

Bamboo and Cane Study of Zhemgang Dzongkhag

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All botanical materials collected during the study are deposited at the National Herbarium (THIM) of the RNR-RC Yusipang.

1.0 BAMBOOS OF ZHEMGANG

During the fieldwork in Lower Kheng in 1996 and Upper & Middle Kheng a total of 21 bamboos were seen, out of a total of 30 species recorded for Bhutan. They are listed below with their local names and distribution. (L- Lower Kheng, U- Upper & M- Middle Kheng).

No.	Species or variety	Kengkha	Distribution
1	<i>Arundinaria racemosa</i> Munro	Maxilla	U
2	<i>Bambusa alamii</i> Stapleton	Jacsui	L
3	<i>Bambusa clavata</i> Stapleton	Pagshi	M
4	<i>Bambusa nutans</i> Wallich ex Munro subsp. cupulata	Jushi	M,L
5	<i>Bambusa nutans</i> Munro subsp. cupulata (thorny variety)	Gren	M,L
6	<i>Bambusa tulda</i> Roxburgh	Jushi	L
7	<i>Borinda grossa</i> (Yi) Stapleton	Rhui	U,M
8	<i>Cephalostachyum latifolium</i> Munro	Pishima	M
9	<i>Cephalostachyum capitatum</i> Munro	Pishima	M
10	<i>Chimonobambusa callosa</i> (Munro) Nakai	Rawa	M,L
11	<i>Dendrocalamus hamiltonii</i> Munro var hamiltonii	Pagshi	L
12	<i>Dendrocalamus hamiltonii</i> Munro var. edulis Munro	Pagshi	M,L
13	<i>Dendrocalamus sikkimensis</i> Gamble	Zang	M,L
14	<i>Drepanostachyum annulatum</i> Stapleton	Phan	M
15	<i>Drepanostachyum intermedium</i> (Munro) Keng f.	Phan	M,L
16	<i>Drepanostachyum khasianum</i> (Munro) Keng f.	Phan	M
17	<i>Neomicrocalamus andropogonifolius</i> (Griffith) Stapleton	Yula	L
18	<i>Pseudostachyum polymorphum</i> Munro	Dai	M,L
19	<i>Thamnocalamus spathiflorus</i> (Trin.) Munro var. bhutanensis	Rhui	U
20	<i>Yushania microphylla</i> (Munro) R.B. Majumdar	Meg	U
21	<i>Yushania pantlingii</i> (Gamble) R.B. Majumdar	Zing	M

1.1 FIELD IDENTIFICATION OF BAMBOOS

The bamboos of Zhemgang Dzongkhag have been described and illustrated previously in *Bamboos of Bhutan: An Illustrated Guide* (Stapleton 1994d). The details and illustrations were field-tested during this fieldwork, and were found to be adequate for recognition of the bamboos in the field. Any newly gathered local names and uses will be added to the descriptions presently given in the Bamboos of Bhutan. Furthermore, details and illustrations of the canes found in the Dzongkhag will be included, to produce a Field Guide to Bamboos and Canes of Bhutan. This will be published as a Ministry of Agriculture publication, the printing being funded by ISDP.

1.2 SPECIES ENCOUNTERED

The total of 21 bamboos encountered in the Dzongkhag represented 19 species from 11 genera. The naming of these species was discussed in Stapleton (1994a; 1994b; 1994c) and more general details on identification and uses of these species were given in *Bamboos of Bhutan: An Illustrated Guide* (Stapleton 1994d).

Note. Languages for local names K-Khengkha; D-Dzongkha; B-Bumthangkha; S-Sharchopkha; L-Lhotsampa.

Arundinaria

Temperate spreading bamboos, usually small, of Asia and N. America. Nearly all bamboos smaller than *Bambusa* and *Dendrocalamus* used to be placed in this genus. Now many of them have been transferred to newer genera such as *Yushania*, *Drepanostachyum*, *Chimonobambusa*, *Thamnocalamus* and *Borinda*.

1. Arundinaria racemosa Munro *Maxilla* (B).

A small spreading, wild bamboo harvested only for brushes, if at all, but forming large areas of pastureland and forest browsing, usually in combination with another small spreading species *Yushania microphylla*. *A. racemosa* is found on the drier or steeper sites, while *Y. maling* is common on the flatter and wetter areas. Important for livestock and wildlife.

Bambusa

Subtropical and tropical clump-forming bamboos, usually cultivated rather than wild, of medium to large size, usually with strong, thick culm walls, small branches and small leaves.

2. *Bambusa alamii* Stapleton *Jacsui* (K); *Mugi Bans* (L).

A small to medium-sized bamboo, cultivated at low altitudes to provide material for weaving baskets and mats. The relatively small size of the culms for a species of *Bambusa* could make this a useful species for furniture manufacturing.

3. *Bambusa clavata* Stapleton *Goog* (K); *Pakshing* (D); *Chile Bans* (L).

A medium to large bamboo, with strong narrow culms and long internodes, probably endemic to Bhutan. Used for general constructional purposes. The dimensions of the culms could make this a useful species for furniture manufacturing.

4. *Bambusa nutans* Wallich ex Munro **subsp. *cupulata*** Stapleton *Sai*, *Tschali* (K); *Jushing* (D); *Leesing* (S); *Mal Bans* (L).

A widely cultivated form of a large bamboo, found throughout the E. Himalayas, with tall, strong, straight culms. This bamboo finds many constructional uses, and is highly recommended for planting. It is also used for bows. The use of rhizome and culm offsets is the only appropriate technique for planting this species.

5. *Bambusa nutans* Wallich ex Munro **subsp. *cupulata*** Stapleton - thorny variety *Gren* (K). N.B. This bamboo shares the local name *Gren* with the cane *Calamus acanthospathus*.

A smaller variety of this species, apparently localised in Zhemgang Dzongkhag with thicker, more crooked, less rounded culms, and thorny branchlets. It is apparently prized for the strength of the culms, which are used for construction. This bamboo is probably a wild ancestor of the more widely planted clones with straighter culms and no thorns.

6. *Bambusa tulda* Roxburgh *Jushing* (D); *Singhane Bans* (L).

A medium to large bamboo of Lower Kheng with shorter less straight culms than *B. nutans*, used for a wide variety of purposes, including bows.

Borinda

Includes the largest temperate clump-forming Sino-Himalayan bamboos, producing surprisingly large, strong, durable culms with long internodes, at relatively high altitudes in Bhutan, Tibet, Yunnan, Burma and Vietnam.

7. *Borinda grossa* (Yi) Stapleton *Rhui* (B,K); *Baa* (D).

Common in mixed coniferous forest in Upper and Middle Kheng, from 2,500-3,000m, especially in association with *Tsuga dumosa*. The culms are long, straight, and tough, producing durable woven mats and fencing panels. This is the main source of mats and fencing material in Upper and Middle Kheng, and represents a valuable resource.

Stands of the species seen between Ura and Shengkhar were in good condition, without evidence of over-exploitation. Cultivation of this species is highly recommended closer

to villages, and may be possible at substantially lower altitudes down to 1,600m, especially if it can be underplanted where an existing open canopy provides the shade that is probably necessary for this species below 2,500m.

Cephalostachyum

Primitive bamboos with flowers in dense clusters, growing in dense clumps of thin-walled weak culms in subtropical forest from 500-2,000m.

8. *Cephalostachyum latifolium* Munro *Pishima* (K); *Murali Bans* (L).

A medium-sized bamboo that straggles over tree branches, but does not climb. The culm walls are thin and weak, but they are easy to split or crush, and they can be woven into mats for roofs and walls. The large leaves make good animal fodder.

9. *Cephalostachyum capitatum* Munro *Pishima* (K); *Murali Bans* (L).

Similar to the previous species, and more common in Upper Kheng, but with smaller leaves. This species has recently flowered gregariously and died throughout Middle and Upper Kheng, so that it is presently not being used at all. Only a few seedlings were noted in the forest.

Chimonobambusa

Spreading bamboos with swollen nodes that bear thorns in many species, and 3 branches.

10. *Chimonobambusa callosa* (Munro) Nakai *Rawa* (K); *Khare Bans* (L).

Thorny, spreading bamboo with brittle culms, widespread in broadleaved forest from 1,330-2,600m. The culms are used entire for flooring and ceilings, and are split to provide *eccra* walling in traditional houses.

Dendrocalamus

Large-stature, subtropical bamboos with large leaves, large branches, and thin-walled culms.

11. *Dendrocalamus hamiltonii* Munro var *hamiltonii* *Pakshing* (D); *Sueding* (K); *Tama Bans* (L).

Medium to large bamboos with thin walls and pendulous culms. This species occurs naturally in the subtropical forests throughout the Himalayas. The type variety becomes rare to the east of Bhutan, where it is gradually replaced by the variety *edulis*, which reportedly produces sweeter shoots.

12. *Dendrocalamus hamiltonii* Munro var. *edulis* Munro *Pakshing* (D); *Soo* (K); *Tama Bans* (L).

More common in the Dzongkhag than the previous variety, this variety apparently gives sweeter shoots, but is otherwise quite similar. The triangular pointed culm sheath auricle that identifies this species in the field is particularly well developed in the large and vigorous plants seen beside the Mangde Chhu on the Tingtibi-Gomphu road near Zurfe.

Culm sections are used entire for beer containers, *chetangma* and *metangma*, covered in woven *Yula* strips, and for arrow quivers. They are also flattened and made into milk pails and butter churns stitched with cane from *Calamus acanthospathus*. Culms are split or woven into panels for walls of smaller buildings and outhouses. In addition branches are cut for splitting into tying material, foliage is harvested for animal fodder, and new shoots are cut in the summer for human consumption.

The frequent and prolific flowering of this species makes it an easy plant to raise, and it also regenerates very readily on its own. In addition, it is very easy to propagate vegetatively. It is a frequent constituent of disturbed areas of natural forest and abandoned or fallow *tseri*.

This bamboo could provide the basis for a bamboo shoot industry, if the product proves marketable. Trial production runs of canned Bhutanese bamboo shoots have apparently been undertaken by *Tashi Commercial*, but it is not known which species were used or whether the trials were successful. Large quantities of this bamboo are presently finding little use along the Mangde Chhu, especially along the Tingtibi-Gomphu road.

Because of its common occurrence in the forest, this species is not planted. It was reported that farmers from other villages will come and harvest this species if it is planted, assuming it to be natural.

13. *Dendrocalamus sikkimensis* Gamble *Zang* (K); *Demtshar* (D); *Dhungre Bans* (L).

Another naturally occurring species of subtropical forest, this large bamboo with tough culms has been the traditional source of water containers (*palang*) and butter churns made from complete culm sections (*zadung*). For hygiene reasons these uses are nowadays of some concern. However, production of these items as ornamental products for sale to tourists is still possible.

This species is found on drier sites than *D. hamiltonii*, often growing on the spurs and ridges arising above the Mangde Chhu. Modern uses are restricted to construction and fencing. The shoots are bitter, and if the edible shoots of *D. hamiltonii* were harvested from the forest care would be required to ensure that the bitter shoots of *D. sikkimensis* were not collected in error.

Drepanostachyum *Phan* (K); *Tite Nigalo* (L).

Small subtropical clump-forming bamboos of drier forest types such as *Schima-Castanopsis*, found from 1,000-2,200m. A source of animal browse and fodder, with small, rather crooked culms that are not used for weaving. Also a useful component of bio-

engineering for slope stabilization along sub-tropical roadsides. Characteristics of the 3 species are similar. The shoots of all species are bitter.

14. *Drepanostachyum khasianum* (Munro) Keng f.

This species, which has a ring of hairs around the nodes, has recently flowered gregariously in Upper Kheng and most clumps have died. Regeneration was not seen.

15. *Drepanostachyum intermedium* (Munro) Keng f.

This species, which has prominent ciliate auricles, has recently flowered gregariously in Middle Kheng and most clumps have died. Dense regeneration of seedlings was observed near Zhemgang.

16. *Drepanostachyum annulatum* Stapleton

This species, which has a ring of dense hairs around the nodes and culm sheath bases, was only seen in a few locations.

Neomicrocalamus

Climbing or straggling bamboos with narrow flexible culms.

17. *Neomicrocalamus andropogonifolius* (Griffith) Stapleton *Yula* (K); *Ringshu* (S,D); *Langma* (L).

The most valuable bamboo for handicrafts, because of its flexible culms with a hard, shiny surface. The surface layers of the culm are split off, dyed, and woven into distinctive and attractive patterns, used for making or covering food and drinks containers and more modern items such as place mats, pen holders and desk stationery.

This is a climbing species that requires the shade and support of trees. It apparently grows in clumps that are often dense, so that sustainable management is simple, as long as harvesting does not become too intense, and a suitably long rotation is followed. It is locally very abundant, but the localities in which it grows are limited, as it is quite demanding, requiring warm fertile sites with abundant rainfall.

Cultivation of this species is strongly recommended. However, it requires a fertile site and overhead tree support. Vegetative propagation by rhizome and stem offsets should be straightforward.

Pseudostachyum

Genus with only one species, *P. polymorphum*.

18. Pseudostachyum polymorphum Munro *Dai, Dem* (K); *Philim Bans* (L).

Small spreading bamboo of wet, subtropical river valleys with extremely thin culm walls and solitary shoots with very pendulous tips. The thin nature of the culm walls makes them easy to crush or split, and they are harvested for conversion into panels for house walls, and mats for roofing.

Thamnocalamus

The commonest clump-forming temperate bamboos in the Himalayas.

19. Thamnocalamus spathiflorus (Trin.) Munro **var. bhutanensis** Stapleton *Rhui* (K, D); *Rato Nigalo* (L).

This is a small clump-forming temperate bamboo, growing in similar areas to *Borinda grossa*, but on steeper or less fertile sites. The culms are not harvested as they are much smaller and less straight than those of *Borinda grossa*. This species should not be planted.

Yushania

Spreading temperate bamboos, very small when grazed, but reaching larger sizes when protected from animals. These bamboos can be serious weeds where regeneration of timber trees is concerned. Opening the canopy in large clear-fell areas leads to the development of very dense bamboo thickets, in which tree seedlings cannot become established. These species should not be planted.

20. Yushania microphylla (Munro) R.B. Majumdar *Meg* (K).

The more common of the two constituents of alpine bamboo pastureland, found especially on wetter, flatter sites, where its hollow rhizomes may allow transport of air to waterlogged roots. The shoots and leaves of this bamboo may be important to the black-necked crane and other wildlife, and the species is very important to livestock such as yaks in winter.

21. Yushania pantlingii (Gamble) R.B. Majumdar *Zing* (K).

Forming dense, impenetrable thickets when the canopy is removed, this bamboo is a serious weed that prevents regeneration of forest trees. Under an existing canopy it produces much smaller, isolated culms that are used for making arrows. This bamboo should not be planted.

1.3 USES OF BAMBOOS IN THE DZONGKHAG

A clear separation can be made between use of bamboos for rural domestic and agricultural requirements supporting the subsistence economy, and the production of marketable items such as the weaving of bamboo culms into *bangchung* or harvesting shoots for canning.

Rural domestic and agricultural requirements consume the vast bulk of bamboo extracted from the forest. This form of consumption is an important element of the self-sufficient farming systems of Lower, Middle and Upper Kheng. One species, *Rhui* (*Borinda grossa*) is extracted much more than any other in Upper and Middle Kheng. The main use of this species is the weaving of roofing mats, which are used for all outbuildings, animal houses and temporary shelters. The poorest inhabitants of some villages also use these mats for the house roof, a practice which is much more common in the eastern Dzongkhags of the country.

The second major use of *Rhui* (*Borinda grossa*) is for fencing. Loosely woven fencing panels provide good protection for field crops, not only against domestic livestock, but also against wildlife, such as wild boar and barking deer.

Other species are also used for making roofing mats when *Rhui* is not available. Where *Rhui* is available the other species are still put to other, less demanding uses, such as fencing poles and rails, the roof lattice, flooring, walling (*eccra* walls) and ceilings. These species are either more closely available wild bamboos collected from the forest, such as *Rawa* (*Chimonobambusa callosa*), or locally cultivated bamboos, such as *Goog* (*Bambusa clavata*) and *Jushing* (*Bambusa nutans*). In lower areas of Middle Kheng, along the Mangde Chhu Valley, large amounts of *Dai* (*Pseudostachyum polymorphum*) are used for walling and flooring of houses in poorer areas. *Pakshing* (*Dendrocalamus hamiltonii*) was also used to make a variety of containers, baskets, mats and implements, often in conjunction with canes such as *Calamus acanthospathus* and *C. latifolius*.

Thus most species of bamboo are put to some use, especially if they grow in abundance. However, *Rhui* (*Borinda grossa*) is by far the most important bamboo for domestic and agricultural purposes in Upper and Middle Kheng, while a wider range of species are used at lower altitudes.

In contrast the bamboo handicraft industry, found only in Lower Kheng, particularly in Bjoka Gewog, uses the one bamboo species *Yula* (*Neomicrocalamus andropogonifolius*) much more than any other bamboo. Split culms are woven into distinctive and attractive patterns, used for making or covering food and drinks containers and more modern items.

1.4 THE BAMBOO SUPPLY SITUATION

During this study it was not possible to obtain any reliable quantitative indication of present bamboo resources. While some indication was gained of a general trend for all cane resources to be dwindling, and cane collecting trips were often reported as taking longer each year, present supplies of bamboos were not perceived to be a problem.

While supply may not be a problem in meeting present demand for rural products, the time and effort required to collect the bamboo poles of *Rhui* (*Borinda grossa*) from an altitude of up to 2,000m above the villages of Middle and Upper Kheng stands out as a particular, potential problem. If, in future, manpower is put to other uses or seasonal migration takes

people out of the villages during the winter, then it will become more difficult to supply fencing and mat-making bamboo materials from much higher altitudes.

Supply of *Pakshing* (*Dendrocalamus hamiltonii*) was possibly on the increase at lower altitudes in Middle Kheng, accompanying general forest degradation along riverbanks and colonisation of old *tseri* land by this frequently-flowering species, which will also root from fallen branches.

Supply of wild *Yula* (*Neomicrocalamus andropogonifolius*) in the forest around Bjoka does not seem to be a problem at the present time, but as a precautionary measure, cultivation of this species has already been initiated on a modest scale.

1.5 DEMAND FOR BAMBOO PRODUCTS

The demand for basic roofing mats and farm implements appears to be stable. Basic baskets, trays, and mats made from bamboo and cane are not being replaced by imported plastic or metal substitutes in rural areas. Bamboo drinks containers are being replaced by glass bottles, and a few old tarpaulins are now used instead of large bamboo mats for drying crops, but the majority of bamboo products will continue to be used. The impact of corrugated steel roofing is limited to more affluent households and probably will never affect outbuildings, animal houses and temporary shelters, which consume the vast majority of bamboo matting.

The need for fencing is, if anything, increasing. The permanent cultivation of suitable *tseri* land, and the increase in crop damage by wildlife such as wild boar and deer are two factors leading to increased demand. It has sometimes been suggested that barbed-wire fences may replace bamboo fencing panels altogether. However, bamboo fencing panels are still of benefit even after timber poles and barbed wire have been installed. While barbed-wire can control domestic livestock, it is of little use against wild boar and deer. Keeping wildlife out of field crops is always a major problem when forest land is adjacent to fields, as is the case in scattered settlements such as those of Zhemgang Dzongkhag.

Demand for bamboo cash crops within the Dzongkhag is presently very restricted. Most bamboo is harvested from the forest for personal use. Weaving of *Yula* (*Neomicrocalamus andropogonifolius*) into *bangchungs* and other articles is apparently undertaken in only one area, Bjoka Gewog of Lower Kheng. Production of a saleable commodity in such a remote area is a remarkable achievement, and represents a valuable skill in an area with severe development problems. Demand for *Yula* products is likely to rise with an increase in number of tourists visiting the country. As these products are so distinctive, diversification of the range is likely, and demand for woven *Yula* products as a means of packaging other commodities produced in Bhutan seems likely in the future. Thus the international market may have considerably more potential.

1.6 RECOMMENDATIONS FOR CULTIVATION OF BAMBOOS

Very little bamboo has been cultivated in the Dzongkhag. This is presumably because supplies in the natural forest have generally been sufficient to meet local needs. Extraction of natural bamboo is evidently taking place on a substantial scale, with *Rhui* (*Borinda grossa*) and *Yula* (*Neomicrocalamus andropogonifolius*) being the most important species.

According to Dzongkhag forestry officials the latter has recently been planted on a modest scale, both on private land and also in government forest areas, to supplement present supplies. It is recommended that this initiative should be monitored and supported.

It is strongly recommended that trial plots of *Rhui* (*Borinda grossa*) be raised at progressively lower altitudes, closer to the villages of Middle and Upper Kheng. In addition, trial plots of other bamboo species that are known to grow well at lower elevations should be raised in the immediate vicinity of villages, so as to produce suitable material for woven panels. *Parang* (*Himalayacalamus hookerianus*), a species widely cultivated in Chirang, would be a good choice for this purpose.

Further development of the cane and bamboo handicrafts cottage industry in Bjoka would require cultivation of *Yula* (*Neomicrocalamus andropogonifolius*), as well as appropriate cane species. Siting such plantations would require care because of the exacting requirements of this bamboo. If existing areas of *Yula* in government forest are being managed sensibly, it could make sense to transfer such areas to community forest status, after production of the necessary management plans. Combined plantations or management of *Yula* with cane species (used for the top rings of baskets and for tying the woven bamboo sections) are suggested. They require similar environments, and growing them together would simplify production of the end products.

One recommendation concerning canes is that the initiation of a cane furniture industry should be considered. The use of bamboo sections for some of the load-bearing parts of such furniture could be an alternative to collecting or cultivating high quality large-diameter canes. In addition small woven *Yula* sections or even panelling could be incorporated to give a clear Bhutanese identity to the products. Species of bamboo that might give culm sections of appropriate size for furniture include *Bambusa alamii* and *Bambusa clavata*.

In addition, locally cultivated bamboo species could usefully be included on a small scale in almost any government, community, or private forestry programmes throughout the Dzongkhag, using traditional planting techniques.

Where possible a combined selection of different species of bamboo should always be planted. This provides a buffer in the event of a gregarious flowering of any single species, which can disrupt the supply of bamboo products for several years.

Care should always be taken with any economic activity based upon only one species of bamboo. Information on flowering is indispensable for proper planning, and local knowledge on the past flowering behaviour of important species should be actively sought. In the event of a gregarious flowering of an important bamboo species, supplies of culms will be completely or seriously interrupted. Alternative species or sources of supply, or some other activity is necessary to provide income from the time of initiation of flowering to the establishment of mature clumps, which may take several years. *Yula* (*Neomicrocalamus andropogonifolius*) is of particular concern. Absolutely nothing has been recorded about the flowering behaviour of this species. It is recommended that other genotypes of *Yula* should be collected from Tashigang Dzongkhag, and planted in a separate site in Lower Kheng. If *Yula* does flower gregariously then plants from Tashigang might have a different flowering cycle, and they might be able to provide a supply of weaving material while supply from the Zhemgang plants is disrupted.

1.7 RECOMMENDATIONS FOR MANAGEMENT OF BAMBOOS

The general forestry principle of sustained yield is applicable to bamboos, but the mechanism of obtaining it is somewhat different. As new culms are produced from the rhizome system every year within each bamboo clump, it is possible to harvest older culms on an annual basis. Removal of older culms stimulates production of new culms and increases productivity. Clear-cutting whole areas or even whole clumps is not advisable, as this substantially reduces the size of new culms for several years.

Control of the rotation length is effected by selecting the age of culms to be removed. Removal of 3-year-old culms is a sensible procedure, because this leaves 2-year-old culms with foliage to provide adequate resources for production of good new shoots. Harvesting 2-year-old culms leads to production of a larger number of smaller, softer culms. Balancing size against productivity and durability of culms involves judgements that can only be made by people who are closely involved with the use of the bamboos, for each particular species and end-use. Therefore exact rules cannot be given for the management of bamboos in general.

If production of edible shoots were the main management objective for an area of bamboo, then a different management technique would be necessary. Removal of too many shoots from any individual clump leads to a substantial progressive decline in the number and size of new shoots. Each new shoot represents a heavy investment on the part of the plant, and their removal is a great drain on the clump. Therefore only a proportion of the new shoots from each clump should be removed each year. Older culms should still be harvested, but at a reduced intensity, as this stimulates production of new shoots within the clump.

Regeneration of forest bamboos after flowering is an important part of long-term management procedures. Protection of the area from fire and grazing livestock is usually sufficient to allow natural regeneration to re-establish bamboo clumps. Raising seedlings in a separate nursery is not normally necessary, but this can provide insurance against accidental damage to regeneration.

Replanting of cultivated bamboos such as *Bambusa* species is usually undertaken vegetatively from non-flowering clumps. In this way superior cultivated clones have long been selected and perpetuated in Asia, and these have much less tendency to flower, as well as superior culm characteristics.

2.0 THE CANES OF ZHEMGANG DZONGKHAG

2.1 BACKGROUND

Canes (also known as rattans) are spiny, climbing palms. They grow in a range of ecological conditions and constitute an integral part of the forest ecosystem. There are over 600 species of cane, grouped in 13 genera, occurring throughout sub-tropical and tropical Asia. Canes reach their northernmost limit in southern China, Taiwan and the foothills of the Himalayas where they can be exposed to temperatures of less than 0°C. Canes are considered to be valuable non-timber forest products with immense ethnobotanical significance being used for a wide range of household, construction and commercial purposes on local, national and international levels. Although it is not known exactly how much cane is harvested in Bhutan each year, nor what the value of this raw or processed cane amounts to, it is certain that canes play an important role in the rural economy of several districts.

Cane species are found throughout Zhemgang Dzongkhag, where they are commonly utilized and processed into a range of goods. The richest cane resources of the district are found in Lower Kheng. Most cane utilisation occurs on a local, non-commercial level, however, in the Bjoka Gewog of Lower Kheng, cane and bamboo (*Yula*) are used together in the *bangchung* cottage industry. *Bangchung* are light round baskets traditionally used for carrying food, and are increasingly sold to tourists as souvenir items.

2.2 CANE SPECIES OF ZHEMGANG DZONGKHAG

During the fieldwork six species of cane belonging to two genera were encountered and collected. It is thought that about ten species of cane might occur in the country as a whole. All these species are probably being exploited to varying extents for a range of purposes. The species seen in Zhemgang are given below.

No.	Species	Khengkha	Distribution
1	<i>Calamus acanthospathus</i> Griffith	Krath	L,M
2	<i>Calamus erectus</i> Roxburgh	Bher	L,M
3	<i>Calamus flagellum</i> Griffith	Soka, Tangtangma	L,M
4	<i>Calamus latifolius</i> Roxburgh	Khran	L,M
5	<i>Calamus leptospadix</i> Griffith	Tangtangma, Titipi	L
6	<i>Plectocomia himalayana</i> Griffith	Lepan, Patcha, Ray	U,M,L

2.3 FIELD KEY FOR CANE SPECIES OF ZHEMGANG DZONGKHAG

- Leaflets < 2cm wide. Leaf rachis with reddish-brown hairs **5. *Calamus leptospadix***
- Leaflets > 2.5cm wide. Leaf rachis without reddish-brown hairs
- Leaves with a cirrus (spiny extension of the leaf axis)
- Leaf sheath with black, needle-like spines arranged in irregular spirals..... **6. *Plectocomia himalayana***
- Leaf sheath with broad, flattened spines, sparsely arranged **4. *Calamus latifolius***
- Leaves without a cirrus
- Non-climbing cane. Leaf sheath with black spines regularly arranged in horizontal rings and with no flagellum (spiny axis arising from the leaf sheath).. **2. *Calamus erectus***
- Climbing canes. Leaf sheath with irregularly arranged spines and a flagellum.
- Solitary cane. Leaf sheath with fine spines of equal length. **1. *Calamus acanthospathus***
- Clustering cane. Leaf sheath with mixed spines of several lengths. **3. *Calamus flagellum***

2.4 DETAILS OF THE CANE SPECIES

Note 1. Local names are given in Dzongkha (D), Kengkha (K), Lepcha (L) and Sharchop (S).

Note 2. Distributions of canes in Bhutan are recorded here only as those districts in which the species have been seen or collected. It is likely that further fieldwork in lowland areas of Bhutan will find new records of canes in other districts.

1. *Calamus acanthospathus* Griffith *Krath, Gren* (K), *Gauribet* (L), *Munzi* (S).

A solitary-stemmed, climbing cane. The leaf sheaths are armed with densely-arranged spines, and a long spiny, flagellum (specialised climbing organ) which helps the cane to grow high into the forest canopy.

Distribution: Bhutan (Mongar, Sarbhang and Zhemgang) and India (Arunachal Pradesh, Assam, Meghalaya, Sikkim and West Bengal).

Uses: *C. acanthospathus* is a very important species in Bhutan and the cane is used for a variety of purposes. The high flexibility of the cane makes it especially valuable for tying and stitching. Examples of its use are tying wooden fences, stitching the seams of bamboo milk pails and butter churns made from flattened culms of the bamboo *Dendrocalamus hamiltonii*, and the edges of baskets woven from other species of cane, such as *khran* (*Calamus latifolius*), or bamboos such as *yula* (*Neomicrocalamus andropogonifolius*). *C. acanthospathus* provides the most flexible cane, used for the finest stitching, seen on *bangchung* and similar products. Other uses of this cane have been recorded as bridge construction, rope manufacture and production of walking sticks.

Ecology: Dense, broad-leaved forest from 1000-1950m altitude.

Conservation status: The conservation status of *C. acanthospathus* has not been explicitly studied. However, villagers have repeatedly said that they must travel increasing distances each year in order to harvest adequate quantities of this cane. A 'vulnerable' conservation status for the species in some areas of the Dzongkhag is very likely. This is due to a combination of its growth characteristics and high desirability. *C. acanthospathus* has a solitary habit which means that each plant comprises only one stem. This makes the species susceptible to over-exploitation, as harvesting necessarily kills the whole plant. In contrast, all other species of cane in Bhutan are multi-stemmed, so each plant continuously produces offsets that can be either harvested for cane, or used for vegetative propagation.

Recommendations for development of *C. acanthospathus*.

As mentioned above the solitary habit of *C. acanthospathus* makes this species especially vulnerable to any increase in its harvest. Any significant increase could rapidly result in the loss of the species from accessible areas of forest. If any major increase in utilization of *C. acanthospathus* is planned it is recommended that cultivation (including deliberate propagation and protection) of this species be investigated. The solitary habit of this species means that simple propagation by vegetative offshoots is not possible. At the moment the only possibilities for cultivation of *C. acanthospathus* are collection of seedlings from the forest (wildings), or germination from seed. Collection of wildings from the forest is obviously not recommended. This would only serve to increase pressure on wild populations of the species. Therefore propagation from seed would be necessary, yet nothing is known of flowering behaviour, seed production or cultivation requirements of this species. It is recommended here that propagation techniques for *C. acanthospathus* should be a future area of research (see Section 2.10 for general information on cane cultivation).

2. Calamus erectus Roxburgh *Bher*, *Soka* (K); *Phakgre bet* (L).

[In Lower Kheng this species is recorded as *Bher* but in Middle and Upper Kheng its name is said to be *Soka*. *Soka* is a name sometimes also given to *C. flagellum*. The use of the leaves of both species for roofing thatch is the probable cause of this shared name.]

A non-climbing, clustering cane which lacks climbing organs of any sort (cirrus or flagellum) and therefore rarely grows higher than 3m tall (although given adequate support it can reach 6m). It is easily identified by horizontal rings of spines on the petiole and leaf sheath.

Distribution: Bhutan (Samchi, Sarbhang, Deothang and Zhemgang), Bangladesh, Myanmar and India (Assam, Manipur, Meghalaya, Sikkim and West Bengal).

Uses: The short cane of *C. erectus* is not considered usable in Bhutan. However, it is recorded (Basu 1992) as being used quite commonly in hut construction in Assam. In Lower Kheng the leaves of *C. erectus* are used for roofing thatch, but in Middle Kheng the longer-lasting leaves of *C. flagellum* are apparently preferred. The seeds of *C. erectus* are sometimes chewed as a substitute for betel (*Areca catechu*).

Ecology: Lower hill forests from 300-1200m altitude, often on drier slopes.

Conservation status: This species is not considered to be threatened or in short supply, although there is said to be a general decrease in quantity in Lower Kheng due to over-harvest.

Recommendations for development of *C. erectus*.

Field tours indicate that *C. erectus* is abundant in the Dzongkhag and will remain abundant as long as the leaves are harvested in a sensible and sustainable manner. Common-sense practices for sustainable leaf harvest include:

DO restrict the number of leaves cut from each plant, and always ensure that enough are left for healthy plant growth.

DO NOT cut the stem for leaf harvest, but where possible leave the stem intact.

If it is necessary to cut the stem, then always cut **ABOVE** the rhizome so as to ensure healthy regeneration.

3. *Calamus flagellum* Griffith *Soka, Tangtangma* (K); *Rabi bet* (L).

A clustering cane that climbs with the help of a flagellum (climbing organ). The leaves have no cirrus. The leaf sheaths are heavily armed with densely-arranged spines of mixed lengths.

Distribution: Bhutan (Samchi and Zhemgang) and India (Assam, Meghalaya, Sikkim and West Bengal).

Uses: The leaves of *C. flagellum* are used in Middle Kheng for roofing thatch, which is said to last up to 20 years. In contrast, thatch of *C. erectus* leaves has a much shorter life, but is still commonly used in Lower Kheng. The cane of *C. flagellum* is rarely utilised but occasionally may form the top ring of baskets.

Ecology: Lower and middle hill forests from 400-1400m altitude.

Conservation status: This species is not considered to be threatened or in short supply, although there is said to be a decrease in quantity in Lower Kheng due to over-harvest.

Recommendations for *Calamus flagellum*

Evidence gathered so far indicates that cultivation of *C. flagellum* is not necessary. The only recorded use of the cane of the species is as the top ring of baskets, but it is not considered as good as *C. acanthospathus* for this purpose. It is the leaves (rather than the cane) of *C. flagellum* which are more commonly harvested, and therefore the practices that were suggested for sustainable harvest of leaves *C. erectus* (see above for details) also apply to *C. flagellum*. As long as the leaves of both species are harvested in a sensible manner, there will be no need for cultivation.

If future studies should consider cultivation of either *C. erectus* or *C. flagellum* to be necessary, then it is recommended that they be cultivated by propagation of vegetative offsets. The clustering habit of both species means that each plant produces several offsets which can be harvested indefinitely without killing the plant. Of course, preliminary nursery trials should be undertaken first to establish the growth requirements of these offsets.

4. *Calamus latifolius* Roxburgh *Khran* (K).

A robust, high-climbing, clustering cane which is easily identified by the broad, flattened spines which are sparsely-arranged on the leaf sheath. The leaves have a long, spiny cirrus which helps the cane climb into the canopy.

Distribution: Bhutan (Zhemgang) and India (Arunachal Pradesh, Assam, Meghalaya, Nagaland, Sikkim and West Bengal).

Uses: In Lower Kheng the cane of *C. latifolius* is used to make rope, the ring or frame of baskets, and for high-quality mats known as *tan*. In Middle Kheng, villagers consider it to be the best cane for weaving strong, long-lasting baskets but its increasing rarity means that alternatives (such as *Plectocomia himalayana*) must sometimes be used. The species appears to be absent from Upper Kheng.

Collections made by the authors of *C. latifolius* in Middle Kheng, indicate that this cane is stronger and generally larger than all other indigenous cane species in Zhemgang Dzongkhag. The cane of *C. acanthospathus* rarely exceeds 2cm in diameter and its flexibility makes it more suited to stitching and tying than any structural purpose. In contrast, *C. latifolius* cane can reach 3cm in diameter (or maybe more) and its robust strength could make it well suited to manufacture of stronger items such as furniture. The species is already used in furniture manufacture in Assam (Basu 1992).

Ecology: Further study of the ecology of *C. latifolius* is required to supplement what little is known of the species in Bhutan. Previous studies record it as a species of moist hill forests (Noltie 1992), found from 700 to c. 1600m, often near fresh water swamps (Basu 1992). This study found it growing (near Tama) on a steep, damp slope, in low light conditions, in association with the bamboos *Dendrocalamus hamiltonii* and *Pseudostachyum polymorphum*.

Conservation status: Field tours have found *C. latifolius* to be the least common of all cane species in all parts of Zhemgang Dzongkhag. Its rarity and economic value suggests that conservation of this species should be of concern.

Recommendations for development of *C. latifolius*.

It is recommended that diversification of potential uses of *C. latifolius* cane and its cultivation be the subjects of particular study. Of all Bhutanese species, the size and strength of cane of *C. latifolius* makes it most suited to manufacture of structural items such as furniture, but yet no such use has been recorded in the country. In fact, it seems that no indigenous cane species is used in Bhutan for the manufacture of any furniture. Basu (1992) notes that *C. latifolius* is used in India to make furniture frames and, in the longer term, study into similar uses in Bhutan is positively recommended here. Production of large cane items, such as furniture, are likely to be much more profitable than production of smaller, handicraft items, such as baskets or *bangchung*. On the other hand, manufacture of furniture requires a higher level of investment, organisation and infrastructure, including transport facilities.

5. *Calamus leptospadix* Griffith *Tangtangma*, *Titipi* (K).

[N.B. The name *tangtangma* is used in Lower Kheng to refer to *C. leptospadix*, but is used in Middle Kheng for *C. flagellum*.]

A slender, clustering cane. Leaves have a spiny cirrus and the leaf rachis is characterised by abundant reddish-brown hairs. Leaf sheaths are armed with sparsely-arranged spines of mixed lengths.

Distribution: Bhutan (Samchi, Sarbhang and Zhemgang) and India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Sikkim and West Bengal).

Uses: *C. leptospadix* is generally considered a useless cane in Zhemgang Dzongkhag, although, when split it is sometimes used in production of rough baskets or rope.

Ecology: Low and middle hill forests below 700m altitude. When given forest cover, *C. leptospadix* is a high climber, but, when growing along damp river plains it tends to form thickets (Basu 1992).

Conservation status: Observations made on field tour in Lower Kheng found this species to be abundant in its natural habitats.

Recommendations for development of *C. leptospadix*.

In Zhemgang Dzongkhag, this species is found only in Lower Kheng. It is generally considered less useful than other canes, but it may be used in areas where preferred species of cane are absent. For example, there is very little *C. acanthospathus* (*Krath*) in the area around Pangbang and so *bangchung* makers use *C. leptospadix* instead for stitching and tying of the baskets.

6. *Plectocomia himalayana* Griffith *Patcha* (edible shoot) and *Patsa* (cane) (D); *Lepan*, *Ray* (K); *Tokri bet* (L).

A clustering, climbing cane. This is the most common cane species of Middle and Upper Kheng, but is less common in Lower Kheng. It is easily identified by its black-brown, needle-like spines arranged in irregular spirals on the leaf sheath.

Distribution: Bhutan (Mongar, Sarbhang and Zhemgang) and India (Arunachal Pradesh, Sikkim and West Bengal).

Uses: *P. himalayana* is harvested both for its edible shoot, which is much prized as a bitter vegetable, and also for its cane, which is woven into strong rope, or split into strips for tying fences and for making rough baskets. Each stem of this species flowers only once in its lifetime, before it dies, and this may lead to the canes being rather weak and pithy. Basu (1985) interestingly notes that one 2m length of *P. himalayana* stem provides enough drinkable water to quench the thirst of four men on a hot day. However, the canes can reach substantial proportions, large enough for consideration as a potential source of furniture material, if they are strong enough.

Ecology: Middle and upper warm, moist, broad-leaved hill forest from 1500-2500m altitude, on sandy-loam soil. This species is often found in degraded or disturbed areas, with relatively high light exposure, such as gullies or gaps formed by tree-falls or landslides. The

flowering behaviour of this particular species may be an adaptation to the colonisation of these temporary habitats.

Conservation status: *P. himalayana* is still common in Zhemgang Dzongkhag. However, because of its use both as a vegetable and as a source of weaving material, not surprisingly, it is usually rare near villages and paths. Villagers in some regions say they must travel increasing distances, to more inaccessible areas, in order to harvest adequate quantities of the cane.

Recommendations for development of *P. himalayana*

Of all Bhutanese cane species, *P. himalayana* is considered here to be the most suitable for cultivation. It provides both an edible shoot and a good, general-purpose cane. As a species that grows at higher altitudes, in areas that may be disturbed with high light exposure, it would seem a suitable candidate for trial planting in partially degraded forest areas (such as *ex-tseri* or community forests) near villages in Middle and Upper Kheng.

Propagation of *P. himalayana* would be best achieved using vegetative offsets. In this species, offsets arise at internodes along the length of long stolons which spread horizontally along the forest floor. In this way, the species grows in wide, open clumps in which there is little competition between the stems for light. The clustering habit allows sustainable harvest of cane without negative effects on the populations. However, the following common-sense practices for sustainable harvest should be followed for both wild and cultivated stock.

DO only harvest mature stems.

DO cut stems **above** the level of the rhizome, to allow for healthy regeneration.

DO ensure complete harvest of the cane of each stem, thus avoiding waste. The edible top portion (*patcha*) and the lower portion providing usable cane (*patsa*) should be harvested together.

DO rotate harvest areas, so as to allow for forest stocks of *P. himalayana* to regenerate.

2.5 USE OF CANES IN THE DZONGKHAG

On visiting the villages of Zhemgang Dzongkhag it is evident that canes, as well as bamboos, play an integral role in the daily life of the Khengpa. They are used in house, roof and fence construction, basket-making, and for a range of tying and stitching purposes. Life without canes would be very difficult for the typical rural Khengpa household, particularly at the poorer end of the income scale. All six cane species that occur in the Dzongkhag are utilized to varying extents. The most important general-use cane is *Plectocomia himalayana* which is used for a wide range of practical purposes, and also provides edible shoots. *C. acanthospathus* is the best cane for stitching and tying and is often used for basket making in combination with the more robust, long-lasting cane of *C. latifolius*. *C. leptospadix* occurs only in Lower Kheng where it is not the preferred species for any particular purpose. The canes of *Calamus erectus* and *C. flagellum* are not utilized, but their leaves are widely used for thatch.

2.6 TRADITIONAL MANAGEMENT OF CANES IN THE DZONGKHAG

Traditional management of cane resources in Upper and Middle Kheng relates only to harvesting practice. There is no tradition of cultivation or propagation of cane species. Traditionally, only mature stems are harvested, so as to allow for all stems of clump to reach their maximum size before being cut. However, elderly basket-makers say that the younger generation is less aware of traditional cane harvesting methods and that there is an increasing tendency to cut immature stems. Decreasing amounts of cane in the forest, and the subsequent pressure on remaining populations, may also be a cause of premature harvest of stems.

There is widespread knowledge of the growth habits of cane species among those people harvesting and utilising cane. For example, most people were aware that *C. acanthospathus* (*Krath*) has a solitary habit, and that harvest of the cane necessarily kills the plant. Villagers commonly cite this characteristic as a cause of the rarity of *Krath*. Similarly, the clustering nature of *P. himalayana* (*Patsa*) is commonly noted as the reason why the species is less vulnerable to harvest and therefore is still relatively abundant in the forest.

2.7 HUMAN RESOURCES DEVELOPMENT: TRAINING OPPORTUNITIES

Production of woven cane items, such as baskets, requires knowledge and complex skills, acquired over several years and after much practice. It is generally only older men who are knowledgeable in this fine art and can produce well-finished goods. Elderly basket-makers say that members of the younger generation are not interested in learning these skills and those few young people who have learnt them generally make poorly-finished goods.

Handicraft skills such as basket-making are an important and integral part of any culture. Their loss would represent a dilution of Bhutanese cultural heritage. It is recommended that elderly basket-makers in the villages of Zhemgang Dzongkhag be encouraged to pass on their skills to the younger generation. However, it would be difficult to encourage the teaching of these skills without some assurance to the pupils that there will be a market for any cane goods they produce. It is therefore very important that training programmes be established in combination with assistance in marketing of cane products.

2.8 SUPPLY OF RAW AND PROCESSED CANE

All canes are harvested from the forest by the immediate users: basket-makers harvest the cane they require for their craft, others harvest the cane needed for general household use. It is commonly said that canes are not as easy to find as they once were and that several days are sometimes required to harvest adequate quantities. This is particularly true of the high-quality, durable canes like *Khran* and *Krath*. It is clear that without any cultivation, supply of raw cane from the forest can only decline. The species with solitary stems, *Krath* (*C. acanthospathus*) is particularly vulnerable, and is danger of disappearing from more accessible forest areas.

It appears that supply of cane products is presently adequate for domestic use within the subsistence economy. Any development of supply will be limited by the resource base, skill-levels, transport and marketing facilities.

At the present time, the vast majority of cane products are made for use within the household or village in which they are made. In Middle and Upper Kheng it is generally only a few households (often just one or two) that produce woven cane products on any scale. A majority of these products are sold within the village for cash or, more commonly, are bartered for other goods. Some cane products, particularly more elaborate baskets, such as those with an attached lid, are made to order for sale outside the village. Village basket-makers do not travel to markets specifically to sell cane products, although a few baskets may be taken on a journey to be bartered for other goods at the destination.

Many cane products for sale in Zhemgang shops are not made within the Dzongkhag. Cowherders from Trongsa Dzongkhag (Phanling, Chumsay and Wamling villages) reportedly bring cane baskets to barter for goods in the town.

It is clear that despite the economic importance of cane products at the village level and their functional importance to the whole population of Middle and Upper Kheng, there is no regular or organised market for cane handicrafts on a more widespread, commercial basis. This is largely a reflection of the widely dispersed nature of both the population and the cane resources. The only cane products which are routinely harvested and taken to markets, both inside and outside the Dzongkhag, are the edible shoots of *P. himalayana* (*Patcha*).

In Lower Kheng the situation is very different with regard to cane and bamboo products. There exists a developed cottage industry engaged in the manufacture of products specifically for sale outside the Dzongkhag, mainly for the tourist market in Thimphu. This cottage industry is currently provided with assistance in both design and marketing, and looks to receive more development attention in the future. While the supply of the bamboo raw material (mostly *Yula*) has been considered, and cultivation of the species (*Neomicrocalamus andropogonifolius*) has been initiated in Lower Kheng, the supply of cane does not seem to have received attention. This is an important consideration if expansion of this cottage industry is planned. The preferred cane species for *bangchung* production is *Krath* (*C. acanthospathus*), and this should be considered a point of concern, because increased harvesting from the forest could rapidly deplete supplies. If production increases, then use of cane from alternative species should be encouraged. In the region around Pangbang, where *Krath* is very rare, cane of *C. leptospadix* is already used as an alternative.

2.9 DEMAND FOR CANE PRODUCTS

As an integral part of the subsistence agricultural system and rural domestic scene, production of cane products for handling agricultural produce is assured a future. At present, products made from alternative materials are not major competitors to their cane equivalents. The poor transport system and widely dispersed nature of rural households protects against an influx of products, based upon materials such as plastic, which are intrinsically too expensive anyway.

Demand for edible cane shoots of *Plectocomia himalayana* is consistently high and may increase with increasing purchasing power. This seems to be a speciality of the Bhutanese palate, however, and an export market does not exist.

At present, bamboo products form the bulk of bamboo and cane sales to the tourist market, with cane contributing only a minor proportion of individual items. Tourist consumption of

cane products is low, primarily because there are few purchasable cane items on offer to them. It is well known that high-quality cane baskets are rarely bought 'over the counter' but must be made to order. This immediately places them out of the reach of the average tourist. However, demand by Bhutanese, and potentially also tourists, for high-quality, durable cane baskets is considerably higher than present supply. The production of equivalent baskets made with two layers of woven bamboo (*pakshing* and *yula*) has not met with consistent public approval, as these are not as hard-wearing and long-lasting. For transporting goods on ponies, hard-wearing cane baskets are essential. Even for more general use, a high level of durability is obviously attractive to cost-conscious purchasers. Closing the gap in the market for cane products would be widely appreciated, but will not be possible until details of Bhutan's cane resources are better understood.

It is this lack of understanding, in terms of both current quantity and future ability to sustainably maintain a constant supply that limits cane development projects. Demand for cane furniture in local and world markets is high, yet no furniture is made from cane in Bhutan. Until the Bhutanese cane resources are better understood, it would be premature, and unwise, to recommend cane furniture production as anything other than a future area of study. It is our opinion that production of cane furniture in Bhutan would have to be supplied by cultivated cane, or bamboo substitutes. General aspects of cane cultivation are discussed below.

2.10 CULTIVATION OF CANES

Despite their economic importance and ethnobotanical significance, canes are not commonly cultivated. Nevertheless, given the correct conditions, cane cultivation is both possible and economically viable. In Central Kalimantan two Indonesian cane species have been successfully grown in plantations for over 100 years, and in many parts of south-east Asia canes can be found growing in village backyards to supply individual household needs. In Bhutan, the idea of cultivating canes is treated with a little amusement by the average villager, who understands only too well that canes, because of their climbing, spiny nature, are not immediately suited to the kitchen garden! In our opinion there exists great potential for cultivation of canes in a forest environment in *ex-tseri* land or community forests. However, further socio-economic studies as well as propagation and cultivation trials would be required before concrete recommendations can be given. However, some general suggestions are offered, and areas where knowledge is presently limited are highlighted.

Cultivation of cane is initially dependent upon a good understanding of the biology, ecology and cultural requirements of the species. Unfortunately, knowledge in all these areas is in short supply for the six Bhutanese cane species. Important areas of study include:

Phenology (flowering behaviour of the plants in relation to environmental conditions): Canes differ in the time and duration of flowering, and time and quantity of fruit set according to species and environmental conditions. Information on flowering and fruiting patterns are significant to planning and development of cane cultivation. An understanding of flowering and fruiting times maximises efficient harvest of fruit from wild plants and synchronises this harvest with nursery activities. It is also important to know how much harvestable fruit each plant produces, in order to plan the scale of cultivation.

Germination: Cane species vary in the length of time taken by seeds to germinate. Trials with a range of south-east Asian canes species indicate that germination can take from one to several months. Germination trials are generally undertaken to ascertain optimum nutrient, moisture and light requirements of each species.

Seed storage: Ideally seeds should be germinated as soon after harvest as possible. However, if this is not convenient then seed storage requirements should be studied in order to minimize loss of seed viability. For example, seed of the economically-important south-east Asian species, *Calamus manan*, should be air-dried at room temperature overnight to reduce moisture content to <35%, prior to storage in plastic bags at 14-16°C for up to two months.

Light requirements: Optimum growth of cane seedlings is dependent upon the correct light regime. Cane species vary in light requirements according to the ecological niches that they naturally occupy. For example, stemless species (such as *Calamus erectus*) tend to be suited to low light levels of the forest undergrowth, but high climbing species (such as *C. acanthospathus*) prefer higher light levels.

Moisture requirements: Cane species will vary in their moisture requirements. However, in general canes cannot survive severe drying out or permanent waterlogging.

Nutrient requirements: Forest conditions in the sites where canes are naturally found usually provide satisfactory levels of nutrients. However, any cultivation of canes in different sites would benefit greatly from fertilization. Nitrogen, phosphorous and potassium are the most important nutrients for healthy cane growth. Quantity and combination will vary according to the age and size of the cane and the soil in which it is growing.

The areas identified above relate to the basic cultural requirements of cane species. It is very important to any project seriously contemplating cane cultivation on a commercial scale that suitable studies are conducted to evaluate the feasibility of the chosen cane species for cultivation.

2.11 CONSERVATION OF CANES IN ZHEMGANG DZONGKHAG

As Dransfield (1989) noted, recent years have seen an increase in the quantity of cane harvested from wild populations throughout Asia, to supply the growing global trade in cane products. If positive action is not taken to conserve cane resources worldwide then the valuable biodiversity that canes represent may be in danger of being lost. Basu (1985, 1992) reported that several cane species in India are already vulnerable, for example, *Calamus inermis* and *Plectocomia himalayana*, both of which are harvested in Darjeeling and Sikkim.

The conservation status of cane species in Bhutan is not yet clear. The *Zhemgang Dzongkhag Baseline Survey* reported that of all forest products, villagers travel farthest to harvest canes and bamboos, and our findings support this general observation. These distances are increasing each year, and so cane harvesting trips are becoming increasingly costly to villagers.

In Lower Kheng, *C. flagellum* and *C. erectus* populations are said to be decreasing due to over-harvesting of the leaves for roofing by the growing human populations. In Middle and Upper Kheng *P. himalayana* is also in decline. Nevertheless, all three species remain more

common than other canes in the Dzongkhag, and there is little problem yet with their supply. *C. acanthospathus* has always been scarce in Zhemgang, as might be expected for such a highly-prized solitary cane. We have found the rarest cane in Zhemgang Dzongkhag to be another extremely valuable species, *C. latifolius* (*Khran*).

It is recommended that active conservation of canes, with a view to their improved management and sustainable use, be initiated by a more quantitative survey of the species. Only then will there be sufficient evidence for any reliable statement of their conservation status. Identification of the species concerned, with gathering of basic ethnobotanical information including local names is only the first step. With the help of the local names and illustrations in the revised and expanded field guide, *Bamboos and Canes of Bhutan*, which is intended to follow from this project, it should be possible to obtain more information on stocks of the different cane species remaining in the Dzongkhag. Forest inventory procedures could also be refined to include canes on a species by species basis. Only with such information could a sound strategy for sustainable use and conservation of cane species be formulated.

3.0 OVERALL SUMMARY ON BAMBOOS AND CANES

The rural subsistence economy in the Dzongkhag uses a wide range of both bamboo and cane products. Supplies of these are potentially rather precarious, and some assessment of resources, even if only approximate, on a species by species basis is recommended, in the course of routine forest inventories. This report highlights which of these species are most important and the accompanying field guide to recognition should allow forestry personnel to identify them.

Cultivation of certain species is recommended to supplement natural supplies and/or to provide the resource closer to its point of utilisation. New forestry legislation provides mechanisms for transferring control of existing bamboo areas to local communities, and conversion of *tseri* land to more permanent forms of land-use. These changes in land-use and control would provide opportunities for cultivation of a range of plants, including non-wood forest products such as bamboos and canes, which might otherwise suffer with any decline in forest cover or quality.

Bamboos and canes are good choices of understorey crop for areas of forest in which the trees cannot be felled, for reasons of slope stability, inaccessibility or conservation. Similarly, if canes and climbing bamboos are to be cultivated, planting in association with trees that will not be felled is obviously desirable. For example, canes are often planting in conjunction with rubber trees, which can be tapped near to the ground while the canes are undisturbed in the canopy.

All levels of society make some use of non-wood forest products. However, it is the poorer sections of the community which rely most heavily upon them, for example, to provide bamboo walls and cane thatch roofs for their houses. Recent years have seen a growing awareness of the economic potential of non-timber forest products and they are, worldwide, being incorporated into a range of development activities. Whatever the benefits of development of non-timber forest products to the wider community, great care must be taken not to disrupt supply of these products to the rural subsistence economy. The most

important priority is considered here to be maintenance of a supply of non-wood forest products to those people who are most dependent upon them.

It is beyond the scope of this report to suggest the extent to which bamboo and cane-based industries should be developed to produce items for sale outside the Dzongkhag. At the present time, transport problems in many areas make any specialisation of the rural economy extremely difficult. An additional problem is the lack of knowledge, in terms of quantification, of bamboo and cane resources in the forest on a species by species basis. Nevertheless, several possibilities for future development can be highlighted. The canning of bamboo shoots of *Dendrocalamus hamiltonii* on a semi-industrial scale has great economic potential in the immediate future. Commercial possibilities for canes can only be considered feasible in the longer term. The manufacture of cane furniture using the larger cane species, *Calamus latifolius* and *Plectocomia himalayana*, could be a beneficial area for future study. Incorporation of bamboo as structural component or ornamental woven panelling has been suggested under the bamboo recommendations. Upholstering with Bhutanese fabrics would give a further degree of national identity to such products.

These are two suggested developments of bamboo and cane resources with economic potential. However, before either can be seriously recommended several important constraints should first be considered. These include the need for conservation of the valuable biodiversity that bamboos and canes represent, and the safeguarding of adequate supplies of these resources to support the subsistence agricultural and domestic activities, especially for poorer sections of the rural community.

Human resources development is an area of concern. In Upper & Middle Kheng knowledge and skills involved in the manufacture of utensils and handicrafts and the management of both canes and bamboos in the forest are apparently not being handed down to the younger generation. Such skills may be particularly appropriate to handicapped members of the community, who cannot participate in other activities. Further weaving and dyeing skills may be available in other countries of the region, and a study tour for selected skilled Bhutanese weavers could be of value. In addition Forestry Department personnel presently lack the knowledge of bamboo and cane management necessary for production of the working plans required under new social forestry legislation. The IDRC-funded International Network for Bamboo and Rattan (INBAR) in Delhi could be instrumental in assisting in such HRD activities.

3.1 SUMMARY OF BAMBOO RECOMMENDATIONS

A total of 21 bamboos have been found in Zhemgang Dzongkhag. These provide a range of domestic and agricultural supplies and implements. Most of the bamboo harvested comes from wild stands in forest areas. Two species are of particular importance. The temperate species *Rhui* (*Borinda grossa*) is very important in Upper and Middle Kheng for roofing and fencing. The subtropical species *Yula* (*Neomicrocalamus andropogonifolius*) is very important in Lower Kheng for the supply of weaving material to the cottage industry producing *bangchung* and related items for sale outside the Dzongkhag.

Recommendations for further activities and investigations:

1. A more quantitative assessment of bamboo resources and consumption should be undertaken through standard forest inventory procedures and other resource base investigations. Indigenous information on past flowering behaviour should also be gathered for important species.
2. To increase the supply and accessibility of *Rhui* (*Borinda grossa*), trial plots and if appropriate, plantations should be raised on good sites at a range of progressively lower altitudes such as 2,000m, 1,800m and 1,600m using traditional vegetative propagation techniques.
3. The species *Himalayacalamus hookerianus* (*Padang*) should be cultivated at altitudes of 1,600m - 1,200m to provide roof panel weaving material as an alternative to *Rhui* (*Borinda grossa*). Traditional planting material is available in Chirang.
4. Existing stands and new plantations of *Yula* (*Neomicrocalamus andropogonifolius*) in government forest should be investigated to assess the possibility of transferring them to community management.
5. Continued planting of *Yula* (*Neomicrocalamus andropogonifolius*) should be encouraged, if possible in combination with species of cane that are used for finishing the bamboo products, especially *Khrat* (*Calamus acanthospathus*). Requirements of the species in terms of site and compatible supporting tree species should be investigated, to produce recommendations for its cultivation.
6. Consideration should be given to how income from *Yula* (*Neomicrocalamus andropogonifolius*) products should be maintained if supply of the species is interrupted by a gregarious flowering.
7. Plants of *Yula* (*Neomicrocalamus andropogonifolius*) should be brought from Tashigang Dzongkhag to establish a plantation of a slightly different genotype that might flower at a different time to the Zhemgang genotypes, if the Zhemgang genotypes all flowered together.
8. Use of *Yula* (*Neomicrocalamus andropogonifolius*) weaving for packaging other Bhutanese products, for example medicinal herbs, could be explored. Use of more permanent dyes or paints could also be investigated.
9. Locally cultivated bamboos should be incorporated, even if only on a small scale, into any new community or private plantations.

10. Management of areas of bamboo in government forest should be monitored to provide information on over-exploitation or diminishing supplies.

11. The economic potential of edible shoot production based upon *Dendrocalamus hamiltonii* should be investigated, with market research and appropriate socio-economic studies, as well as a quantitative appraisal of resources of this particular species and its varieties. It is very abundant along the Mangde Chhu, but provision of culms of this species for local production of utensils and handicrafts should be considered satisfactorily before exploitation of shoots began on any large scale.

3.2 SUMMARY OF CANE RECOMMENDATIONS

1. Estimation of existing stocks and present harvest of all cane species.

- incorporation of canes into routine forest inventory on a species by species basis. This could be more easily achieved with the use of the field guide *Bamboos and Canes of Bhutan*.
- further gathering of indigenous knowledge of individual cane species in terms of resource size, ecological requirements and harvesting. Indigenous knowledge could be gathered with interviews and questionnaires.

2. Encouragement of sound, traditional management of wild cane stocks to help sustainable harvest and conservation of all cane species. This may require training of the younger generation in these management methods (see Cane Recommendation 5).

3. Relieve harvesting pressure on the vulnerable, solitary-stemmed species, *C. acanthospathus*.

- discourage the harvest of immature stems of this species.
- encourage the use of alternative sources of cane (either from clustering species or from *C. acanthospathus* grown in cultivation). *C. leptospadix* is already used as an alternative to *Krath* in the Pangbang area.
- leave sufficient mature canes in all harvesting areas for production of fruit, and therefore seedlings, for regeneration and maintenance of healthy cane population levels.

4. Initiation of a program of studies into cane cultivation. Such studies could be incorporated into a postgraduate research program. Areas of study should include:

- flowering and fruiting behaviour, and ecology of all cane species in natural forest environments.
- detailed cultivation requirements, from seed germination to establishment of *C. acanthospathus*, and for offset propagation of *P. himalayana* and *C. latifolius*.
- exploration of the potential for cane cultivation in community forest and private *ex-tseri* land. *Plectocomia himalayana* is likely to be the most suitable species for preliminary planting trials at higher altitudes in Middle and Upper Kheng, and simple field trials could be initiated immediately. Field trials could be conducted in conjunction with those of *Borinda grossa* (see Bamboo Recommendation 2)

5. Initiation of training schemes for young people to learn the necessary skills for manufacture of high-quality Bhutanese cane products, to preserve this element of the

national cultural heritage. Training schemes should be accompanied by assistance in marketing of cane products. (see Cane Recommendation 2).

6. Establishment of a marketing infrastructure within Upper & Middle Kheng for cane products. This could be tied in with bamboo and cane marketing activities in Lower Kheng.

7. Preliminary investigation of the potential of larger cane species, particularly *Plectocomia himalayana*, and *Calamus latifolius*, for furniture manufacture. Considerable expertise is available in India for further information and advise on practical aspects of this manufacture.

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