TOWARDS A SUSTAINABLE DEVELOPMENT OF THE BAMBOO INDUSTRY IN GHANA

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ABSTRACT

The potential role of bamboo is underscored in Ghana. This paper aims at highlighting the potential for sustainable use of bamboo in national development in Ghana. Information on sources, potential and perceived uses of bamboo as well as constraints in the bamboo sector were obtained through structured questionnaire and semi-structured interviews from locations spreading across all major ecological zones of Ghana. Results indicate availability of bamboo on community lands, farmlands, fallow fields and forest reserves and that its economic use is more pronounced in the Southern part of the country. Key challenges facing the bamboo industry that need consideration for its effective development revolve around the need for improved fast growing quality bamboo resources and development of effective sustainable management and harvesting techniques in natural stands. Efficient processing and preservation techniques are also major areas of concern as well as product development and promotion. To improve the bamboo sector and ensure its competitiveness as an alternative source of wood and a sustainable enterprise, a comprehensive policy is required to put in place relevant interventions. Key interventions must include regulations for extraction of bamboo and support for relevant research institutions to improve resource quality and quantity as well as product quality. The capacity of large and small scale entrepreneurs must be enhanced for improved value addition and marketing of products.

Keywords: Bamboo sector development, bamboo production-to-consumption systems, non-timber forest products

INTRODUCTION

Bamboo has an enormous potential for alleviating many of the social and environmental problems of the developing world today (Quintans, 1998). The global market potential for bamboo is estimated at more than $2 billion annually (ENS, **2004**). It is a versatile, fast growing and renewable resource with over thousand non-timber and timber uses. Bamboo has been used for a variety of purposes including environmental restoration and in the production of handicrafts, artefacts and furniture. Bamboo-ply, laminated boards, flooring, roofing sheets, props and many others, have been key wood substitutes of bamboo in the construction industry world-wide. Other vital products such as medicines, food, charcoal, vinegar, beverages, natural pesticides, and toiletries, among many others have been produced from bamboo (Hammond, 2006). Indeed bamboo resources if properly harnessed in West Africa and Ghana can provide alternative viable livelihood enterprises for large, medium and small scale entrepreneurs including the rural poor.

In Ghana, bamboo and rattan resources constitute the two largest non-timber forest products. Ghana's forest resources continue to deplete at an alarming rate (GNA, 2005). The rate of deforestation in the country is estimated at 3% per annum (Appiah *et al.*, 2007). Although the government of Ghana recognizes the potential of bamboo to supplement economic timber species to fill an annual wood demand deficit of about 3 million cubic meters, this potential has rarely been tapped and the resource is largely underutilized. Its commercial importance and industrial application are unpopular although there are a number of general uses particularly at the rural level, and commercial processing has recently begun. Furthermore, the bamboo sector lacks substantive basic information on the problems and opportunities to enable implementation of appropriate interventions for efficient utilization of the resource to enhance the sector. A study analysed the bamboo economy of Ghana mainly to understand its production-to-consumption system (PCS) and identify constraints and opportunities for its enhancement (Obiri *et al.*, 2006). This paper highlights the challenges facing the bamboo industry in Ghana identified during the PCS study and suggests measures that need to be addressed for its sustainable development.

METHODS

Conceptual Framework

The conceptual framework used for the study was the Production-to-Consumption Systems (PCS) approach which essentially entails a description and analysis of the entire chain of activities from production of raw material through various stages of intermediate sales and processing, to the consumer of the final product. The "systems" include the technologies used to process the material as well as the social, political and economic environment in which these processes operate. Essentially, an analysis of the PCS enables identification of all the constraints limiting bamboo management and use, and highlights opportunities that, if taken, would promote bamboo-based development. Development and research programs can then be planned which utilize and develop the opportunities whilst circumventing, or even eliminating, the constraints (Belcher, 1995).

Study Sites

The bamboo PCS study covered six major ecological zones of the country (wet and moist evergreen, deciduous, transitional and the guinea and coastal savannah zones) spreading over nine administrative regions namely, Northern, Upper East, Upper West, Ashanti, Brong Ahafo, Greater Accra, Eastern, Central and Western Regions (Figure 1). This was to enable a comprehensive knowledge on the availability, distribution, species types and utilization of bamboo in the various ecological zones to be generated.

Biophysical Features of Study Sites

Mean annual temperatures range from 26.1° C in places near the coast (south) to 28.9° C in the extreme north. Rainfall distribution is bimodal in the coastal savannah, transition, deciduous, moist and wet evergreen forest zones. The mean annual rainfall ranges from 800 mm in the coastal zone to 2,200 mm in the wet evergreen forest zone. In the northern guinea savannah zone, the rainfall distribution pattern is unimodal. Mean annual rainfall in this zone ranges from 700 - 1200 mm. Bamboo resources are more predominant in the forest zones with larger concentrations in the wet and moist evergreen zones.

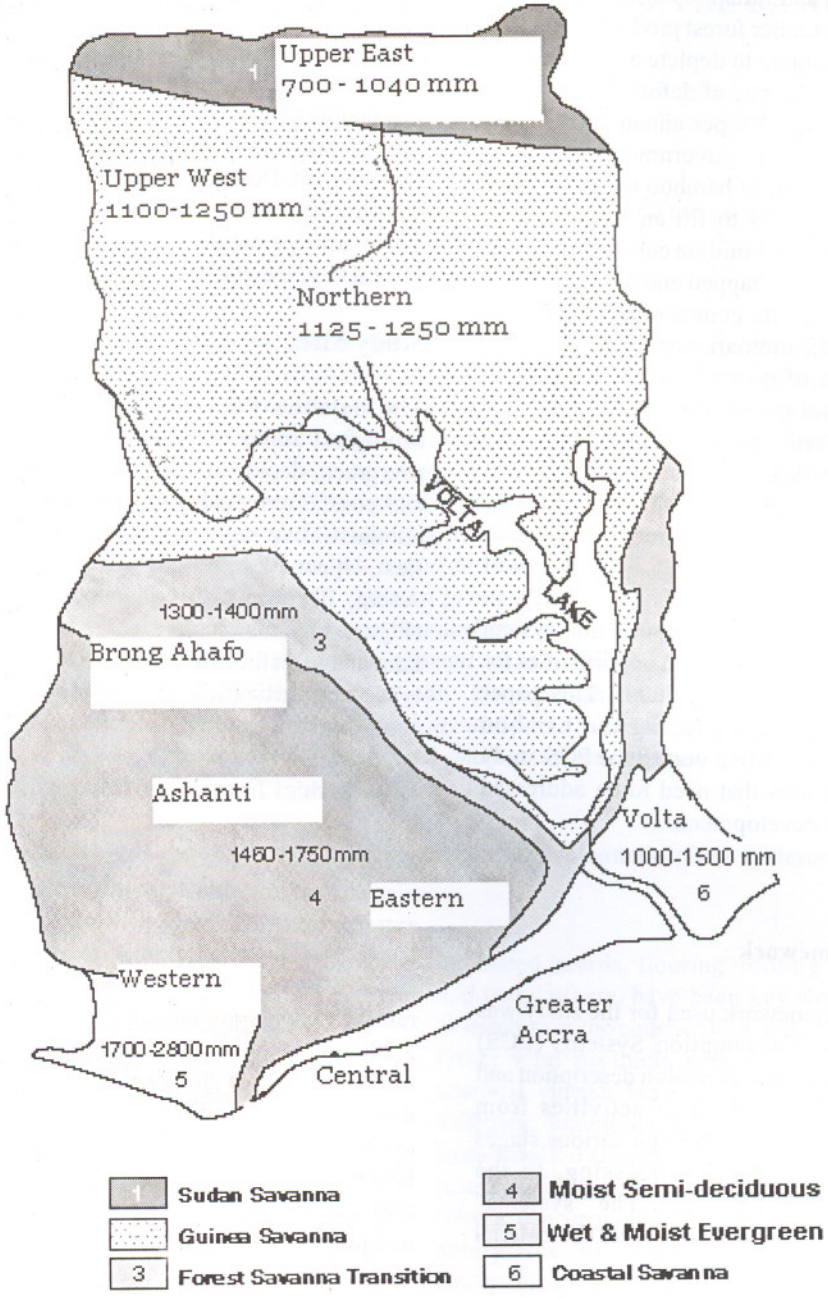

Figure 1: Ecological map of Ghana showing study regions

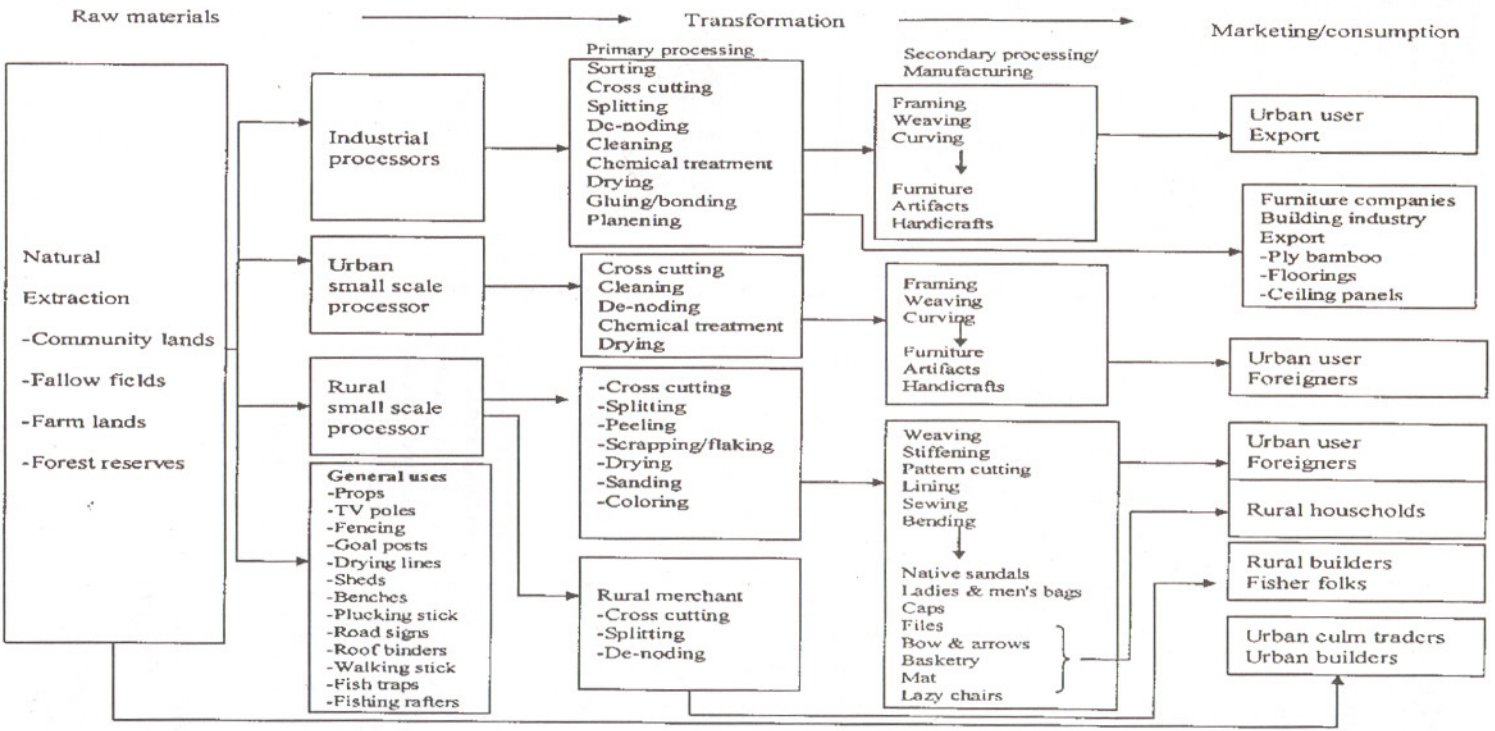

Figure 2: The bamboo production-to-consumption system of Ghana. (Source: Survey data, 2004)

Data Collection and Analysis

Structured questionnaire and informal interviews were employed in gathering data from resource owners, collectors (harvesters), processors and traders in the bamboo sector. Literature search also generated information on various institutions in bamboo sector research and development in the country. A total of 160 respondents were interviewed across the ecological zones. Respondents were non-purposively selected. Data collected covered respondent characteristics, resource availability, ownership, access, establishment, harvesting, management and species types, processing techniques, products, uses and marketing of products. Problems/constraints in the sector and possible solutions as well as costs and revenues in harvesting, processing and marketing were also gathered. The data collected was analysed with Microsoft excel by descriptive statistics.

RESULTS AND DISCUSSION

The Bamboo Production to Consumption System of Ghana

In Ghana bamboo is extracted from natural sources mainly from community lands, farmlands and from forest reserves. The raw or unprocessed culms are either sold as props for construction or used directly by rural households, or may be processed by few large and numerous small scale processors into a variety of products mainly for sale on rural and urban markets and for household consumption (Figure 2).

The People and the Resource
Characteristics of Respondents

Five main categories of actors were identified in the PCS of the bamboo sector in Ghana. These are resource owners, collectors/harvesters, processors, traders as well as formal institutions in research and development. Bamboo processors form the majority of the primary respondents interviewed (Figure 3). Generally, males dominate the sector, comprising 94% of respondents interviewed. The females are mainly involved in selling unprocessed bamboo culms in southern Ghana.

In Northern Ghana, the resource is found in limited locations and in small clumps of 1-4 clusters owned by individuals on farmlands and homesteads. In southern Ghana the resource is relatively in abundance, found on community lands, farm fallow fields belonging to individuals and/or families and in forest reserves. A higher proportion (65%) of the collectors harvest bamboo from community lands (Figure 4).

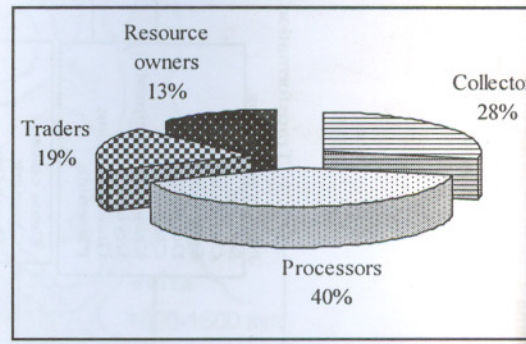

Figure 3: Primary respondents interviewed

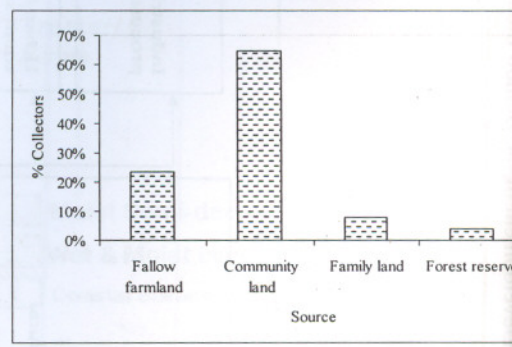

Figure 4: Bamboo collection sources in South Ghana

Access to Bamboo for Harvesting

Access to the bamboo resource for household and commercial purposes by non-owners in most cases attracts a fee ranging from GH¢5 to GH¢10 or more on community and private lands for 100 pieces of culms in the south. In the forest reserve a permit is issued for GH¢10 for a months' collection during which about 100 to 150 head loads of culms are harvested. In the north GH¢ 0.10 – 0.50 may be paid per culm.

Management, Techniques and Frequency of Harvesting

Bamboo regenerates naturally in all areas surveyed in both northern and southern Ghana and the resource is largely unmanaged. No regular harvesting techniques are applied in harvesting culms. Desirable matured culms are identified by colour (yellowish brown) or thickness of the culm and indiscriminately harvested (especially in the south) usually with a cutlass or machete.

In the Guinea and Sudan Savanna zones in the north of the country, harvesting of the culms is often done in the dry season for off-season processing and also to enhance regeneration during the wet season. In the South of the country however, commercial harvesting is done all year round predominantly from the deciduous, moist and wet evergreen forest zones covering Ashanti, Eastern and Western Regions. This is because the resource is readily available and the demand for culms is higher in this zone. 80% of the collectors interviewed supply clients throughout the year. Although the evergreen forests in the Western Region have the largest stocks of bamboo in the country, 60% of the commercial collectors interviewed in the south obtained their stocks from the Eastern Region in the deciduous forest zone (Figure 5). These supply the culms to processors and unprocessed culm traders in Accra where the culm is in greatest demand.

Bamboo Species Harvested

Two main species of bamboo were identified in natural stands. *Oxynanteria abbyssinica*, the indigenous species, is found in the north with smaller culm sizes. *Bambusa vulgaris* is the predominant bamboo species in southern Ghana, constituting 95% of the stocks in this area (Oteng-Amoako *et al*, 2005). Both the green and yellow (*Bambusa vulgaris "vitata"*) types are available, however, the green type is naturally widely distributed in the wild, hence the one predominantly collected for both domestic and commercial uses. Thirteen other exotic species were found in botanical gardens, arboretum and experimental orchards (Table 1).

Processing and Manufacturing

Large and small-scale entrepreneurs are involved in processing and manufacturing of products from bamboo (Table 2). The large-scale producers are few and are based in the south using industrial machinery in production. The small-scale are based in both rural and urban areas and employ a variety of tools in manual production. The urban small – scale form the majority with 70% based in Accra.

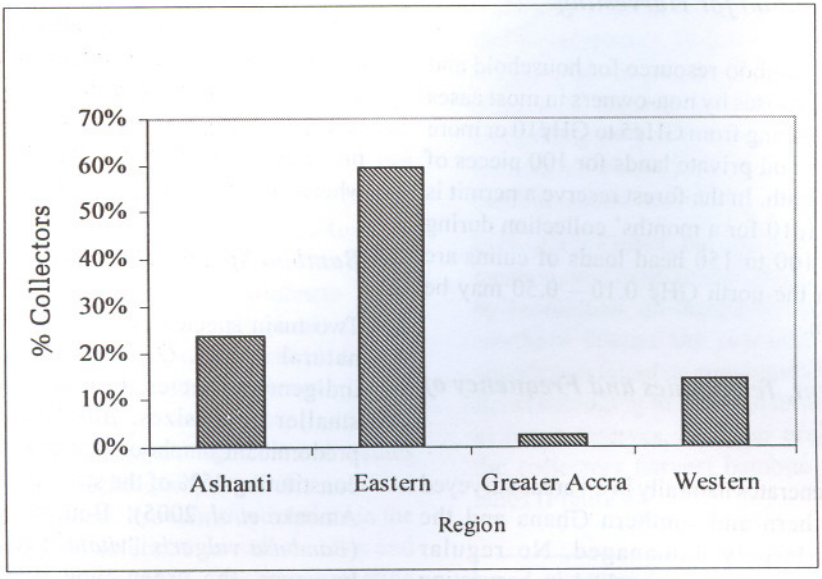

Figure 5: Commercial bamboo collection regions in Southern Ghana

Table 1: Bamboo Species in Ghana

Species	Location	Culm Diameter Range (cm)	Extent of Utilization
Oxynanteria abbyssinica	Northern savannas	0.9-2.6	80% household 20% commercial
Bambusa vulgaris	Transition and forest zones	5-10	85% commercia 115% household
Gigantochloa albociliata, Ddendrocalamus asper, Dendrocalamus strictus, Dendrocalamus membrenaceous, Dendrocalamus brandisii, Dendrocalamus latiflorus, Bambusa edulis, Bambusa burmanica, Bambusa nutans, Bambusa textiles, Bambusa multiplex, Bambusa ventricosa, Bambusa oldhamii, Guadua angustifolia, Guadua chacoensis, Thyrsostachis siamensis	Botanical gardens Arboretum Experimental orchards/gene bank	Not determined	.Ornamental Germplasm

Table 2: Processor types, techniques and products

Processor category	% Respondent	Major tools and processing techniques	Products
Large scale	6	Industrial machines	Ply bamboo, ceiling panels, floorings, window blinds, doors, furniture, etc. and artifacts including carvings.
		Sorting and culling of defective culms, Cross cutting, splitting, de-noding cleaning, curing/treatment in hot water & insecticide/other chemical mixture and drying; planning, gluing, pressing at 90-100°C and pressure of 200kgcm^3 and final planning.	
Urban small scale	80	Cutlass/machete, knife, hacksaw, tape measure, driller, clamp, chisel, hammer, precision cutter, pincers, jack planer, splitting jig, iron rod, sand paper, sanding machine, planer, pencils, markers, brush, gas cylinder and gas blower/touch.	Household and office furniture. Mainly living room and dining sets, beds, shelves, chairs, tables.
			Limited production of jewellery, curtain blinds, desk accessories and artifacts.
		Cross cutting, cleaning, de-noding, curing with kerosene, DDT, Gammalin 20, diesel mixes, sun drying, framing, joining, sanding and vanishing	
Rural small scale	10	Cutlass for cross cutting, de-noding.	Roofing material and fishing rafters.
		Crosscut culm into pieces at nodes, split, peel and scrap into thin flakes for sun drying. Sand, colour, weave and stiffen dried flakes. Cut pattern, line with cloth material and sew into product.	Native sandals, ladies and men's bags, caps and files.
Northern small scale	4	Knife & fire	Bow and arrows, livestock pens, baskets, mats, walking sticks and lazy chairs.
		Cleaning, splitting, bending, weaving and binding depending on product.	

Techniques in large scale processing

Typical large scale processing involves sorting the raw bamboo culms on delivery by gatherers to cull out defected ones and cross-cutting the culms into desired lengths for splitting, de-nodding and cleaning. The split culms are treated by boiling in water and insecticide/other chemical mixture and dried by solar kiln dryer or air/sun drying. The treated culms are then smooth-planed and a number of pieces glued together and pressed at a temperature range from 90-100°C and pressure of 200 kgcm^3. The output goes through final planing to yield the pre-finished product, e.g. bamboo ply that is either sold to domestic furniture companies or further processed into finished products.

Techniques in Small Scale Processing

In urban small scale processing, the raw bamboo culms are cleaned, denoded, cured/treated with insecticide (e.g. Desban, Gammalin 20-DDT) and kerosene/diesel and sun-dried. The desired product is manufactured, sanded and vanish applied for finishing. Processing of the culm into products is quite rudimentary in the north. The knife is the

major processing tool used sometimes with fire to facilitate bending. Processing then entails, cleaning/ scrapping, cutting, splitting, and weaving/bending of the culms into desirable products (Table 2).

The rural processors surveyed usually do only primary processing by splitting sun dried culms with a cutlass after cross cutting, de-noding and later sell them for rural construction, particularly for roofing. A group of handicraft producers were also encountered manufacturing products such as native sandals, ladies and men's bags, caps, files, etc. This group crosscut the culm into pieces at the nodes. Each piece is split into 8 pieces, peeled and scrapped into long thin flakes/stripes. The flakes are sun dried, sanded and coloured (optional). The dried flakes are woven and stiffened. A desired pattern is cut depending on the intended product, lined with a cloth material and sewn or manufactured into the product. Tools used in this process include cutlass/ machete, knife, hacksaw, tape measure, drilling machine, clamp, chisel, pair of scissors and a sewing machine.

Marketing and Consumption

Over 90% of bamboo vendors deal in unprocessed bamboo culms sold mainly for scaffolding in building construction mostly in urban areas. Most of the manufactured products are marketed or sold by the processors directly to local clients, and sometimes tourists, although wholesale contracts by few product dealers in Accra are also honoured.

General Uses of Bamboo

Aside the manufactured products listed above, a number of general uses are found across the country (Table 3). In the north, long bamboo poles are valuable assets for women during the off-season for harvesting fruits e.g. *Parkia biglobosa* (Dawadawa) and for pulling down branches from tall trees for firewood and so on. Households boil bamboo leaves with or without other additives for curing common diseases such as fever, jaundice, bilharzias and diarrhoea. The leaves are believed to have antibiotic properties, e.g. cleansing mouldy spots on infected chicken eggs.

All around the country bamboo poles are generally used to suspend television aerials to enhance reception. Likewise whole or split poles are used in fencing. Bamboo culms also find use in both urban and rural construction. In urban areas of the south bamboo culms are used for scaffolding. In rural settings around the country it is used particularly as frames for mud houses, props, rafters, roof material and for binding thatch in roofing houses, construction of livestock pens and so on.

In the north it is also used in binding thatch in the manufacture of covers to cap food barns. Bamboo culms are also generally used in making benches, sheds, drying lines and goal posts in rural areas of the south. The yellow type of *B. vulgaris* and *B. multiplex,* among others, are usually planted as ornamentals in homes, hotels, offices and other public places particularly in the south.

Challenges in the Ghana Bamboo Sector

The study identified three major challenges facing the bamboo sector in Ghana. These are an unsustainable bamboo resource base, inefficient processing and low quality products sold on a poorly developed market.

Table 3: General observation on uses of bamboo

General use	Location
Plucking poles and walking stickLeaves as medicines for fever, diarrhoea and fungal infections	North
Television aerial suspension and fencing	North and south
Rural house construction (frames, props, thatch binding, roofing)Fishing rafters and fish traps Livestock pens, feeding and water troughs	Rural north and south
Drying lines, goal posts, benches and sheds	Rural south
Props for scaffolding Ornamental	Urban south South

The Resource Base

Generally there is insufficient knowledge on the extent of the resource available to support the industry, although it is speculated that there are some considerable bamboo resources (about 5% of the forest vegetation over an area of about 300,000 ha) in Ghana, especially in the Western region. Also, the material available to the industry is normally of variable quality. This is because of the lack of knowledge on the management of natural stands coupled with the fact that versatility of bamboo as a green gold is largely unknown as a low socio-economic value is usually ascribed to the resource. Consequently, the resource is rarely managed, leading to poor clump formation. Culms are densely packed in clumps or clusters, making harvesting difficult and dangerous (injuries, itching and sometimes death reported by harvesters), as matured culms are located in the middle portions of clumps. Thus harvesting is often unsustainable and unsuitable for the intended use. The culms also grow poorly often bending at the apex sometimes with crookedness resulting in wastage of culm as only the first 14 feet of the culm from the base is ideal for processing.

Lack of proper regulation or rules on exploitation of bamboo in the country is also a major threat to the resource base. With the exception of a permit granted (without supervision) from the Forestry Services Division (FSD) for exploitation in forest reserves, bamboo exploitation may be controlled on community lands through local/traditional regulations. However access is granted at a fee without strict control. Exploitation in the north is regulated by socio-cultural believes/taboos. For instance it is believed that thunder will strike a harvester in the wet season. Also harvesting by a drunken person kills the clump and the resource is perceived as ancestral relics requiring permission and payment in kind e.g. chicken to pay homage before harvesting.

Lack of formal rules in the south has resulted in wasteful harvesting and utilization of bamboo. Often the resource is indiscriminately harvested and handled (e.g. burning of clumps to make way for

agriculture, clear cutting and cutting at any convenient point destroying/hampering clump regeneration). This, together with the rising demand for bamboo props for urban construction all year round in the south, is an indication of the resource getting endangered in a short time. In the north respondents reported that bamboo resources have dwindled considerably. Generally the resource usually growing on compound farms has been handed down by generations of fore fathers and is culturally believed to have spiritual links with ancestors, barring its planting.

Processing/Manufacturing

Generally, processing enterprises are supplied with poor quality bamboo for product manufacture.

Bamboo culms procured may be crooked and prone to shrinkage and cracking. Also large-scale producers prefer culms with bigger diameter and longer internodes to ease splitting and for more splits. However, those supplied may be inappropriate. Although a wide range of tools and equipment are employed in processing of bamboo and manufacturing of products by small-scale processors, these are less efficient. Thus the production process is laborious causing drudgery with high risks of injury.

Perhaps the most critical of the challenges encountered by the processing enterprise is effective preservation, as this significantly affects product quality or durability and production cost. According to the large scale processors, known effective chemicals such as hydrogen peroxide are expensive and can render production unprofitable if applied at the large-scale industrial level. Most small scale processors, due to lack of knowledge and effective preservation methods, simply apply mixes of chemicals such as DDT, Dursban, Gammalin 20, Kerosine, Diesel and the like in an attempt to protect products against insect borers and fungal growth. Some of these chemicals apart from being harmful to human health, have been ineffective in ensuring product durability leading to reduced shelve or service life in products.

Another problem crippling the industry is insufficient knowledge in product development. There is a wide range of products to be derived from bamboo by both the small and large-scale producers for both domestic and international markets. Whereas the large-scale producers have been able to develop a number of complex tertiary products including bamboo ply, ceiling panels and floorings as well as home and office accessories, the major product domain by the small-scale producers has been furniture.

Products and Markets

The two major categories of products marketed are raw bamboo culms and manufactured products. Over 90% of the actors in this segment are raw culm dealers. With no management and with unsustainable harvesting, the raw materials supplied to the raw culm dealers to be sold as props in construction are of poor quality.

Dealers attributed insufficient knowledge in identifying matured culms on the part of collectors or the resource becoming less available close by as the causes for the inferior quality in culms supplied. The usually crooked culms often sold untreated and left at the mercy of the sun and rain often shrink, crack and are destroyed by insect borers and fungus. Some of the culms may also be of inappropriate diameter and internodes for clients. For instance the construction industry, which is the largest consumer of raw culms, prefers bigger diameter culms for better support but usually smaller diameter ones are most available. Dealers claim the high cost of culm extraction and haulage to marketing centres deters suppliers/collectors from securing the product from remote forest areas where better quality culms may be available.

Similarly, manufactured products often displayed by small scale producers along major routes in cities

and towns have shorter shelve and service life. Although these products may be nicely finished, they are prone to the adversities of the weather and deteriorate over a short time from insect and fungal attacks. With less durable products, therefore, there is limited access to international markets, not to mention the insufficient knowledge in global market niches for various products and the lack of sufficient capital and technical know-how for producing high quality, standardized products for competitive international markets.

RECOMMENDATIONS AND CONCLUSIONS

A number of interventions are required for reducing the barriers to effective development of the bamboo sector in Ghana. The major critical areas are those related to policy, improvement of the resource base, product manufacture, preservation and product durability, marketing and research.

Policy

The government of Ghana through the Ministry of Lands, Forestry and Mines (MLFM), has established the Bamboo and Rattan Development Programme (BARADEP) to promote the development of the bamboo sector in the country (MLFM, undated). This notwithstanding, a clear policy for bamboo sector development needs to be put in place. Relevant areas this policy would need to outline include resource sustainability through devising regulatory and legislative procedures for bamboo exploitation to protect the resource from depletion and for improving the resource stock.

Some sensitization has begun by the BARADEP but this needs to be increased to portray the versatility of bamboo as a green gold especially among rural people and entrepreneurs. Also the promotion of bamboo as an essential wood substitute together with promotion of bamboo based industries and enterprises through various means including institutional support services in enhancing skills through education and training, credit, marketing and export facilitation would naturally improve the sector tremendously. Policy on research support for resource development, processing and marketing of products is key, to tapping the socio-economic potential of bamboo for foreign exchange earnings and enhancing the livelihoods of the rural and urban poor.

Research

Research has a number of tasks to honour if the bamboo sector is to progress steadily. Areas of interests for research may include technologies for managing natural stands and sustainable harvesting as well as establishment of germplasm to ensure sustainable supply of quality culms. Cost effective preservation of culms, effective drying schedules and quality glue for effective bonding also need to be determined. A sustainable resource base cannot be developed without adequate knowledge on available resource stock on which projections can be based to ensure adequate supply of raw material for the industry. There is probably the need to first device a reliable cost effective inventory method to assess the stocking of the commercial species.

Until recently, only limited research on bamboo preservation had been conducted at the Forestry Research Institute of Ghana (FORIG). Although currently some basic research on anatomical and physical properties, preservation, determination of genetic diversity and appropriate management and harvesting methods is underway at FORIG, there may be need for studies on mechanical properties and on development of prototype products of the major commercial species, *Bambusa vulgaris,* to aid the development of suitable products for different market segments.

Also technologies for managing natural stands needs to be targeted at yielding quality straight culms to minimize wastage whereas that for harvesting would need to enhance regeneration and

reduce injury and skin irritations. Methods for propagating quality bamboo seedlings at the nursery, incorporating into cropping systems and cultivation in plantations are highly essential for the production of appropriate materials and sustenance of the resource base for the industry. Biotechnology would be crucial in the production of sufficient culms for the industry and developing culms with desirable traits including straightness, bigger diameter, and longer internodes, less starchy culms that are urgently needed by both small and large scale processors. Research on product preservation should be targeted at cost effective and safe preservation technologies for enhancing product durability. This should take into consideration, prevention of borer and fungal attack, shrinkage, cracking in both raw (primary preservation) and processed products.

Product Manufacture, Durability and Marketing

The development of a wide range of quality products for various markets would require appropriate processing machines and technology. Most importantly, for the small scale processors improved simple tools to reduce drudgery and injury would be required. Processors also require transfer of improved technical knowledge on processing techniques for the development of a wider range of durable attractive products, especially for international markets. They also require knowledge in cost effective and safe preservation methods to enhance product durability and protect human health. Interventions to support marketing of products may include promotion and standardization as well as identification of appropriate market niches for the different products to be produced

The bamboo industry in Ghana, is to a large extent, a low input and labour intensive system, although the few large scale producers have set the space to improve on processing techniques for more complex products to substitute timber with limited capital. To sustain this, support of the government is essential.

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