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Bamboo and Cane Vulnerability and Income Generation in the Rural Household Subsistence Economy of Bjoka, Zhemgang, Bhutan

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Little qualitative and quantitative information is available on bamboo and cane ecology and management. Harvesting of these two nonwood forest products (NWFPs) takes place on a substantial scale, exacerbated by commercialization, thereby exerting pressure on supply with a significant detrimental impact on the species. This article examines the resource availability of bamboo, Neomicrocalamus andropogonifolius*, and cane,* Calamus acanthospathus*, their role in the subsistence economy, traditional knowledge, postharvest practices, and species vulnerability to commercialization at Bjoka, Zhemgang, in central Bhutan. The gross commercial growing stock of bamboo is estimated at 1924 m^3. Based on artisans' knowledge, gross commercial cane stock is an estimated 16–27 metric tons. Annual supply declined for the period 1995–2003. Bamboo and cane account for 66% of gross annual household income and are economically profitable. Specialization in the manufacture of high-quality finished bamboo and cane products helps to combat food insecurity in these rural areas with limited road and market infrastructure. Transactions with middlemen are important but lead to artisans being underpaid because the latter have limited access to markets. Bamboo and cane craft items are used for a variety of domestic, agricultural, and commercial purposes. Driven by commercialization, traditional management concentrates on harvesting without adequate regeneration, resulting in adverse impacts on species' survival. Vulnerability status with overall rankings of 22 and 32 indicates moderate and high vulnerability for bamboo and cane, respectively. Young people are less skillful in high-quality craftsmanship. Training schemes are needed to improve quality, promote sustainable harvesting, and preserve this unique cultural heritage. Further studies and policy and management are required to conserve and properly utilize these resources ecologically, while sustaining local enterprises economically.*

Keywords: *Bamboo; cane; subsistence economy; vulnerability; commercialization; Bhutan.*

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Introduction

Little qualitative and virtually no quantitative information on the ecology and management of bamboo (*Neomicrocalamus andropogonifolius* Griff Stapleton) and cane (*Calamus acanthospathus* Griff) is available. MoA (1997) describes harvesting of bamboo taking place on a substantial scale, fueled by commercialization, thereby exerting considerable pressure on supply with significant impact on the species at Bjoka. A precautionary principle needs to be exercised, with economic activity based on only one species of bamboo and cane. Phonology of the species and indigenous knowledge about domestication and management are not documented. Local artisans travel long distances to collect adequate quantities of this bamboo, which indicates diminishing supplies (MoA 1997). With increased commercialization, there is a need to domesticate bamboo (Stapleton 1994c). However, understanding its ecological requirements is a prerequisite for domestication and cultivation and in situ management to succeed.

Little is understood about the roles of bamboo and cane in the household subsistence economy and harvesting and regeneration techniques, resulting in insufficient recognition by policy-makers and managers, respectively. Owing to little accommodation in policy, scientific regulations on sustainable harvesting, regeneration, and marketing are limited (Chandrasekharan 2006). Knowledge about the roles of bamboo and cane could give a positive impulse to decision-makers to concentrate on prioritized NWFPs that not only contribute to local economies through income generation but also conserve forest ecosystems. Local craftsmen are not fully aware of their economic

potential owing to limited access to markets and pricing policy. If existing areas of bamboo and cane in the government reserve forest were managed sensibly, it could make sense to transfer ownership status within the framework of community-based natural resource management (DoF 2006). In order to provide inputs on policy and management decisions required for conservation and sustainable utilization of these two NWFPs, the present study examines resource availability, the role of these resources in the household subsistence economy, traditional knowledge, postharvest practices, and species vulnerability to commercialization.

Methods and study area

Rapid rural appraisal was conducted with households using semistructured questionnaires, including group discussions with key informants. The key informants were heads of families who make decisions. Following consultation with local village representatives, a total of 75 households engaged in bamboo and cane craft manufacture were selected from a village household list and interviewed. The interviewees were 51% male and 49% female. Questions focused on household demography, role in the subsistence economy, traditional knowledge, and postharvest practices. In order to obtain information on product prices and markets, we interviewed commercial entrepreneurs engaged in bamboo and cane crafts. To estimate resource availability, bamboo clusters from accessible natural forests were sampled by laying out 100-m^2 temporary observation plots (Rai and Chauhan 1998). On each plot, bamboo clumps and tree associates ≥ 10 cm dbh (diameter at breast height, 1.30 m above ground) were enumerated by species. On one-fourth of the observation plots, culms per clump, clump dbh (cm), height (m), and culms quality (green sound and damage; dry sound and damage and decayed) were recorded. Species vulnerability to commercialization was assessed using a rapid plant vulnerability assessment scale (Watt 1998; Wild and Mutebi 1996; Messerschmidt et al 2001).

Bjoka subdistrict lies between longitude 90°1′E and latitude 27°58′N, bordering on Ngangla in the west, Bardo to the north, and Mongar to the east, and covers a geographical area of 196 km^2 (Figure 1). Panbang and Tingtibi are the nearest commercial towns accessible on foot, requiring 12 hours and 2–3 days, respectively. Historically, Bjoka is a resettled village populated by migration of people from eastern districts of Bhutan. Total population consists of 1714 persons in 139 households spread across 27 villages. Development infrastructure includes an agricultural extension center, a basic health unit, a primary school, and 10 rural water and sanitation schemes. Land use consists of 12 ha of wetlands, 88 ha of drylands, 760 ha of shifting cultivation, 738 ha of mixed agriculture, and 454 ha of natural pastures. Forest types include broadleaf (16,960 ha), broadleaf with conifer (59 ha), scrub forest (11 ha), rocky outcrops (149 ha), water basins (312 ha), and settlement (7 ha) (MoA 2002).

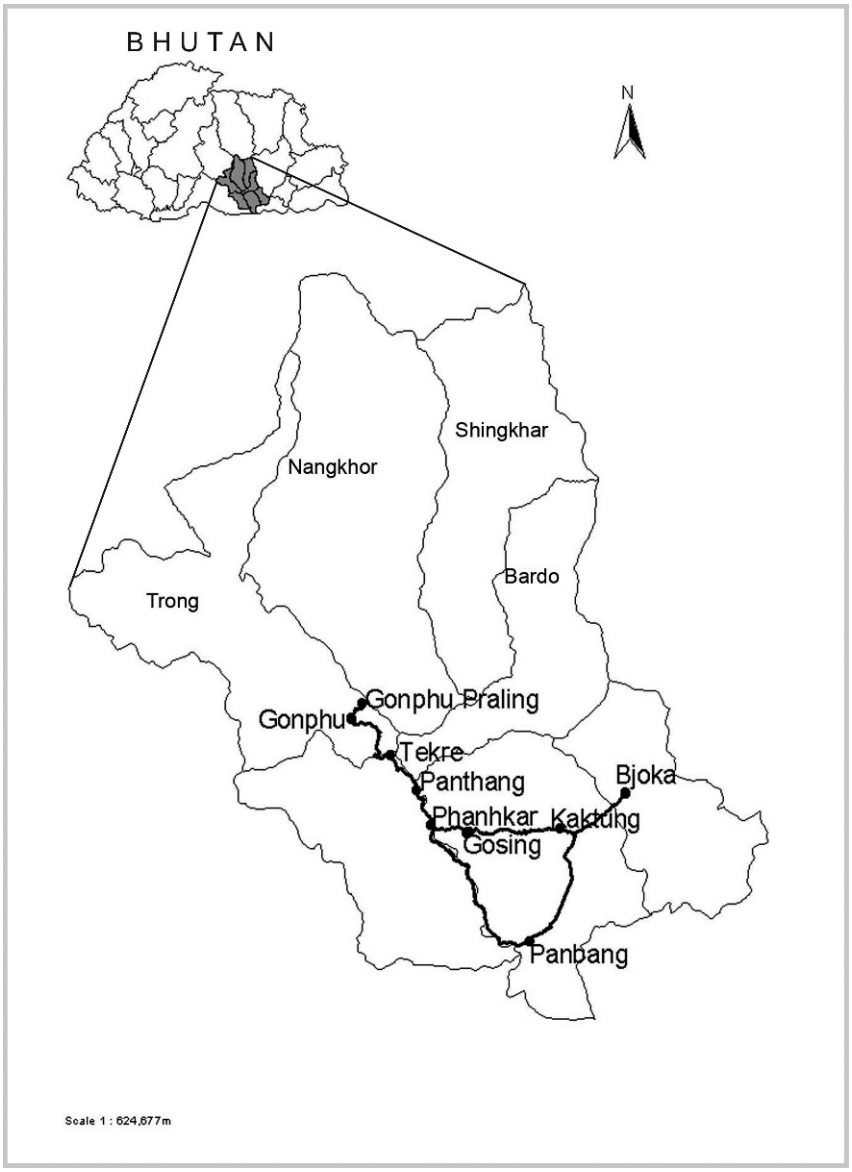
Findings and discussion

Morphology, distribution, and growing stock

N. andropogonifolius, locally named *yula,* is the commercially important bamboo of lower Kheng. Its morphological features are presented in Figure 2. Stapleton (1994c) noted this bamboo as one of the 21 species found growing in the lower, middle, and upper Kheng in Zhemgang. The rhizome grows to about 1 m, and one or more culms arise from a single clump to a height of about 12 m. Culms are smooth, shiny, and narrow, with internodes 50 cm long that look glossy and green and have typical branching from the nodes. Culm sheaths are tough and smooth, with their apex very narrow and needle-shaped, and leaf sheaths are thin, broad, and acuminate (Stapleton 1994a; Noltie 2000). The inflorescence appears similar to that of small bamboo such as *Arundinaria,* but they have 6 stamens instead of 3, indicating that they are related to *Bambusa.* The midculm buds are tall and narrow with up to 18 similar branches, or the central branch may be predominant and similar in size to the culm. The long scrambling central branches spread over small trees with sprays of small broadleaves hanging out into the light. As a climber, this bamboo requires the shade and support of trees (Stapleton 1994a). The smaller branches readjust quickly to changing light direction by the growth of small swellings around the joints.

Noltie (2000) noted this bamboo occurring in subtropical forests ranging in elevation from 300 m to 1800 m in Manas and Deothang, Gongdue, and parts of Lingmethang, Kangpara, and Thrimshing in eastern Bhutan in conjunction with *Ceplalostachyum latifolium* and *Chimonobambusa callosa.* It often grows in dense clumps but in limited localities characterized by fertile soils (sandy clayey to clayey loam texture) and high precipitation (1503 mm/y). The floristic composition of natural forest where this bamboo grows shows that *Ostodes paniculata, Eurya acuminate, Castanopsis indica, Adenia macrophylla,* and *Betula alnoides* dominate. Grierson and Long (1984) attest that these tree species are characteristic of warm broadleaf forest in Bhutan. *C. acanthospathus,* locally named *krath,* is the commercially important cane (rattan) used in conjunction with basket making from bamboo. It is a solitary stemmed cane with armed leaf sheaths and densely arranged spines (Figure 2) and a long spiny flagellum as a specialized climbing organ, which helps it to grow high into the forest canopy. Occurrence of this cane in conjunction with *Plectocomia himalayana* was reported within Bhutan and Nepal (Stapleton 1994b; Mukhia and Wangchuk 2000; DoF 2004; Amatya 1997).

FIGURE 1 Location of Bjoka subdistrict in Zhemgang district in Bhutan. The bold lines represent routes used to move from Gonphu Praling to Panbang and Bjoka in central Bhutan. (Map of Bhutan and routes drawn by Rinchen Dorji)



N. andropogonifolius collection localities and their growing stock estimates are given in Table 1. These localities require a 2-hour walk to reach from the village. Canes are found throughout Zhemgang, with lower Kheng as the richest repository. *C. acanthospathus* locations and their growing stock estimates are given in Table 2. Cane collection localities require a minimum of 3–4 hours' walk, but this distance increases every year (Dorji and Beek 2006), indicating diminishing supplies.

Contribution to household economy and supply and demand trends

Bamboo and cane products account for 66% of gross annual household incomes followed by cash crops (orange and cardamom; 29%) and livestock products (5%; Figure 3A). Most households (97%) are engaged in the manufacture of crafts (MoA 1997). Besides elders, children are also engaged but are less skillful in weaving, which is mainly off-farm work from December to May. This underscores specialization in the manufacture of

FIGURE 2 Morphological features of *N. andropogonifolius* and *C. acanthospathus*. (Sketches drawn by Chris Stapleton)

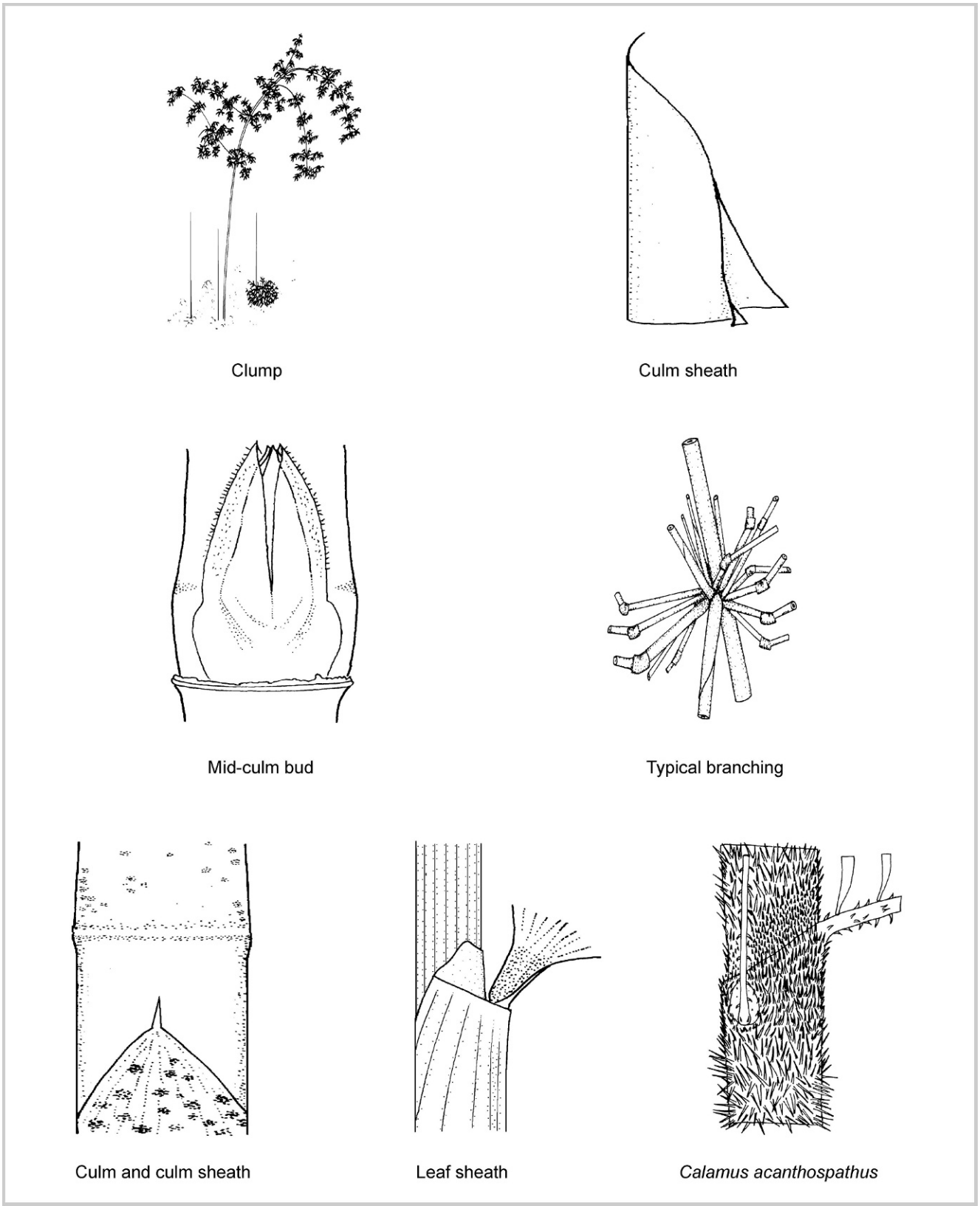


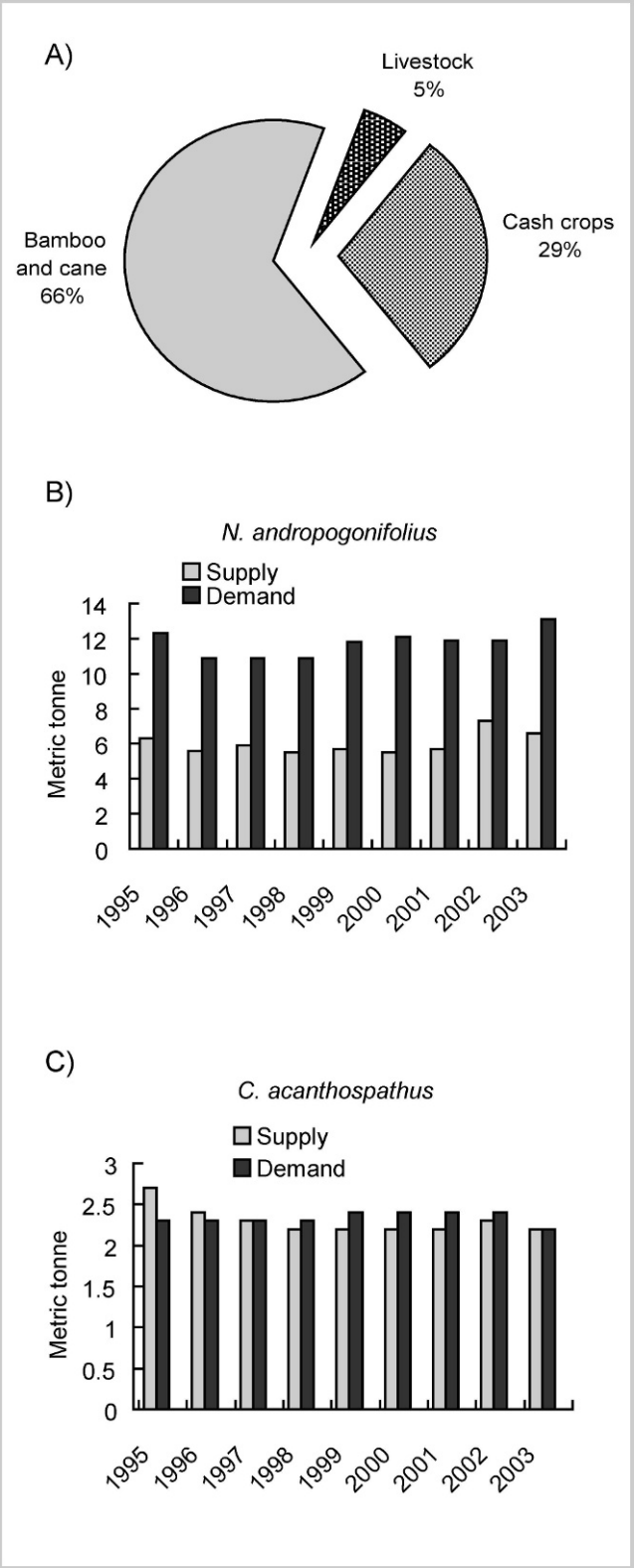
TABLE 1 Total commercial growing stock of *N. andropogonifolius*; t denotes metric tons; total commercial standing volume, based on estimate from sampling that 56% of total culms are green, sound, and commercially utilizable; m^3 denotes cubic meters, assuming that 1 t of bamboo weighs ~1.2 m^3.

Location	Area (ha)	Total culms	Commercial and noncommercial standing volume (t)	Total commercial standing volume (t)	Total commercial standing volume (m^3)
Tsalati	2.8	133,672	293	164	197
Phagpakar	1.2	57,288	125	70	84
Tshakaling	1.2	57,288	125	70	84
Wagombrag	2.0	95,480	209	117	141
Wamlathang	2.0	95,480	209	117	141
Plam	1.6	76,384	167	94	113
Lungtarpong	0.8	38,192	84	47	56
Charsingpong	1.2	57,288	125	70	84
Gongchukhan	2.8	133,672	293	164	197
Phuborong	0.8	38,192	84	47	56
Senglengbrangsa	0.6	28,644	63	35	42
Tachung	0.8	38,192	84	47	56
Phungphungla	6.0	286,440	627	351	421
Kunchungbrogsar	2.0	95,480	209	117	140
Yeamong	0.4	19,096	42	23	28
Bogmo	1.2	57,288	125	70	84
Total	**27.4**	**1,308,076**	**2864**	**1603**	**1924**

TABLE 2 Total growing stock of *C. acanthospathus,* based on informants' estimate that utilizable length of cane stem is about 30 m, excluding about 0.66 m at the base and 4 m from the top; utilizable stem cut into 3-m-long stems to obtain 10 pieces weighing 5 kg; n.a.: not available.

Location	Area (ha)	Total commercial volume maximum (t)	Total commercial volume minimum (t)
Phatari	4.0	6.98	4.09
Senglengbrangsa	0.6	1.05	0.61
Jatshaminplam	2.0	3.49	2.05
Serthang	n.a.	n.a.	n.a.
GowalapoThorcho	7.0	12.21	7.17
Kila	1.8	3.14	1.84
Khagparang	n.a.	n.a.	n.a.
Tala	n.a.	n.a.	n.a.
Total	**15.4**	**26.87**	**15.76**

FIGURE 3 (A) Contribution to household subsistence economy by *N. andropogonifolius* and *C. acanthospathus*; (B, C) supply and demand trends for *N. andropogonifolius* and *C. acanthospathus*.



crafts as a strategy to combat food insecurity exacerbated by limited road and market infrastructure. Cash incomes earned are invested in purchasing food items from the Food Corporation of Bhutan and groceries at Panbang or Gonphu Praling. Mitigation strategies include bartering with livestock products and farm labor (MoA 2002).

Taking into account the production cost of regularly woven *nyekayama* and *tangkama bangchu* (small baskets woven out of bamboo and cane strips used for a range of food and beverage containers), household net benefits were calculated on a monthly and seasonal basis. Actual costs incurred are purchase of kerosene for weaving at night, consuming about 5 L a month, costing Nu 70 (US$ 1 = Ngultrum 44.25 in 2005); dyes (red, yellow, and green) costing Nu 390 in order to produce 20 pairs of *nyekayama* (13 pairs) and *tangkama* (7 pairs); and Nu 2 per pair paid as a levy to the government when products are marketed outside the district. The cost of 20 baskets amounts to Nu 500, excluding opportunity costs for collection. As most households sell their products to middlemen on doorsteps, transport costs are excluded.

Total benefits amount to Nu 1330, with a net benefit of Nu 830 per household per month. Considering 6 working months, total net benefits amount to Nu 4980 per household. Besides these products, numerous other crafts are manufactured on a demand basis. This simple cost–benefit analysis reveals profitability. The annual bamboo supply averaged 6 metric tons against a demand of 12 metric tons, indicating pressure on supply leading to overharvesting, whereas cane supply equals demand (Figure 3B, C). The increase in women and children collectors who lack appropriate harvesting knowledge, the decrease in rainfall, and the pressure from commercialization contribute to this decline (MoA 1997).

Species vulnerability and the impact of commercialization

Species vulnerability is a measure of the increased risk of extinction as a result of unsustainable harvesting or other perturbation(s). Sustainability of a species is maintained if the impact of anything that affects its natural condition is low or minimal and if the species is not threatened with extinction. Thus, low species vulnerability indicates that a species is probably sustainable if existing conditions remain in a relatively steady state. For example, if bamboo and cane are seen as not very vulnerable to extinction, then they can be harvested continuously (ie provided that the harvest rate is adjusted to result in negligible impacts on the structure and dynamics of the plant populations being exploited or on the surrounding ecosystem; Peters 1994).

Rapid vulnerability of *N. andropogonifolius* and *C. acanthospathus* could result from current conditions, trends, and commercial harvesting practices. Do these factors conform to the sustainability of the species or characterize a resource being pressurized to extinction?

TABLE 3 Rapid Vulnerability Assessment checklist for *N. andropogonifolius*. For each category, species vulnerability was rated by marking a ✓ in the appropriate column; the number of ✓ was summed up per column and multiplied by the relevant factor to obtain the overall score.

Column:	A	B	C	D
Category	**Nil: 0**	**Low: ×1**	**Moderate: ×2**	**High: ×3**
Natural conditions and effects on life of species **Life form and provenance**				
(1) Reproduction and longevity			✓	
(2) Habitat			✓	
(3) Growth rate		✓		
(4) Abundance and distribution		✓		
Use and demand				
(5) Part used		✓		
(6) Demand			✓	
(7) Substitutes			✓	
Social, cultural, and economic effects on a species **Basis of management**				
(8) Traditional management			✓	
(9) Scientific management				✓
Commercial effects and other outside influences on a species **Harvesting and commercial use**				
(10) Seasonality			✓	
(11) Commercialization			✓	
(12) Roads	✓			
(13) Grazing			✓	
(14) Other potential threats	✓			
Column totals	0	3	16	3
Grand total (sum of A, B, C, D)				**22**
<13: *low vulnerability;* 14 to 26: *moderate vulnerability*; >27: *high vulnerability*	Overall assessment of bamboo vulnerability in Bjoka, Zhemgang: ***Moderate***			

In order to collect information, key informants were interviewed and evaluated according to the sustainability criteria and indicators (Watt 1998; Wild and Mutebi 1996) from serial numbers 1–14. The checklist is based on a set of categories within which specific threats are discussed and scored (ranked). A score of 0 implies nil, 0–13 implies low vulnerability and is no cause for alarm; 14–26 indicates moderate vulnerability and that remedial actions to reverse the trend may be necessary; and 27–39 reveals high vulnerability and a high probability of extinction unless immediate actions are taken to halt or reverse the trend. To begin with, in the vulnerability ranking process we defined and discussed 14 categories of potential threats. Note that there is a partial overlap between some categories. Using this ranking system, the vulnerability of *N. andropogonifolius* was assessed at an overall rank of 22, or moderate (Table 3), and that of *C. acanthospathus* was assessed at 32, or high (Table 4). Messerschmidt et al (2001) noted a similar vulnerability status for bamboo in the high forest of eastern Bhutan.

TABLE 4 Rapid Vulnerability Assessment checklist for *C. acanthospathus*. For each category, species vulnerability was rated by marking a ✓ in the appropriate column; the number of ✓ was summed up per column and multiplied by the relevant factor to obtain the overall score.

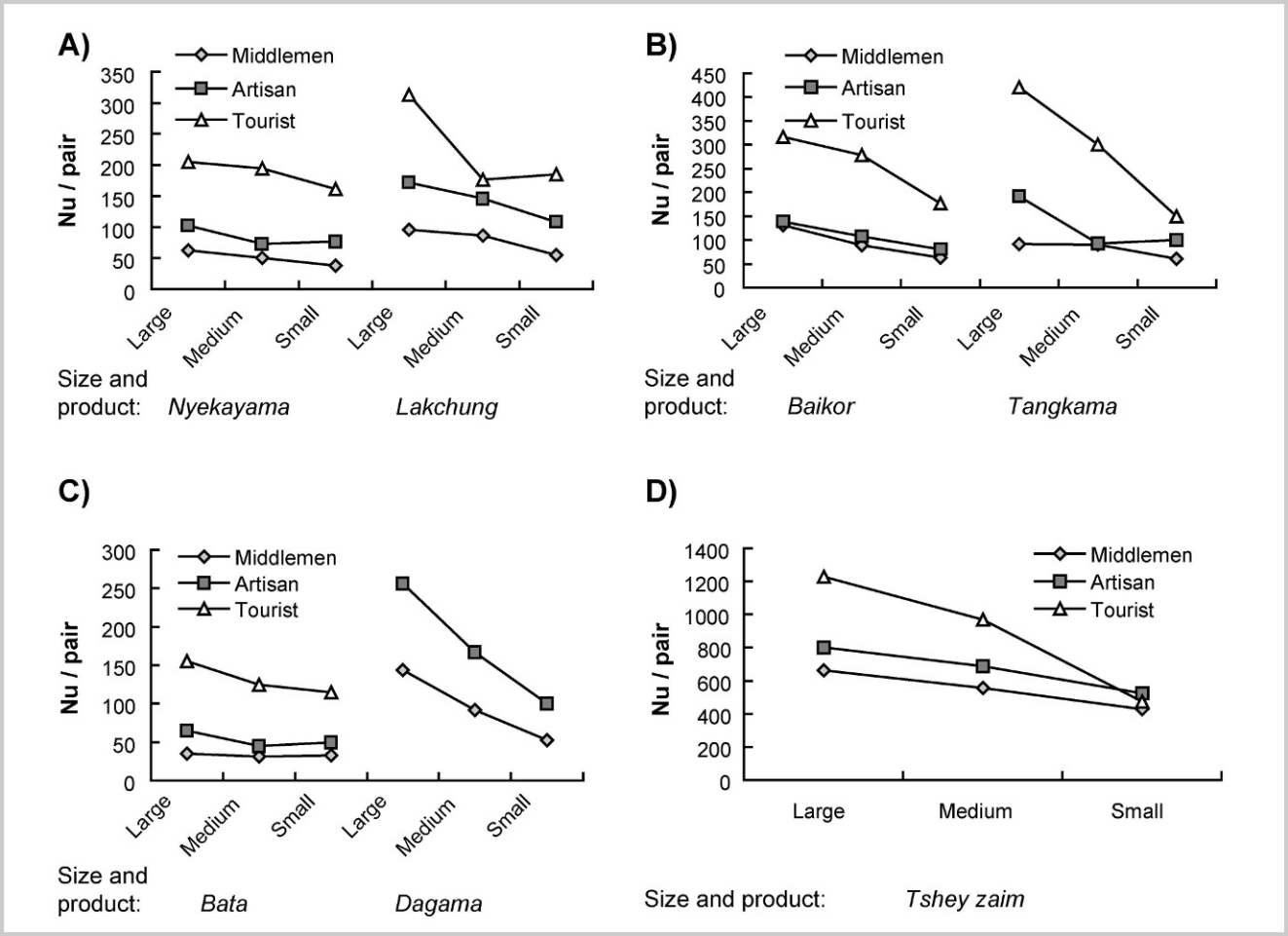
Column:	A	B	C	D
Category	**Nil: 0**	**Low: ×1**	**Moderate: ×2**	**High: ×3**
Natural conditions and effects on life of species **Life form and provenance**				
(1) Reproduction and longevity				✓
(2) Habitat			✓	
(3) Growth rate			✓	
(4) Abundance and distribution				✓
Use and demand				
(5) Part used				✓
(6) Demand				✓
(7) Substitutes			✓	
Social, cultural, and economic effects on a species **Basis of management**				
(8) Traditional management				✓
(9) Scientific management				✓
Commercial effects and other outside influences on a species **Harvesting and commercial use**				
(10) Seasonality				✓
(11) Commercialization				✓
(12) Roads	✓			
(13) Grazing			✓	
(14) Other potential threats	✓			
Column totals	0	0	8	24
Grand total (sum of A, B, C, D)				**32**
<13: *low vulnerability;* 14 to 26: *moderate vulnerability;* >27: *high vulnerability*	Overall assessment of cane vulnerability in Bjoka, Zhemgang: ***High***			

Indigenous knowledge

Life without bamboo and cane is unthinkable for the poorer households of Bjoka. Most people live in simple houses built of bamboo splits and cane leaves (MoA 1997). They use this bamboo more than any other bamboo for weaving distinctive and attractive patterned traditional items for household and commercial use. MoA (1997) points out a clear separation between the uses of bamboo for rural domestic, agricultural needs and production of marketable items. Cane is used for a variety of purposes ranging from tying to stitching in conjunction with bamboo strips. Because *C. acanthospathus* yields high-quality flexible strips, it is most sought after in tying bridges, basket frames, and even walking sticks (Pradhan et al 1996). Young succulent cane shoots are a delicacy in Bhutanese cuisine.

Artisans restrict collection of this bamboo during June, July, August, and September to allow regeneration. Plenty of rainfall is a prerequisite for regeneration, which ensures continual supplies in the following year and vice versa. When offshoots fail to stem, they defer collection

FIGURE 4 Price (Nu per pair) of large-, medium- and small-size *nyekayama, lakchung, baikor, tangkama, bata, dagama,* and *tshey zaim* (cane products). "Middlemen," price received at household doorstep from middlemen; "artisan," price received by artisans after having transported their products by themselves to commercial outlets (eg to Thimphu); "tourist," price paid by visiting foreign tourists in Thimphu. (Nu: Bhutanese ngultrum; exchange rate in 2005: US$ 1 = Nu 44.25)



for 1–2 years and then resume. Harvesting is governed by traditional rules and norms. An elected head of the subdistrict and representatives of a village or a cluster of villages draw up informal bylaws, either in the presence or the absence of local foresters. These regulate community collection on an equitable basis. During the restricted period, if an individual breaches the rules, fines are imposed at the rate of Nu 100 per person, and if substantial amounts are levied, they are donated to monasteries for performing rituals for community well-being. The community appoints a village forest guard, particularly during the restricted period.

Harvesting is limited to 2–3-year-old quality culms by cutting above the second or third internodes to stimulate regeneration and prevent dying of the clump after flowering. Planting of wildlings is done during June underneath broadleaf trees and shrubs and requires protection from fire and browsing by cattle. In response to diminishing supplies, farmers have domesticated this bamboo on their shifting cultivation land, where broadleaf trees provide ample shade and support. The composition and structure of this forest can be described as multispecies and multistoried, emulating a "near natural forest" embedding ecological and economic stability. Similar to bamboo, cane habitats are characterized by dense undisturbed forest. Cane regeneration is slow, and its solitary habit (each plant comprises only one stem and harvesting necessarily kills the whole plants) increases vulnerability (MoA 1997).

Basket making starts with harvesting 2–3-year-old bamboo culms, whose nonworkable top and bottom portions are cut off, retaining 12–15-foot-long culms.

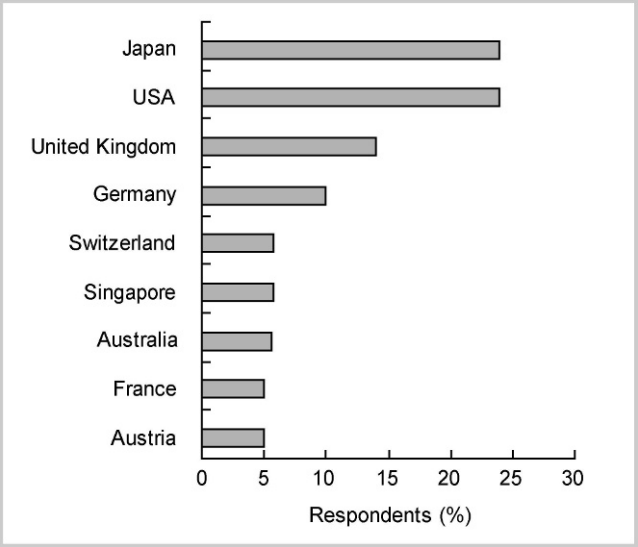
These utilizable culms are cut into internode length sections, bundled, and carried to homes, where they are split into strips while the sections are green. These strips are then boiled in turmeric solution for about 12 hours until they appear yellow. These yellow strips are then soaked in commercial dyes of different colors (red, green, and yellow) and dried under shade for between 3 and 12 hours to allow complete drying and coloring to take effect. Local dyes are becoming scarce due to the unavailability of resources. These colored strips are then woven as external basket covers, while the internal strips are the noncolored ones. Finally, small thread-like colored cane strips are used to tie basket frames in the manufacture of a beautifully crafted basket.

Markets and pricing

Bamboo and cane products are almost entirely marketed by middlemen. Occasionally, artisans transport their products to far-flung markets (eg Thimphu), but few travel far from their villages. Middlemen are important in craft transactions, but their untimely appearance does not allow artisans to sell their products, especially during food-insecure months. The prices paid by middlemen, artisans, and tourists according to basket types and sizes are shown in Figure 4. Considering the middleman's price as a baseline price, outside district prices are substantially higher. For instance, tourist prices are double the artisan price even if transportation costs are taken into account. By selling products at doorsteps, artisans forgo substantial profit. Tourist prices could increase potentially if simple value-adding tasks such as product labeling are performed in addition to improving quality.

It appears that artisans are grossly underpaid for the amount of work and skill involved. A market survey revealed that 24% of bamboo and cane products were exported by Japanese tourists, another 24% by American tourists, 14% by tourists originating from the United Kingdom, 10% by tourists from Germany, 6% each from tourists from Switzerland, Australia, and Singapore, and 5% each by tourists from Austria and France (Figure 5). These products are exported as souvenirs for relatives and friends and for cultural exhibits. Tourists prefer smaller products that are exemplary in cultural terms and beautifully crafted.

FIGURE 5 Percentage of bamboo and cane products purchased by foreign tourists according to country of origin.



Conclusion and recommendations

In view of diminishing resource supplies, further studies and policy and management decisions are needed to conserve these resources ecologically and utilize them economically. Plantation trials of *N. andropogonifolius,* possibly in combination with *C. acanthospathus,* should be initiated in areas characterized by highly fertile soils and high precipitation to improve accessibility and supply. These long-term studies should include flowering and fruiting, climate, soils, and silvicultural requirements and should also incorporate genotypes from their ecological ranges to safeguard their genetic base.

The current harvesting practices from the natural forest require regulation without compromising the regenerative capacity of these resources while maintaining forest ecosystem integrity within the framework of community-based natural resource management. Notwithstanding, domestication and cultivation under the private and community forestry programs as poverty reduction strategies and the use of substitutes like *C. leptospadix* in order to reduce the harvesting pressure on this solitary stemmed cane should also be encouraged. High-quality finished-product-making requires special skills acquired after much practice. In order to preserve this unique cultural heritage, training schemes in the manufacture of high-quality finished products, sustainable harvesting techniques, value chain analysis, and promotion of entrepreneurship are needed.

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