knew how to make this hat and it was hardly ever worn in the present day community. The present price was as high as Rs 800/- due to the time and effort needed for its crafting.

4.5.2. *Lera*. The *lera* is the traditional backpack used by Apatani men to carry some basic rations and personal belongings while on a trip to the jungle for hunting or collecting cane. Exclusively woven from *tasurr* cane, it comprises a single rectangular pouch piece, which branches out into two broad divisions that extend into the shoulder straps. The shoulder straps are of braided cane, one end of which is knotted to a loop at the base of the backpack and the other to the branched extensions at the top. A single strand of twisted cane twine hangs down from the front to be used as an attachment to tie small game to the pack.

4.5.3. *Liya*. The *liya* is a small basket with a square base and a circular section. It is used to keep dried meat or fish. Its four base legs and rim strengthening elements are fashioned out of half split *tasurr* cane, while its body is woven out of *tarpi* cane. It lasts for an average of five years with regular use.

4.5.4. *Rapya/Raju*. The *rapya* or *raju* is a crudely woven long basket with an open hexagonal weave which is used for collecting firewood. It is very commonly used in every home and made entirely from *tarpi* cane. A basket of the same kind made up of bamboo with a combined weave structure was called *barju*, but this was not made use of as frequently as the *raju*.

4.5.5. *Paro patre*. The *paro patre* is the pyramid shaped open weave basket that functions as a hen cage and carrier. It is one of the most common craft products very often made at home by a family member. It has a small opening and wooden door through which the hen could enter and was typically kept inside the house in the rice pounding room on a bamboo shelf.

4.5.6. *Puping*. The *puping* is an almost square woven mat of usually 1.3×1.3 m (though it could also be larger in size), which is made from the *bije* bamboo. It is used to dry paddy or millet in the sun and was common in most households in every village. It sometimes has a natural attractive multicoloured pattern formed from the different layers of the bamboo skin. The weave is typically a fine herring bone diagonal pattern.

4.5.7. *Sarse pakhe*. The *sarse pakhe* is a huge, shallow bamboo tray used for drying millet to make millet beer. It is roughly woven out of bamboo and smoked over the fire to give it an attractive and protective sheet.

4.5.8. *Supung pinta*. Dried gourd is left to dry on the creeper and then cut open from one end when it hardens, to form a naturally shaped flask. The gourd (*pinta*) for this purpose was carefully selected, as its shape was crucial to the finish of the product. The *supung pinta* was a ceremonial flask used to keep and distribute rice beer during various ritual ceremonies, marriages and festivals. It consists of a dried gourd, which was completely covered with a finely woven cane pattern that gives

it a base, a lid and a handle. One or more pieces of this locally valued product can be found in every Apatani home. This technique provided immense possibilities for new product development and can be used to camouflage many used glasses and plastic bottles to make various new products.

4.5.9. Yatii. The *yatii* was the traditional bamboo raincoat used extensively in farming by the Apatani until a few years ago when plastic replaced it. It used to be made in two pieces, both of which are held together by long twisted bamboo twine. The upper part used to be rectangular, with one end extending into a triangular cap. The lower rectangular part in the same weave and forms a cover for the back. Both parts have braided cane straps that are held across the forehead. The entire shield was made of a double layer of an open hexagonal bamboo weave between which were sandwiched either tree bark or leaves. When not required, the upper caps piece folds back over the lower piece. The edges were strengthened and kept together by tightly bound half split *tasurr* cane pieces.

4.5.10. Yading. The *yading* has also lost its use in the present context and was rarely made. It was a tall cylindrical woven bamboo container with a narrowed neck and woven lid, which was used to store personal possessions like clothing and valuables. The rim elements and edges of the *yading* were made from half split *tasurr* cane.

4.5.11. Yagii. The *yagii* was a closed weave basket with a square base and a circular rim made in many sizes and used for collecting and carrying paddy from the fields. This basket was supported on the forehead with wide woven cane straps (*se*). The woven body may be of bamboo or cane, but the rims and side supports were made only from half split pieces of *tasurr* cane. The weave at the rim was sandwiched between two coils of half split cane which are further bound together by cane binding that passes over and through the rim elements. This was probably the most important of all craft products and a large number of such baskets were found in every home.

4.5.12. Yakhang. A huge lidded woven cylindrical container of about 4 feet height made of either cane or bamboo was called a *yakhang*. The rim elements and side supports were made only from half split pieces of *tasurr* cane. Its insides were coated with a resin locally called *sankhang*, which was made from the large *sankhasane* (a local tree) found only in the forests of Hong village (Talle valley) and in the Nishi community areas. This huge container was used for storing millet beer. Smaller versions of the *yakhang* were sometimes seen.

4.5.13. Yapyo. The *yapyo* or the winnowing tray was perhaps the most universal of all bamboo home products in India. In the Apatani plateau it remained a necessity in every household and was said to require special skills in its making. There were

only two or three people in every village who could make this product, which was the only one that was exclusively woven out of the wild *yabing* bamboo. It was usually well finished and strong with a characteristic flared U shape and standard size. The edges of the fan were strengthened by split cane pieces.

4.5.14. *Yo patre*. The *yo patre* was an obsolete craft product, remnants of which can be found mostly in Hong village. This large suitcase-like shallow woven bamboo box was used to store dried meat, fish and fermented soyabean. It has a woven lid and clasp loop. The *yo patre* could last for 10 to 15 years with regular use. It has been entirely replaced by plastic and metal containers and no longer made anywhere in the valley.

4.5.15. *Yopo*. The *yopo* was a closed weave basket with a tightly braided string handle. It has the same square base and circular section as the *yagii*. It was made with either cane or bamboo and was more carefully woven than the *yagii* as it has ceremonial uses. Many sizes of this basket were made, and commonly used to store rice powder and rice grain.

The craft products with high local demand were *yagii*, *yopo*, *yapyo*, *supung pinta*, *rapya/raju,aji pua,sarse pakhe*, *puping,paro patre*, *illyo hubyu* and the *liiya*. Minor products like the *nyiye pakhe*, *yormii sudu*, *meghe* and *giiri* and *punyu* were made and used in every household but never sold (Table 6). Products that have a varied demand and which are used only in a few households included *lera*, *barju*, *o sadr/badr* and the *chiba*. The few products that have stopped being made and which have totally lost their use were the *yatii*, *yo patre*, *byopa*, *yading* and *yakhang*. The *yapyo* or winnowing tray, though made by only a few artisans in each village, has a high local demand of an average of one piece per household every 2 years. The local demand for items such as the traditional bamboo-folding raincoat (*yatii*) and the intricately woven cane hat (*byopa*) has diminished considerably and they are rarely found or made. Industrial products that were cheap and readily accessible to all have replaced them. The *o badr* and *o sadr* face stiff competition from the plastic sieves readily available in the market and these items were slowly losing their local market. Wooden and tin trunks have replaced the elegant *yading*, which could be revived and modified for a different market and use.

The bamboo and cane requirement for different items vary from product to product (Table 7). The annual requirements for different craft products vary from family to family, and village to village (Table 8, Fig. 7). The demand for the grain carrying head basket (*yagii*) and the storage basket (*yopo*) was very high and common across all the villages in the plateau. An average of 2 bamboo *yagii* baskets, 1 cane *yagii* basket and 1 cane *yopo* and 1 bamboo *yopo* per household was required annually in all the villages. The demand for the grain drying mat (*puping*) was equally high and, on average, 2–3 mats per household was found to be the general annual requirement across all the settlements (Table 8). A *supung pinta* was required in every household but once made lasts for 10 years. Every household had

Table 7.

Cane and bamboo utilisation in traditional Apatani craft products

Product	Local name	Size	Bamboo		Cane	
			Sp. used	Nos. used	Cane sp.	Qty used
1. Cane grain carrying basket	<i>Yaso yagii</i>	Large	—	—	PH + CA	300 m PH twine, 4 m whole CA
		Medium	—	—	PH + CA	240 m twine, 3 m whole CA
2. Bamboo grain carrying basket	<i>Yayi yagii</i>	Large	PB	8	CA	3 m whole(rim)
		Medium (44 cm diam. × 35 cm ht)	PB	3–4	CA	2.5 m whole
3. Cane grain storage basket	<i>Yaso yopo</i>	20 cm × 24 cm ht 75 cm ht	—	—	PH + CA	(40 m PH twine, 3 m whole CA) (144 m PH twine, 4 m whole CA)
4. Bamboo grain storage basket	<i>Bije yopo</i>	28 cm diam. × 24 cm ht	PB	2	CA	3 m whole
5. Cane firewood collection basket	<i>Rapya/Raju</i>	Standard	—	—	PH + CA	117 m twine
6. Bamboo firewood carrying basket	<i>Barju</i>	Standard	PB	2	CA	—
7. Cane meat/chilli/yeast container	<i>Liiya</i>	20 cm diam. × 20 cm ht	—	—	PH + CA	33 m PH twine, 2 m whole CA
8. Bamboo lidded container for rice/vegetables	<i>Aji-Pua/Apin pua</i>	Standard	PB	1	CA	2 m whole CA
9. Cane lidded container for rice/vegetables	<i>Apin pua</i>	Standard	—	—	PH + CA	4 m whole PH, 2 m whole CA
10. Bamboo container for dried meat	<i>Yo patre</i>	Standard	PB	5	—	—
11. Bamboo tray for drying millet beer	<i>Sarse pakhe</i>	Standard	PB	5	—	—
12. Rice container	<i>Yading</i>	Standard	PB	2	—	—
13. Clothes box	<i>Yading</i>	Standard	PB	7	—	—
13. Cane covered gourd bottle for rice/millet beer	<i>Supung pinta</i>	Standard	PB	—	CA/PH	44 m twine

Table 7.
(Continued)

Product	Local name	Size	Bamboo Sp. used	Cane		Qty used
				Nos. used	Cane sp.	
14. Huge millet beer storage basket	<i>Yakhang</i>	1. Large 2. 32 cm diam. × 50 cm ht	PB	5	PH, CA PH, CA	612 m twine —
15. Winnowing tray	<i>Yapyo</i>	Standard	CP	10	—	—
16. Bamboo filter for millet beer	<i>O Sadr</i>	Standard	PB	1	—	—
17. Cane filter for millet beer	<i>O badr</i>	Standard	—	—	PH, CA	44 m twine
18. Bamboo grain drying mat	<i>Puping</i>	1.3 m × 1.3 m	PB	5, i.e. if 2 layers are used	—	—
19. Cane jungle backpack	<i>Lera</i>		—	—	CA	20 m whole
20. Dao cover	<i>Illyo hubyu</i>		PB		CA	5.5 m whole
21. Traditional hat	<i>Byopa</i>		—		CA	10 m whole
22. Traditional raincoat	<i>Yatii</i>	Standard	PB	4	CA	3 m whole
23. Fishing trap	<i>Nyiye pakhe</i>	Standard	PB	1 = 8 pcs	—	—
24. Hunting trap	<i>Giiri</i>	Standard	PB, CC		CA (negligible)	—
25. Tongs	<i>Meghe</i>	Standard	PB	1 = 200 pcs	—	—
27. Rope for tying mithun	<i>Subu sa</i>	15–20 m long	—		CA	60 m whole
28. Basket straps	<i>Se</i>	Standard		—	PH/CA	48 m twine
29. Hen coop	<i>Paro patre</i>	Standard	PB	1–2	—	—
30. Bamboo and cane mug	<i>Turla</i>	15 cm ht	DH	*1 = 6 pcs	CA	6 m twine binding only
31. Bow and arrows	<i>Apii aliya</i>	Standard	CC+DH	*1 = 150 pcs	—	—
32. Bamboo cooking spoon	<i>Punyu</i>	20 cm long	PB	*1 = 100 pcs	—	—
33. Chilli or salt bamboo container	<i>Yormii/ pilla sudu</i>	20–25 cm ht pcs	PB	*1 = 7 pcs	—	—

*1 = 100 pcs implies that it is possible to make an average of 100 spoons from a single bamboo culm. PB = *Phyllostachys bambusoides*, CC = *Chimonobambusa callosa*, DH = *Dendrocalamus hamiltonii*, CA = *Calamus acanthospathus*, PH = *Plectocomia himalayana*.

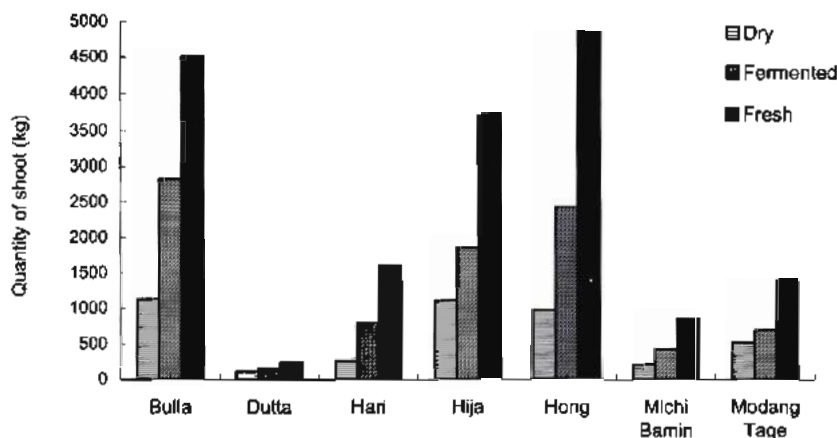


Figure 6. Annual bamboo shoot consumption in different villages of Apatani community.

chickens for house use and though the demand fluctuates with regard to number of birds maintained, the average annual requirement for the bamboo hen-coops or *paro patre* was 3 per household. It was found that a small scale industry based on bamboo and cane products still has a considerable local market but one which is inevitably in a process of rapid change. The local market will also need new and more economically produced products. The local requirement was too small to entirely sustain a bamboo and cane industry in the long run and will definitely need to address and access outside urban markets. This implies a complete change in the production process and various design and technology inputs to ensure supply and quality control.

Nearly 112 917 bamboo culms (including 13 070 culms of wild *yabing* bamboo) were used annually for craft in the Apatani plateau (Table 9). Twine of *tarpi* (1 434 048 m) and *tasurr* (30 047 m) were used for the making of craft products in the region (Table 9). Many of the products are made in a range of different sizes. The prices of the different items varied from village to village. The cost was found to be low and lower than actual costs of production in almost all the cases. The entire production process was entirely need-based and not market oriented.

4.6. Bamboo shoot

The local demand for bamboo shoot was very high as vegetables were scarce. Every household uses fresh, dry and fermented bamboo shoot in almost the same quantity in every village (Fig. 6). Over 95% of the households purchase both dry and fermented bamboo shoots from Nishi tradesmen. The local market prices vary from Rs 5.00 per 250 g for dried bamboo shoot (*hi*), Rs 10.00 per 450–500 g (bamboo *chunga*) for fermented shoots (*hikhu*), and Rs 8–10 per kg for fresh bamboo shoots. Two species of wild bamboos are commonly used for dry and fermented bamboo shoot, of which the slightly sweet flavoured *yabing* (*Cephallostachium capitatum*) was the preferred one, though less common than the

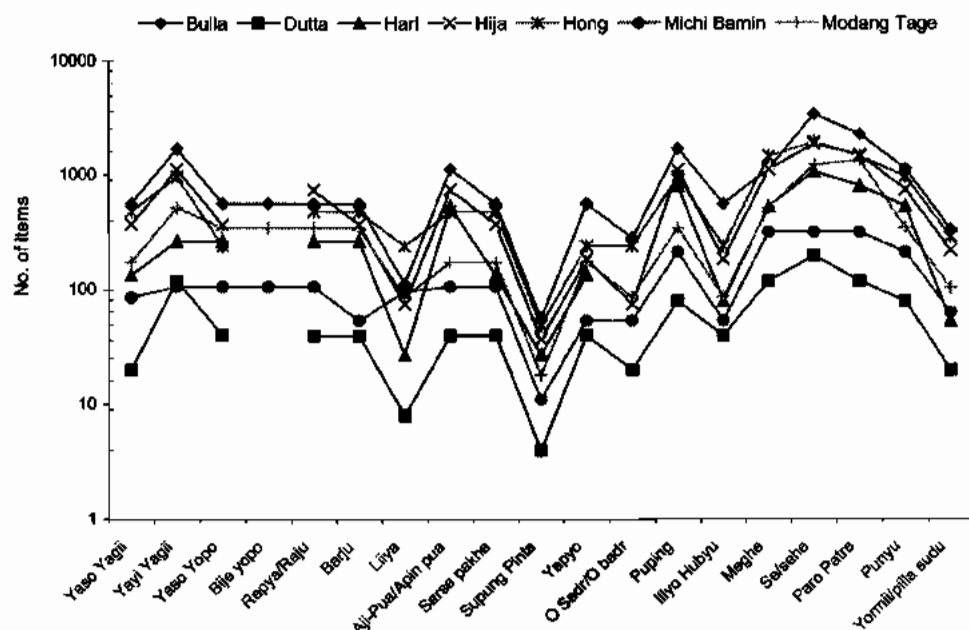


Figure 7. Annual requirement of different craft products for various villages in the study area.

yayi (*Dendrocalamus hamiltonii*). It was found that the former was most often collected from the clan or individual forest areas, particularly in Hija and Bulla, while the latter whose consumption was far greater, was entirely bought from the Nishi tradesmen at a price of Rs 10/- per bamboo *chunga* (cylindrical container of 20 × 4 inch size). The average annual consumption of fermented bamboo shoot (*hikhu*) per household was estimated at 4 kg, but may be as high as 18 kg for a few selected households. In smaller households it was just 2.5 kg per annum. The average annual consumption of dried bamboo shoot (*hi*) was estimated to be about 2.4 kg per household. Fermented bamboo shoot was available between January and March. Fresh bamboo shoot of *Phyllostachys bambusoides* (*bije*) was collected during March and May from the individual bamboo gardens (*bije*). Its quantification was difficult since only those shoots that grew outside the boundary or on the main path of the plantation were cut. The bamboo stock was kept preserved primarily for housing and fencing purposes. In Hari village an average of about three baskets (*raju*) of fresh bamboo shoot per household were recorded as collected every year during season. The annual average household consumption was estimated about 8 kg (Fig. 7). Thus on an annual basis, a total of 14.5 kg of fresh, dry and fermented bamboo shoots per household was estimated consumed in Apatani belt and over 60% of this demand was met from outside the Apatani valley.

5. DISCUSSION

The tribal communities of Northeast India are highly dependent on natural resources and land uses to fulfil their basic needs [12, 13]. Harvesting of natural resources was sustainable over the years; however, due to population growth during recent years, there has been a tremendous increase in biotic pressure to the extent that these resources are over-exploited. Bamboo has been an integral part of the local system, and is judiciously guarded and meticulously tended by all communities since it fulfils various basic needs. Use of bamboo and cane go side-by-side and it is considered that there is no life without them in the northeast region, the area that harbours the richest bamboo and cane diversity in the country [6, 20]. There is a strong tradition of utilizing bamboo and cane species in the region. The present study area (Apatani plateau) is well known all over the region for its peculiar fish-rice cultivation and bamboo plantations, mainly of *Phyllostachys bambusoides* [10]. A total of 9 bamboo and 3 cane species were recorded as used by the community, which forms 27% and 18% of the total bamboo and cane diversity, respectively, of the states. Though the Apatani make optimum use of their land, it is only a matter of time before the increasing pressure on the constrained land area makes it difficult to sustain the growing local population [11]. There is a visible shift from an agrarian economy to one that is more service oriented. In such a situation, alternatives for a sound self-sufficient economic base become imperative. The rich natural resource base combined with the traditionally conservationist attitude of the Apatani can provide the solution to this problem. The Apatani have a natural inclination towards plantation and ecology conservation which, if directed still further, can have a tremendous impact on the development of the area. Bamboo and canes are also high on the list of resources, and are used for diverse purposes; for house construction, fencing, crafts, rituals and food requirement. Apatani houses are unique and well known all over the region. However, surprisingly, in spite of its traditionally important role in this sector and the fact that it is so readily available to the people, bamboo and cane are rarely considered as material for rural or urban housing development by either the state or the central governments.

Both bamboo and cane have been and still are inseparable from the life of an Apatani villager. The traditional knowledge and skills related to the management of these resources is immense and an example that can be emulated elsewhere. In short, the development of bamboo and cane utilisation recognising the economic potential of these resources should be the priority of planned development for the area. A bamboo house last for 8–10 years, with regular repair that is needed because of its low durability. The introduction of seasoning and preservative treatment facilities would greatly enhance the durability of bamboo and change its current perception as a material of temporary quality [14]. A common facility centre should be developed that provides treatment facilities for raw bamboo material with related training programmes for its maintenance and continued use at village level. The use of bamboo in traditional housing can be optimized and improved by the use of improved bamboo joinery and trusses [4]. The high tensile strength of

bamboo, which is comparable to and even higher than steel in some species, makes it particularly suitable for large practical experimentation [15]. Bamboo being round and hollow presents peculiar problems of joinery, which is yet another priority area for research and development. Experiments on the structural uses of bamboo and information regarding the comparative strength and durability of different species useful for construction is crucial for the identification of priority species for housing. Bamboo and concrete can co-exist and have been tried in many places; however, the use of these materials together needs further investigation and standardization. Unfortunately, researches done on bamboo over the past 40 years in other areas remain unpublished or at least not disseminated and they have not been applied in the state.

Bamboo shoot has tremendous potential as a commercial business, since it has a large local demand as well as an outside market. However, the Apatani themselves barely produce any bamboo shoot and are dependent on the Nishi for their own requirement to a very large extent. In the present scenario, it cannot be an immediate income generation alternative within the Apatani plateau. However, it could be so if new and degraded areas are brought under bamboo plantation.

Bamboo and cane resources need to be developed to meet local as well as outside demands for socio-economic uplift of the community [16, 17]. There is a strong need to divert a part of the well managed bamboo resource towards income generation, such as bamboo ply production and upgraded bamboo craft products with improved technologies. Bamboo ply flooring and boards would provide yet another building material alternative based on a local resource, which would have both a local and an outside market [14]. It is clear however that though there is enough bamboo for an upgraded craft industry, the present supply will not be enough to sustain a bamboo ply industry unless there is some reduction in its present use in housing and fencing. It needs proper planning and strategy to overcome this situation. The overall consumption of bamboo in the Apatani house can be drastically reduced in the roofing, especially by replacing the bamboo ridging of flattened bamboo culm planks with a CGT ridge piece bolted to the structural bamboo. The use of culms is very high in the typical bamboo tile roof: over 1000 culms on average. CGT sheet roofing remains the best of all available present options, as it is fire resistant as well. A very recent development is the possible production of bamboo ply corrugated roofing sheets, the testing of which is being done at the Indian Institute of Plywood Industry in Bangalore. The amount of bamboo use could be reduced in fencing which consumes significant numbers of culms annually. Support from the local government in the form of loans could address the need for permanent fencing of the farms and plantation areas.

The present study shows that a small scale industry based on bamboo and cane products still has a considerable local market but one which is inevitably in a process of rapid change. The local market will also need new and more economically produced products. The local requirement is too small to entirely sustain a bamboo and cane industry in the long run and will definitely need to address and

access outside urban markets. It implies a complete change in the production process and various design and technology inputs to ensure supply and quality control. Proper seasoning and preservative treatments, change in tools/equipment to enhance efficiency, designing of local crafts and marketing are important issues to be addressed simultaneously for the bamboo and craft production system in the region to upgrade the local skills.

All craft products are always made for home use, and little attention is paid to treatment or finish. Smoking over the fireplace is the only extra treatment given to the product, which protects it from fungus and insects: this is an effective technique but often time-consuming. Proper seasoning and preservative treatments using Boucherie pressure treatment equipment and chemicals have tangible benefits and are much faster processes [18]. There is a great need to set up such facilities and provide related training to local people at the village level to ensure the protection of bamboo products against splitting, fungus and borer attack. Moreover, craft, unlike its common perception in most other areas of India, has never been a means of livelihood in these communities and is mostly still not perceived as being able to provide one. Therefore to bring craft out of the home and into the street, i.e. into a market economy that would provide alternative livelihoods, implies a change in the way bamboo craft is perceived and produced by the local community. Local artisans need some basic training in managerial skills to develop an entrepreneurial attitude towards craft production.

Production technology is the starting point for all research and training inputs in the development of local crafts to increase production speed, reduce drudgery and improve the quality of the finished product. A great deal of practical experimentation with bamboo craft products is required as far as appropriate tools and equipment for its processing are concerned. The tools used at present for bamboo processing are the *ado* (a broad blade machete), a small knife and sometimes a hacksaw, and there is no organised production system available anywhere; this needs measures to produce improvements in craft tools and equipment, which may bring considerable changes in splitting, cutting and finishing stages of local products. Training in the use of such equipment and wood tools like chisels, hammers, files, hand drills and blowtorches that can be applied to bamboo work will have a long-lasting effect. Traditional designs also need modification to suit urban tastes and lifestyles. Design and related training inputs, through interactions between designers and craftsmen become crucial at the next stage of the craft development process. There is also a need to organize workshops for the process of sample product development and explore product potential through finishes and market testing.

Marketing inputs by exposure through workshops exhibitions and identification of sale outlets will complete the process of craft product development. This fine-tuning will prepare local craftsmen for urban and metro markets, since local markets are too small to completely support livelihoods. An understanding and exposure to market needs and trends, and proper costing of craft products through training workshops are essential for the local artisans.

Table 8.

Annual household demand for traditional craft products in different study villages

Product		Local name	Average no. of pieces required every year per household						
			Bulla	Dutta	Hari	Hija	Hong	Michi Bamin	Modang Tage
1.	Cane grain carrying basket	<i>Yaso yagii</i>	1	*0.5	*0.5	1	1	0.8	1
2.	Bamboo grain carrying basket	<i>Yayi yagii</i>	3	3	1	3	2	1	3
3.	Cane grain storage basket	<i>Yaso yopo</i>	1	1	1	1	0.5	1	2
4.	Bamboo grain storage basket	<i>Bije yopo</i>	1	—	—	—	—	1	2
5.	Cane firewood collection basket	<i>Rapya/</i>	1	1	1	2	1	1	1
		<i>Raju</i>							
6.	Bamboo firewood carrying basket	<i>Barju</i>	1	1	1	1	1	0.5	2
7.	Cane meat/chilli /yeast container	<i>Liiya</i>	0.2	0.2	0.1	0.2	0.5	0.2	0.5
8.	Bamboo lidded container for rice/vegetables	<i>Aji-Pual/</i> <i>Apin pua</i>	2	1	2	2	1	1	1
9.	Bamboo tray for drying millet beer	<i>Sarse pakhe</i>	1	1	0.5	1	1	1	1
10.	Cane covered gourd bottle for rice/millet beer	<i>Supung Pinta</i>	0.1	0.1	0.1	0.1	0.1	0.1	*0.1
11.	Winnowing tray	<i>Yapyo</i>	1	1	0.5	0.5	0.5	0.5	1
12.	Bamboo filter for millet beer	<i>O sadr/</i> <i>O badr</i>	0.5	0.5	—	0.2	0.5	0.5	0.5
13.	Bamboo grain drying mat	<i>Puping</i>	3	2	3	3	2	2	2
14.	Dao cover	<i>Iltyo hubyu</i>	1	1	0.3	0.5	0.5	0.5	0.5
15.	Tongs	<i>Meghe</i>	2	3	2	3	3	3	3
16.	Rope for tying mithun	<i>Subu sa</i>	0.3	0.3	0.3	0.3	0.3	0.3	*0.3
17.	Basket straps	<i>Se/sehe</i>	6	5	4	5	4	3	7
18.	Hen coop	<i>Paro patre</i>	4	3	3	4	3	3	2
19.	Bamboo cooking spoon	<i>Punyu</i>	2	2	2	2	2	2	2
20.	Chilli or salt bamboo container	<i>Yormii/pilla</i> <i>sudu</i>	0.6	0.5	0.2	0.6	0.6	0.6	0.6

All the decimal values indicate that the demand for the particular craft product is either 1 piece in five years (0.2) or 1 piece in 2 years (0.5) or 1 piece in 3 years (0.3) as the case may be. The *supung pinta* is one such example, the common local demand for which is a single piece every 10 years per household. The annual demand has thus been kept at 0.1 to compute the average local annual demand for the product in each village.

Table 9.

Total annual demand for traditional products in Ziro area

Product	Total no. of items required every year	Annual requirement of bamboo (no. of culms)	Annual requirement of cane (in m)	
			*Cane twine (PH)	*Whole cane (CA)
1. Cane grain carrying basket	1833	—	458 250	5499
2. Bamboo grain carrying basket	4791	38 328	—	14 373
3. Cane grain storage basket	1941	—	77 640	5823
4. Bamboo grain storage basket	1018	2036	—	3054
5. Cane firewood collection basket	2554	—	298 818	—
6. Bamboo firewood carrying basket	2129	4258	—	—
7. Cane meat/chilli container	649	—	21 417	1298
8. Bamboo lidded container for rice/vegetables	3212	3212	—	—
9. Bamboo tray for drying millet beer	1874	9370	—	—
10. Cane covered gourd bottle for rice/millet beer	202	—	8888	—
11. Bamboo winnowing tray	1307	13 070 (**CP)	—	—
12. Bamboo filter for millet beer	760	760	—	—
13. Bamboo grain drying mat	5220	26 100	—	—
14. Dao cover	1254	15	6897	—
15. Tongs	5888	12	—	—
16. Basket straps	9987	—	479 376	—
17. Hen coop	7786	15 572	—	—
18. Bamboo cooking spoon	4016	27	—	—
19. Chilli or salt bamboo container	1095	157	—	—

*The cane requirement has been divided into two categories according to the two different species of cane used for craft. CA = *Calamus acanthospathus* (tasurr), and PH = *Plectocomia himalayana* (tarpi). All bamboo products are made from the *bije* bamboo (*Phyllostachys bambusoides*) except for

**CP = *Cephalostachys* sp. (yabing).

A large variety of bamboo-cane craft products are made in each of the study villages and there are even now a few old artisans who make these articles in the area. Since there is no direct or formal system of passing down these skills to the younger generation, they are in danger of being lost. The craft was learnt by constant observation and some basic craft instruction. The items are usually made on an order basis and are an income supplement. Very often they are made free of cost for members of the same family. The customer sometimes provides raw material. The species of cane and bamboo used for local artisan purpose are highly suited to craft work and are durable. In the changed lifestyle and with formal education systems taking precedence over all else, these equations have changed and, with the passing of each generation, these skills are gradually disappearing. The finely woven products that require special skills like the hat (*byopa*), backpack (*lera*), the cane covered gourd container (*supung pinta*) and the winnowing tray (*yapyo*) are especially threatened. None of the existing practising craftsmen in any of the villages is less than 50 years of age. The few exceptions lack specialised skills and are able to make only the more simple products. There is an immediate need to transfer these basic skills to the younger generation to protect the traditional knowledge. At present, *Phyllostachys bambusoides*, popularly known as Apatani bamboo, is most extensively used and said never to flower. There is insufficient knowledge about the flowering of this species, and the impact of a possible large scale destruction of this resource due to flowering could be devastating. There is a need to introduce new and large diameter bamboo species. A few such bamboo species, such as *Bambusa balcooa*, and *Dendrocalamus latiflora*, could be introduced to increase design possibilities for bamboo craft and furniture development.

6. CONCLUSIONS

The almost total reliance of the Apatani on their bamboo plantations for their basic needs like housing, fencing and craft is staggering. The high risk and incidents of fire accidents in the tightly packed Apatani settlements has increased the need for bamboo treatments and availability. On the other hand, the plantation of cane is highly desirable, since the present demand is largely being met from the Nishi tradesmen who collect it from forests. A few farmers have started growing cane in their plantation, which needs to be encouraged since the local needs are far more than the availability of the resource. Though the bamboo resources are at present enough to meet the basic requirement of the local community, they cannot be said to be in surplus. The density of the standing bamboo was 4000 to 5100 culms per hectare and only 50% of the culms were mature. When a house has to be rebuilt (after every 8 to 10 years), the requirement of mature bamboo is at least 2000 mature culms, which is just sufficient to get from 1 ha plantation area. All of the plantations are carefully harvested to maintain culm density. The present bamboo stock is sufficient to fulfil current needs, but there is no surplus since everyone does

not have the same plot size. If the socio-economic development of the area is to be dependent on bamboo and canes, there is a need to increase plantation of these species.

A majority of the traditional building technologies are simple, functionally effective and resistant to natural forces like high winds, earthquakes and rain. During recent times there has been an increase in use of imported materials like brick, steel and cement-concrete in house construction, which also require new skills for which old systems are ill prepared. Such materials also need imported labour and traditional practices start disappearing. Furthermore, high transport cost also makes each construction a costly affair for the vast majority of households. If this continues, there will be a loss of self sufficiency and the beginning of dependence for a very basic need (housing) that could easily be met within the community and the area. Therefore it is high time to start researches to increase the versatility and durability of traditional houses through treatments and replacing only a few desired aspects, such as roofing through CGT sheets. Every year, hundreds of houses in the Apatani plateau are gutted in fire accidents (in 1998 more than 500 houses were burnt down in Hija and Hari villages). The hazard is compounded by the tightly packed nature of the Apatani settlement leaving no space between houses besides creating major sanitation problems. Thus the introduction of improved technology to upgrade the durability of the traditional biomass based house in terms of seasoning and preservative treatment of materials can be said to be the priority area in housing intervention [14]. The requirement here is not the number of houses but the upgradation of the existing ones, since homelessness is not an issue in this area.

Any kind of development planning for the Apatani valley must base itself in the development of the natural resources that are found here, especially bamboo and cane. Though there is a great deal of information available related to the subject of utilisation of bamboo [19], the exposure of people in Arunachal Pradesh (as in most parts of the country) to this research has been limited. There is the need for a research and common facility centre or centres at the district level, which would be able to carry out practical research and technology transfer in the use of bamboo related to its traditional status in the area. Rural housing, crafts and generation of many edible products in Arunachal Pradesh need to focus on local resources, which if developed on a sound scientific basis, could become important drivers of socio-economic development for the region.

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