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INTERNATIONAL BAMBOO AND RATTAN ORGANISATION

National Assessment

Bamboo Value Chain Study

Ghana

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The International Bamboo and Rattan Organisation, INBAR, is an intergovernmental organisation dedicated to the promotion of bamboo and rattan for sustainable development. For more information, please visit www.inbar.int.

About this Working Paper

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List of Abbreviations

BIDG	Bamboo for Integrated Development
BRU	Bamboo and Rattan Unit
CBTC	Cane and Bamboo Technology Centre
CSIR-FORIG	CSIR-Forestry Research Institute of Ghana
EPA	Environmental Protection Agency
EPBG	Eco Planet Bamboo Ghana
FAO	Food and Agricultural Organization
FC	Forestry Commission
FCTC	Forestry Commission Training Centre
FSD	Forest Services Division
GBVC	Ghana Bamboo Value Chain
GSS	Ghana Statistical Service
GSA	Ghana Standards Authority
GRA	Ghana Revenue Authority
ICBR	International Centre for Bamboo and Rattan
INBAR	International Bamboo and Rattan Organisation
MLNR	Ministry of Lands and Natural Resources
MOTI	Ministry of Trade and Industry
NBSSI	National Board for Small Scale Industries
NGO	Non-Governmental Organisation
NPVs	Net Present Values
OECD	Organization for Economic Cooperation and Development.
RMSC	Resource Management Support Centre
TIDD	Timber Industry Development Division
TOR	Terms of Reference
VCA	Value Chain Analysis
YEA	Youth Employment Agency

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Executive summary

This paper provides an analysis of the bamboo value chain (BVC) in Ghana and its potential to contribute to the transformation of the economy. Data were collected from resource owners, managers, collectors, processors, marketers and users of bamboo and institutions associated with bamboo in five regions of Ghana (Ashanti, Eastern, Greater Accra, Central and Western). The results indicate that 60% of all harvested bamboo is used as props (support) for construction. Twenty per cent of harvested bamboo is processed and used by artisans in urban areas for the production of furniture, basketry and crafts/artefacts. Twelve per cent of harvested bamboo is processed by established industries for the manufacture of value-added products, such as bamboo mats, bamboo ply, bamboo bicycles, charcoal, briquettes, vinegar, toothpicks, household utensils and barbecue skewers, while eight per cent is used in the rural economy for construction (mainly roofing and house frames), fish traps and television aerial poles.

Eleven groups of actors operate and perform transactions at different points along the bamboo value chain. Nine groups are core actors, including resource owners, harvesters/collectors, traders/middlemen, transporters, raw culm traders, large-scale factory processors, artisanal processors (rural and urban), manufactured product traders and consumers. The two non-core actors are comprised of government regulatory bodies and other institutions that influence operations in the value chain.

Thirty-four (34) bamboo products categorised under 11 product value chains are produced in Ghana with revenue–cost ratios ranging from 1.2 to 25. This means that the bamboo industry is generally profitable for the product items manufactured, with profit margins ranging from 30% to over 200%. Most processors manufacture and stock a mix of products. Furniture is the most dominant product, produced by 60% of artisans. However, over 98% of them lack the requisite equipment and tools for making higher grade products. Some artisans, in place of specialised equipment for bamboo, use wood processing equipment, which is not able to produce the level of quality desired. According to artisans, the lack of bamboo equipment and tools makes bamboo processing difficult and ergonomically laborious, hence affecting the quality of the products. Artisans in the industry also lack higher grade modern expertise in bamboo processing, design and fabrication. Artisans mainly use handheld tools, thus limiting the number of products made. However, artisans have on average 13 years (range: 1-35 years) of experience with bamboo.

Bamboo products are perceived to have low demand with few sales points, usually located at production sites—in remote areas and roadsides in major cities without decent showrooms to market the products. Despite the generally poor perception of bamboo products, the demand for some of the products ranges from medium to high for producers with monthly stocking and sale rates of 30%-100%. The domestic market potential for bamboo culms is dominated by the use of bamboo as props for construction, while bamboo bicycles form the bulk of products for the international market.

The value chain (VC) products that could drive rural economies and the livelihoods of smallholder farmers are those that have current and potential future demand in terms of domestic and international markets. These include planting materials, (i.e.) seedlings/plantlets, culms/poles, toothpicks, barbecue skewers and sticks, bicycles, charcoal and briquettes, furniture, baskets and handicrafts. Commercial set-ups for the medium-scale production of toothpicks, barbecue skewers and sticks, as well as bicycles, charcoal and briquettes, are underway by a few companies. Notable ones include A. A. Kamp Ventures (Tepa, Ashanti – toothpicks), Bamboo Bikes Initiatives (bicycles), Bamboo for Integrated Development Ghana (BIDG) (seedlings, culms), Booomers International Ltd. (bicycles, furniture, etc.), Global Bamboo Products Ltd. (seedlings, culms, charcoal, briquettes), Kwamoka Farms Ltd. (seedlings, culms) Pamplo Ghana Ltd. (Accra – toothpicks, barbecue skewers, etc.), and Silverpicks Ghana Ltd. (Adukrom, Western Region – toothpicks, barbecue, barbecue sticks, charcoal).

The commercialisation of bamboo in Ghana may also be driven by promoting its substitution of timber for the processing and manufacturing of many wood-based products due to its high tensile strength yet flexible fibres. Further, there are other substitute product opportunities, including pulp and paper, rubber/plastics and textiles, with current annual import values of USD 268 million, USD 650 million and USD 292 million, respectively. Bamboo has enormous potential to support the livelihoods of a wide range of actors, particularly in the private sector in Ghana. It is the primary source of income for 43% of the core actors in the value chain and 100% of the artisans engaged in its processing and product manufacture. It is estimated that about 15,000 people are employed in the bamboo sector in the country, providing for approximately 60,000 dependents in their households.

General constraints across the manufactured product VC include poor quality bamboo raw material, i.e. culms, a lack of capital among entrepreneurs to invest in bamboo processing machinery for higher product turnovers, a lack of competitiveness regarding artisanal products, limited modern skills for the diversified utilisation of bamboo for higher grade products, indecent artisanal workshops (often located

under tree canopies) and a poorly developed domestic market for bamboo products. With no official government policy to guide the development of the bamboo industry, growth has been slow over the past two decades in terms of promoting bamboo in Ghana.

The overall demand for bamboo products in Ghana is rated as 2 (on a 3-point scale – 1: low; 2: average; and 3: high) by producers. The high demand for bamboo products on the global market presents good prospects for harnessing the economic potential of the species in the country through the right incentives for investment in the appropriate infrastructure. This study has revealed that there is a need for comprehensive and strategic bamboo sector policy in Ghana to guide the systematic development of the sector. The Ministry of Land and Natural Resources (MLNR) must form a multi-stakeholder Bamboo Industry Development Advisory Group (BIDAG) to advise on and articulate the needs of the bamboo industry. Strong engagement among stakeholders in the bamboo sector, led by the Bamboo and Rattan Unit (BRU) of the Forestry Commission (FC), could explore investment opportunities in terms of funding for bamboo industrial re-tooling, research and support for curriculum development regarding bamboo engineering in secondary and tertiary institutions.

Bamboo businesses must be developed based on product VC that have higher domestic and export market demand to drive the bamboo economy in the country. The proposed policy must also emphasise the development of quality and diversified raw materials as well as support the research and development of bamboo resources and innovative transformation processes for high-quality products. The MLNR and BRU, in collaboration with International Bamboo and Rattan Organisation (INBAR), Council for Scientific and Industrial Research – Forestry Research Institute of Ghana (CSIR-FORIG) and the Ghana Standards Authority (GSA), must work to secure funding for a project to develop standards for bamboo products and to build the capacity of the industry concerning the adoption of these standards. The International Organisation for Standardisation (ISO)-accredited wood and furniture testing laboratory at CSIR-FORIG could be used to facilitate this project. The private sector must be facilitated with fiscal incentives to stimulate resource development and innovative transformation for the better utilisation of bamboo. The Ministry of Trade and Industry (MoTI) and the National Board for Small Scale Industries (NBSSI) should have financial mechanisms for supporting Small and Medium-Sized Enterprises (SMEs) in the bamboo sector. The NBSSI could help promote gender-sensitive bamboo product value chains, including basket weaving, and trade among women and youths for domestic and export markets. Bamboo trade exhibitions will be necessary to enhance the perception of, demand for and competitiveness of bamboo products beyond the poles used in construction and furniture.

1. Introduction

Bamboo is a versatile plant with the ability to survive in a wide range of agro-climatic conditions. Though bamboo originates from Southeast Asia, it is mostly common in tropical and sub-tropical zones in Africa, Asia and Latin America (Troya Mera and Xu, 2014). There are about 70-90 genera and over 1,600 woody and herbaceous bamboo species in the world, widely distributed between 46^0 N and 47^0 S in the tropical, sub-tropical and temperate regions of all continents except Europe (Scurlock, 2000; Lobovikov, 2006; Vorontsova *et al.,* 2016). Africa possesses 43 species on over 1.5 million hectares of land (Bystriakova *et al*., 2007). The environmental, socio-economic and cultural importance of bamboo to local and national economies is globally acknowledged with 10,000 documented applications (INBAR, 2019). The global bamboo economy is now valued at USD 60 billion. The bamboo industry in Africa is growing. In West Africa, bamboo has recently been recognised as a possible source of revenue and has the potential for rural industrialisation and large-scale poverty reduction with sensitisation and government policy support (Simpson, 2011).

In Ghana, bamboo has some applications, including its use in rural housing, fencing, tools, baskets, musical instruments, decorative household utilities, furniture, bicycles, pavilions and props in real estate development, among others (Obiri and Oteng-Amoako, 2007; Opoku *et al*., 2015). However, its full economic and environmental remedial potential has remained underexploited. Although the country is endowed with natural bamboo forests, the main challenge in the promotion of the bamboo industry is its lack of sustainable value chains that take into account multiple actor interests, including potential investors, smallholder farmers engaged in bamboo plantation and small- and micro-scale entrepreneurs exploring bamboo market enterprises and product development for a sustainable green economy.

1.1 Objectives

The overall objective of this assignment is to carry out a study on the bamboo value chain in Ghana and to provide a sufficient understanding of the current status and future potential of bamboo in the country. This is to be achieved through a detailed analysis of the BVC in selected areas of Ghana, identifying existing value chains and specific bottlenecks and opportunities in these value chains that can be addressed and leveraged through project intervention, as well as proposing suitable value chains based on their market potential.

The specific objectives of the study include the following;

1. To identify bamboo value chains and the commercial potential of bamboo products in Ghana.
2. To examine the market trends, demands and competitiveness of selected bamboo value chains (supply and demand), including the prospects within the country and abroad.
3. To identify the value chain actors and their roles in the value chain and influences over bamboo production and the supply chain.
4. To examine the policies and institutional and infrastructural issues that influence the competitiveness and development of the bamboo value chain in Ghana.
5. To identify and examine constraints and opportunities within the selected value chains and recommend strategies and interventions to promote inclusive and sustainable value chain competitiveness.

This report includes a detailed description of the nature of the BVC in Ghana, including the activities of operators and transactions and interconnections in the chain, as well as the influence of service providers and regulatory institutions on its development. The status of the development of the bamboo resource base and its governance, the commercial potential of the bamboo industry including market demand, product value chains, their viability and competitiveness, gender inclusivity, policy and the institutional environment and the challenges constraining the development of the bamboo sector, among others, as well as interventions for enhancing its technical and business capacity, are also presented.

2. Methodology

2.1 Scope and design of the study

The study was conducted in major bamboo production, processing, trading/marketing and consumption locations in the Ashanti, Central, Eastern, Greater Accra and Western Regions of Ghana. It entailed a thorough analysis of the key processes in the bamboo value chain from the resources through their transformation into products and their distribution, marketing and final consumption, by adapting the flow models developed by Hellin and Meijer (2006) and Murererehe and Richter (2011) (Figure 1). Both qualitative and quantitative methods were employed for the study. Four key methods were employed in the data collection:

1. Desk study – a review of available literature, project documents, essays, policy documents and proposals on bamboo in Ghana;
2. Interviews with various actors in the bamboo sector using questionnaires;
3. Survey of the core value chain actors for quantitative data on actor profiles, activities, production profiles, resource capacities, costs and returns in terms of estimating profit for products and transformations along the chain, etc;
4. Analysis and synthesis of the information and data collected.

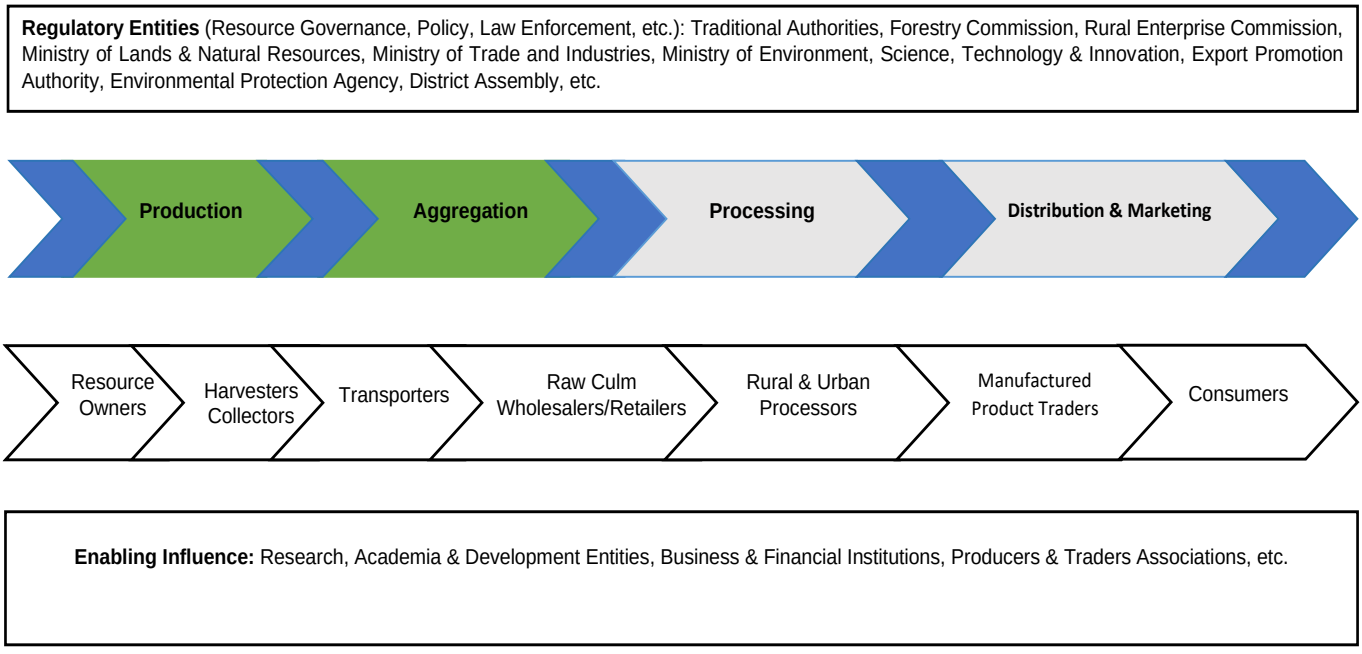


Figure 1: Value chain analysis flow model. Adapted from Hellin and Meijer (2006) and Murererehe and Richter (2011).

2.2 Value chain analysis framework

A value chain is a set of activities that a firm operating in a specific industry performs to deliver a valuable product or service to the market. As a product moves from the producer to the consumer, several transformations and transactions take place along a chain of interrelated activities, and value is added successively at each stage. Value chain analysis (VCA) focuses on all categories of key actors, their relations at all levels and their often-complex networks that influence value creation in the chain. According to Kaplinsky and Morris (2000), VCA offers a framework for analysing the activities and processes involved in the production, transformation and processing of bamboo raw material, including its delivery to the end consumers and, ultimately, its disposal. Concerning the bamboo value chain, the basic elements comprising actors and the activities they perform in terms of the relationships and transactions undertaken to acquire bamboo, the processing of it into products and its distribution to traders and consumers were mapped. The entire value chain analysis was carried out in four stages:

Stage 1: The mapping and description of value chain actors and structures.

Stage 2: The characterisation of the bamboo value chain, covering the production, processing, marketing, distribution, consumption trends, technologies and innovation, enterprise development, power relations, policies, genders, constraints and challenges, etc. that make up the chain.

Stage 3: The estimation of costs and returns for agents in the chain to determine the nature of value addition and the magnitude of product flows, directions and profits at each stage or node in the chain.

Stage 4: A synthesis of the issues relating to resource sustainability, enterprise development, a business-enabling environment, etc., including highlights from steps 1 to 3, constraints or challenges, opportunities and recommendations for remedial measures.

2.3 Study sites and respondents

A sample of key actors in bamboo resource extraction, marketing, processing, manufacturing and consumption in the Ashanti, Central, Eastern, Greater Accra and Western Regions of Ghana were interviewed (Figure 2). Consultations with professional staff at the MLNR and the FC were undertaken. Further consultations with staff from the INBAR West Africa Regional Office were carried out to gain prior knowledge of the key stakeholders in the bamboo sector (Table 1).

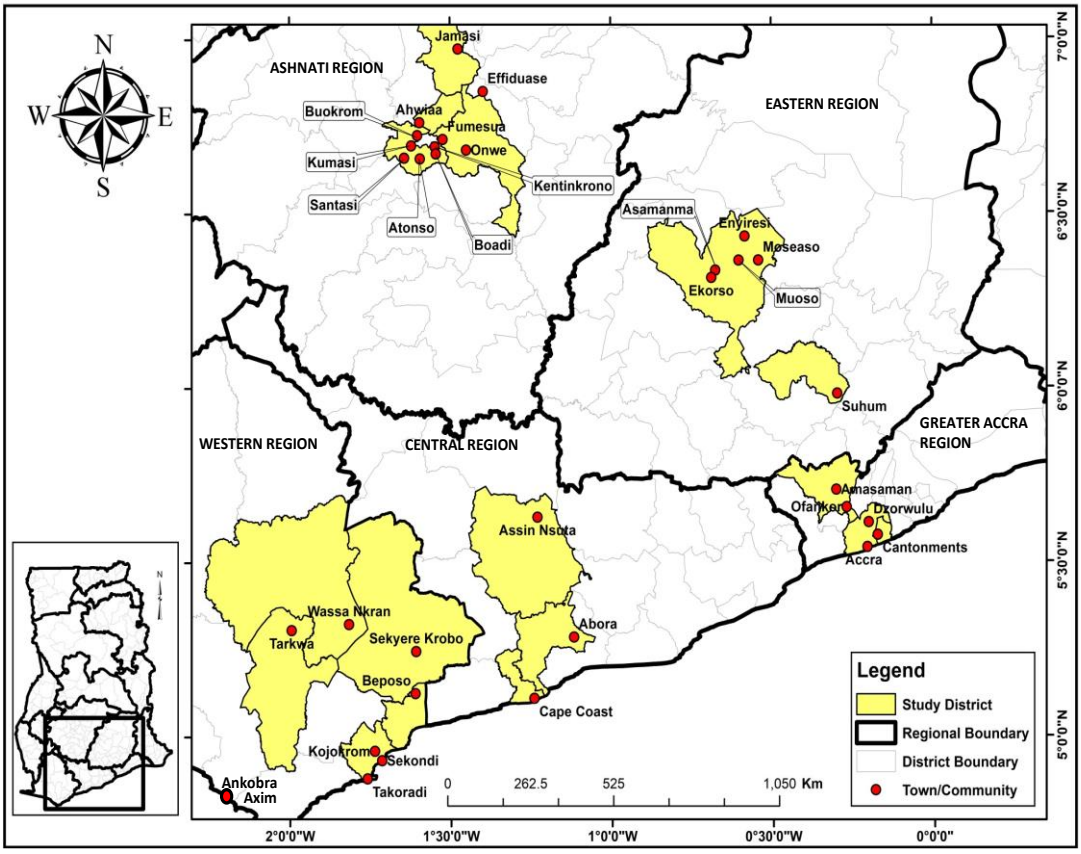


Figure 2: Map of Ghana showing the study sites.

2.4 Data collection

Primary and secondary data were collected. The secondary data obtained from literature provided information on the bamboo industry in the country as well as help with the preparation of questionnaires and informal interview guides. Two sets of primary data (descriptive and input-output/costs and returns) were gathered from the core actors of the value chain. Figure 3 shows the various actors and the corresponding cost and revenue items associated with activities undertaken in the chain as the bamboo raw material is transported from the source and goes through processing and manufacturing to arrive at the markets/sale points and the final consumers.

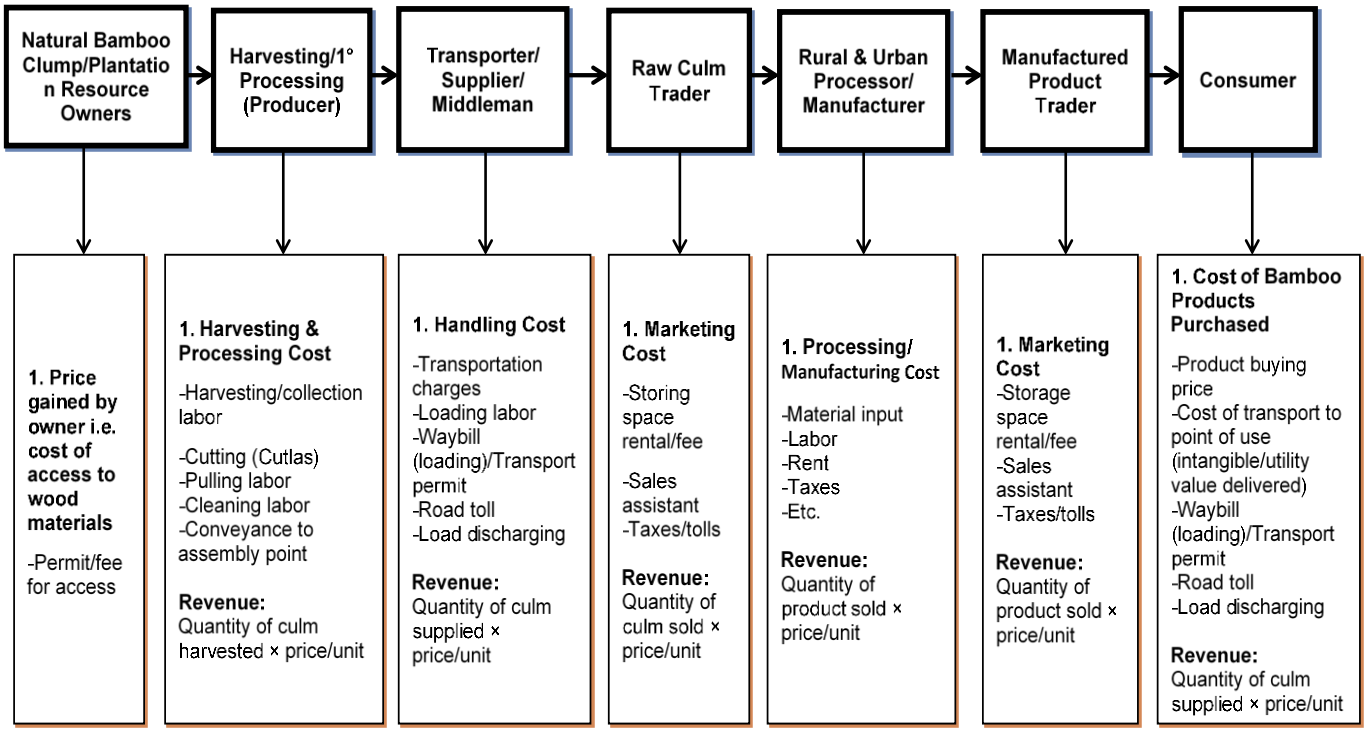


Figure 3: Cost and returns/revenue estimation framework in terms of nodes/products along the bamboo value chain.

Informal and questionnaire surveys

Coded and semi-structured questionnaires were administered to VC actors in a cross-sectional survey at the various locations indicated in Table 1. At each location, interviews and discussions were held with groups and individuals comprising resource owners, harvesters, collectors, market suppliers of bamboo culms, processors (artisans, industrialists, etc.) and consumers. The issues investigated covered the following:

1. Demographic characteristics of actors/agents;
2. Livelihood profiles;
3. Activity profiles in the value chain (description of resource ownership and management, acquisition, collection/harvesting, production processes and techniques, packaging, distribution, marketing and consumption processes);
4. The nature of transactions between agents and actors, including formal and informal institutions.
5. Raw material availability, access, extraction and supply/distribution;
6. Tools, technology and processes in bamboo extraction, processing and manufacturing;
7. The quantity of raw material utilised and finished products manufactured;

8. The technology and skill levels of entrepreneurs, including experience and years of enterprise production;
9. Capital and labour base/the capacity of entrepreneurs;
10. Product design skills and innovativeness;
11. Market orientation/demand and supply status of products;
12. Product marketing skills and capacity;
13. The organisational level of entrepreneurs and their businesses;
14. Constraints in raw material extraction and distribution, processing/manufacturing and marketing;
15. Opportunities for improving businesses (raw material and finished products);
16. Perceptions on the future directions of the bamboo industry;
17. Gender disaggregation along the value chain;
18. Government's perspectives on the regulation and sustainable management of the resource base.

Observations of the bamboo activities of the actors were also carried out. In addition, interviews with other actors or stakeholders, including institutions that influence bamboo resource access and management, were conducted.

2.5 Data analysis

2.5.1 Descriptive analysis

The data were analysed qualitatively and quantitatively using the Statistical Package for Social Sciences (SPSS) and Microsoft Excel spreadsheets. Averages/means and percentages were estimated from the disaggregated data for each VC core actor group and its operations. Differences in responses between sites were tested using the chi-square test of significance.

2.5.2 Costs, revenues, value addition and profits along the BVC

The costs and returns/revenues of value creation were estimated for some of the key product chains (seedlings, culms, furniture, charcoal, bicycles and toothpicks), based on their potential to drive the bamboo economy in Ghana.

2.5.3 Gender analysis

This focused on the assessment of gender inclusiveness, identifying gender-based roles in activities undertaken at the key nodes along the bamboo value chain. Also, gender-based constraints and

opportunities along the VC were analysed, particularly with respect to access to productive resources and agency (FAO, 2016). Productive resources within the framework refer to the physical and social resources required to initiate a livelihood and include access to land, equipment and networks and services such as those related to training and information, technology and inputs and finances. Agency refers to the ability to make autonomous choices and transform those choices into desired outcomes, while power is associated with control over resources and profits. Elements of agency and power include capabilities, self-confidence and decision-making power, which are influenced by the socio-cultural and institutional context within which actors operate.

2.5.4 Analysis of constraints and opportunities

The constraints impeding economic competitiveness along the BVC were examined, and solutions for addressing this limitation and enhancing the value chain were identified using a questionnaire. Data from the relevant sections of the questionnaire were analysed, along with informal discussions with key actors.

3. The commercial potential of bamboo in Ghana: A review

3.1 Introduction

Significant information exists on the commercial potential of bamboo due to its wide range of applications, including medicinal uses to nutritional ones (Zhaohua, 2001; Kassahun, 2014; INBAR, 2019). Globally, around 2.5 billion people use bamboo (Scurlock *et al.,* 2000). The Chinese, in particular, have used bamboo for more than 6,000 years (Troya Mera and Xu, 2014). The global market size of bamboo was estimated to be USD 68.8 billion in 2018 (Grand View Research, 2019). The industrial value of bamboo in China was estimated to be USD 35 billion in 2017 (Dai *et al.,* 2017). For many centuries, bamboo has been used primarily in the construction industry. In recent times, the trend has evolved to other areas of bamboo usage, including the textile, pulp and paper; medical; arts and design; aerospace and food and beverage industries, among others.

The widespread use of bamboo and diversification in product development has opened research opportunities in emerging fields, such as nanotechnology and composite technology (Anane-Fenin and Akinlabi, 2016; Akinlabi *et al.,* 2017). According to Ezenrane (2013), the economic value of bamboo in most developing regions, such as Africa, Asia and South America, is expected to grow in the coming years. Despite the growth of the bamboo industry in the non-traditional sector of Ghana's economy, the commercial potential of bamboo is largely underexplored. This may be due to inadequate investment, a lack of knowledge about the potential of bamboo and limited incentives for the industrialisation of the bamboo sector. Nevertheless, it is generally believed that the industry could contribute significantly to the country's GDP if strategic investments, policy and fiscal incentives are implemented.

3.2 Potential demand for and the consumption of bamboo products

The demand for bamboo products in Ghana has not been estimated but is generally acknowledged to be low (Pentsil *et al.*, 2016). However, the domestic market could be driven by the local commercialisation of bamboo. This can largely be attained by promoting the substitution of timber/wood with bamboo, particularly in building and construction and the manufacture of furniture and other wood products, such as panels, parquet, dowels, storage containers/crates, handicrafts including carvings and household utensils and accessories (trays, spoons, ladles, stirrers, etc.), as well as biomass fuels (charcoal and briquettes).

Other areas of the economy where bamboo has a high commercial relevance are textiles, pulp and paper, toiletries (tissue paper, etc.) and cosmetics (leaves, activated charcoal), food (shoots) and transport (bicycle and boat building industries, etc.). Although some of these products are manufactured in Ghana, a significant proportion are imported to augment local production. With declining timber resources and unfavourable foreign exchange rates, bamboo offers a cost-effective substitute raw material for manufacturing several of these goods. The annual consumption values for some of the candidate substitute products are summarised in Table 1, indicating sectors with a potential demand for bamboo on a commercial scale in Ghana.

Table 1. Demand for potential substitute goods and bamboo in building and construction.

Product sector	**Quantity consumed per annum**
Wood in building and construction or construction and structural end-use (m^3)	104,000
Sawn wood for furniture by small-scale carpenters (m^3)	219,000
Wood pallets and crates (m^3)	12,370
Bamboo in building and construction (culms/pieces)	30,000,000
Charcoal (tons/Ktoe)	700,000/1,250

Sources: (FAO, World Bank World Integrated Trade Solution, 2017; UN COMTRADE, 2018; Trading Economics; Ghana Energy Commission, 2018)

3.2.1 Furniture from timber/wood

The wood requirement of small-scale carpenters, which form the largest group of furniture manufacturers in Ghana, is estimated at 219,000 m^3 annually (Agyarko, undated). This represents about 72% of the total domestic timber requirement for the entire country. Generally, the total volume of sawmill lumber available for domestic use is only 152,660 m^3 per year, yet the demand from the domestic end-users is about 384,730 m^3, leaving a deficit of 230,070 m^3 to be sourced from elsewhere (Agyarko, undated). The demand for wood products has increased in recent times. In 2018, GH¢ 180.3 million (USD 36 million) worth of wooden furniture was imported into the country (Arthur, 2019). Bamboo fibre is similar to that of wood, thus putting it in a good position to meet the fibre demand of the manufacturing industry in Ghana. A wide array of furniture can be manufactured from bamboo. This includes tables, chairs, stools, long chairs and sofa sets, among others. Bamboo furniture is fashionable, functional, durable, eco-friendly and extremely versatile for both indoor and outdoor uses in hotels, restaurants, lobbies, poolside areas, sunrooms, offices, luxury suites, common areas, dining rooms, living rooms, patio settings, etc.

3.2.2 Bamboo in building and construction

Bamboo is currently largely used as props and for landscaping in the building construction industry in Ghana (Opoku *et al.,* 2015). A survey of building contractors showed that 36% of them often used bamboo in their projects, mainly as props, with 63% of these using 100-200 and above culms per project. Although bamboo is regularly used for temporal applications (i.e. props, sheds, benches, etc.), building contractors may use up to 500 culms per project (Opoku *et al.,* 2015). Ghana's current residential property demand is 150,000 units per annum. If Ghanaian architects and building contractors are sensitised to using bamboo as props, the demand for culms may be estimated at 30 million culms per annum, assuming that 200 bamboo culms are used on average per housing project. Further, bamboo as a construction material in tertiary applications is slowly gaining recognition, and there is a potential market, particularly with regard to interior furnishing, panel products and doors and windows in housing, as well as in the eco-tourism sector.

3.2.3 Bicycles

Bamboo is also used for the production of bicycles. Nearly all bicycles used in Ghana are made entirely of steel and imported mainly from Belgium (2.6%), China (12%), Germany (1%), Italy (1.4%), Japan (59%), Malaysia (3.3%), the Netherlands (1.4%), the United Kingdom (5.9%), and the United States of America (USA) (4%). In 2017, over USD 15 million worth of bicycles were imported into the country (OEC, 2017). Bicycles are an important means of transport in Ghana, especially in the northern regions. Promoting the production of affordable bamboo bicycles could potentially drive the commercialisation of the sector.

3.2.4 Charcoal

Bamboo has been used as an energy source by converting it into solid, liquid and gaseous fuels (Chin *et al*., 2017). It is carbonised to produce charcoal with a comparatively good energy content or calorific value. In terms of biomass for energy generation, bamboo has the potential to yield from 5 to 40 tons per hectare per year in rain-fed systems (Frith, 2014). With a calorific value similar to that of wood, bamboo charcoal also produces fewer pollutants (INBAR, 2017). Estimates from the Food and Agriculture Organisation (FAO) suggest that 14 million m^3 of wood are used for energy production in Ghana. Sixty-nine per cent of all urban households in Ghana use charcoal for cooking, and the annual per capita consumption is about 180 kg per annum. The total annual consumption of charcoal is

estimated to be 700,000 tons (Energy Commission, 2018). This gives an indication of the potential market for bamboo charcoal in urban areas.

3.3 Capacity to supply bamboo products on a commercial scale

Data on bamboo products made in Ghana are limited. The capacity to produce them on a commercial scale may be rated as low for many of the product value chains. This may be due to, among other reasons, poor domestic demand and the inadequate technical capacity to increase efficiency and turnover for higher end products that could attract consumer interest. However, trends in the global bamboo economy indicate that the species could be a suitable substitute and alternative high-value raw material for enhancing the green economy in Ghana. The current applications of bamboo in Ghana broadly include fencing, tools, rafts, trellises (frames), wildlife habitats, stream and riverbank stabilisation, ornaments, handicrafts (curtain/blinds, jewellery, wall hangings, etc.) and furniture (wardrobes, beds, sofas, cabinets, bookcases, cots, etc.) (BRU, 2019; FAO and INBAR, 2018; Obiri and Oteng-Amoako, 2007; Owusu *et al.,* 2015; Pentsil *et al.,* 2016; Tekpetey *et al.,* 2015). The use of bamboo culms as props in building construction and television aerials is common (Obiri and Oteng Amoako, 2007). Likewise, the production of a wide range of accessories from bamboo, including toothpicks, barbecue sticks, ice-cream spoons and skewers, among others, is gaining recognition. The demand for bamboo bicycles made in Ghana is rising in Europe and the United States, despite experiencing low demand in the local market due to their high price. The statuses of production of notable bamboo product value chains in Ghana are reported below.

3.3.1 Bamboo furniture and crafts

Bamboo is used in combination with rattan and wood to make furniture. Most of the bamboo furniture makers exist in clusters in five cities in southern Ghana, specifically in Accra, Cape Coast, Takoradi, Kumasi and Koforidua, located in the Greater Accra, Central, Western, Ashanti and Eastern Regions, respectively. Harvested bamboo culms are supplied by merchants on a regular basis to furniture makers, who purchase an average of three bamboo culms per week. The average price of a bamboo culm is USD 0.70. Each furniture maker makes an average of one set of furniture a month, in addition to other bamboo products. According to the interviews with artisans, a set of bamboo furniture made up of one three-seater sofa, one two-seater sofa, two single seaters and a centre table will sell for an average of USD 250.

Artisanal firms in Accra, Kumasi and Takoradi form the majority of producers/suppliers of bamboo products. These are individually based, and the quality of the products manufactured depends on each individual's own skills. Master artisans either work with or without apprentices. In some cases, paid labourers are engaged either on a contractual or daily basis to assist in the processing and manufacture of products. There are isolated medium-scale processors, such as the Pioneer Bamboo Processing Company in the Central Region, that process bamboo into boards, with an output of 10 boards per week, and then into furniture. Global Bamboo Products Limited (GBPL), located in Enyiresi in the Eastern Region, processes bamboo into furniture, carvings, necklaces, skewers, curtains and other crafts. GBPL engages 320 community artisans with an output capacity of 20 sets of furniture and 300 carvings per month (Obiri *et al.,* 2017).

3.3.2 Toothpicks and related products

In 2017, Ghana imported GHC 18 million worth of toothpicks from China for its hospitality industry (AGI, 2018). However, this trend may change in the medium to long term as the production of toothpicks and related products has started locally. Notable is Pamplo Ghana Ltd, an indigenous bamboo processing company that produces quality bamboo products by following standards to meet the demand locally and abroad. The company has a capacity to produce 30,000 packets of toothpicks per month. Pamplo also produces a variety of other products from bamboo, including kebab sticks, cocktail sticks, dowel sticks, tongue presses, coffee stirrers and skewers. The company has plans to supply ice-cream spoons to Fan Milk Ghana Ltd and acknowledges a ready market for the skewers and the kebab sticks, with the growing number of barbecue grills in hotels, restaurants, markets and communities around Ghana. The target clientele for the domestic market in Ghana includes the service industry, i.e. restaurants, fruit sellers, ice-cream companies as well as households. The average consumption of these categories of potential clients for these products, including fruit sellers, households and barbecue grills, is not known. However, statistics indicate a population of 17 million people in urban areas of Ghana (GSS, 2014) who may potentially patronise these products, hence resulting in a possible increase in demand for bamboo raw material.

Another company making bamboo toothpicks and barbecue skewers in Ghana is Nation's Pride Tooth Pick near Kumasi. When operating at full capacity, the company processes 1,000 bamboo stems in a month. Other companies producing toothpicks and other bamboo products include Silverpicks Ghana Ltd, located in Edukrom in the Wassa East District of the Western Region and A. A. Kamp Ventures in Tepa, in the Ashanti Region, with a capacity for producing 100 packages of toothpicks per day.

3.3.3 Bamboo charcoal and briquettes

Bamboo charcoal production in Ghana is not popular due to high dependency on traditional timber species for charcoal production. GBPL also produces and supplies bamboo charcoal and briquettes for both the domestic and export markets. Likewise, Silverpicks Ghana Limited planned to set up charcoal and briquette production lines to supply the domestic market and sub-regional markets in West Africa. However, these production records have not been reflected in official statistics. In 2011, INBAR piloted a programme in Tandan (Ellembelle District) and Daboase (Mpohor Wassa East District) in the Western Region to produce bamboo charcoal. Working with a micro enterprise association in Daboase, about 505 tons of bamboo charcoal were produced from October to November 2011, highlighting the potential for commercial-scale bamboo charcoal production (GBN, 2011).

3.3.4 Bamboo bicycles

Ghana Bamboo Bikes Company Ltd in Ashanti engages 35 employees in bamboo cultivation and the manufacture of bamboo bicycles (Obiri *et al*., 2017). Similarly, Booomers International Ltd, located in Yonso in the Ashanti Region, engages over 50 and 220 young people, directly and indirectly, respectively, including bamboo farmers that supply the raw material for bicycle production.

3.4 Potential to supply bamboo raw material (culms) for commercialisation

3.4.1 Raw material from natural stocks

Most bamboo in Ghana grows naturally in the wild. It is widely spread in the Western North and South, Central, Eastern, Ashanti, Bono and Ahafo Regions. Two species, *Bambusa vulgaris* in southern Ghana and *Oxytenanthera abyssinica* in northern Ghana, are usually harvested for household and commercial purposes. *B. vulgaris* is the dominant species comprising 95% of the stocks and found in high forest zones, along river banks and on community lands. *O. abyssinica* occurs in small clusters of 1-4 clumps on farmlands owned by families in the Northern Savannah Zone (Obiri and Oteng Amoako, 2007). Plantation International (2019) reports annual yields of 2-6 tons per hectare for heterogeneous bamboo in unmanaged stocks. This represents only 20% of the yield of a well-managed bamboo plantation. Partey *et al*. (2016) reports 80-120 Mg ha^{-1} yr-1 for the total dry matter production of four-year-old bamboo under optimum conditions in most of Sub-Saharan Africa.

3.4.2 Governance of the resource and trade in culms from the wild

The FC of Ghana is responsible for the regulation of the utilisation of forest and wildlife resources, including bamboo. The FC is also mandated to oversee the conservation and management of these

resources and the coordination of policies related to them. Bamboo harvesting in northern Ghana is mostly carried out in the dry seasons. In the south, which includes the Ashanti, Eastern and Western Regions, where bamboo is widely found, harvesting is undertaken all year round due to the demand for culms used as props in the building industry. Although 60% of wild stock is in the Western Region, most of the harvesting takes place in the Eastern Region due to its proximity to the capital Accra where demand for the bamboo is higher (Obiri and Oteng-Amoako, 2007; Pentsil *et al.,* 2016; Tepketey, 2011). Bamboo merchants traditionally harvest bamboo from the wild and supply processors, who, on average, pay USD 20.00 per hundred culms of bamboo harvested from traditional land owners or custodians (Obiri *et al*., 2007; Pentsil, 2016). For forest reserve areas, a permit is issued for GHC 10.00 (USD 2.00) per month, which will cover 100 to 150 bamboo culms. In northern Ghana, an average of USD 0.38 may be paid for each culm harvested.

3.4.3 Production potential of bamboo raw material from plantations

There are currently over 18 species of bamboo in the country targeted at commercial bamboo plantation development. In 2003, the Opportunity Industrialisation Centre (OIC), with facilitation from the Bamboo and Rattan Development Programme (BARADEP), imported 13 species from Hawaii into Ghana. The species with a wide range of applicability were distributed to selected institutions and non-governmental organisations for reasons related to their multiplication, growth monitoring and adaptability, as well as to provide resources for private and commercial plantation developers in the country (Masau, 2016). However, there are no reports on the location and status of the bamboo species, although over seven species can readily be identified, including *Bambusa vulgarisvar vittata* (yellow type), *Bambusa arundinacea, Dendrocalamus strictus, Bambusa multiplex and B. pervariabilis*, which are being grown at restricted sites including an arboretum and trial plots (Ebanyele, 2005; Anokye, 2013; BRU, 2019). Others firms and individuals, including private plantation developers, have introduced additional species for large-scale uniform raw material production (Table 2).

Table 2. Bamboo species in Ghana including imports by the OIC and others from 2003 to date.

No.	Species	Source of import	Uses
1.	*Gigantochloa albociliata*	Hawaii	Shoots and Weaving (can be bent like rattan)
2.	*Bambusa edulis*	Hawaii	Weaving, Boards, Furniture, Shoots, Roof purling
3.	*Dendrocalamus brandisii*	Hawaii	Construction
4.	*Bambusa oldhamii*	Hawaii	Furniture, Shoots, Construction, Windbreaks
5.	*Dendrocalamus asper*	Hawaii	Shoots, Furniture, Panels
6.	*Guadua angustifolia*	Hawaii	Construction
7.	*Dendrocalamus strictus*	Hawaii	Weaving, Boards, Furniture, Shoots, Roof purling
8.	*Guadua chacoensis*	Hawaii	Construction
9.	*Dendrocalamus membranaceus*	Hawaii	Furniture, Paper and pulp, Light construction
10	*Thyrsostachys siamensis*	Hawaii	Weaving, Handicrafts, Shoots, Paper and pulp
11	*Dendrocalamus latiflorus*	Hawaii	Weaving, Shoots, Furniture, Boards
12	*Bambusa textilis*	Hawaii, China	Weaving, Shoots
13	*Bambusa ventricosa*	Hawaii	Ornamental
14	*Bambusa burmanica*	Hawaii	Light construction
15	*Bambusa balcooa (Beema)*	India	Energy (charcoal, briquettes)
16	*Dendrocalamus asper*	Asia	Construction
17	*Bambusa arundinacea*	-	Shoots, Construction, Pulp and paper, Furniture, etc.
18	*Bambusa pervariabilis*	-	Furniture, Charcoal, etc.
19	*Bambusa multiplex*	-	Ornamental, Fencing, Handicrafts, Shoots, Furniture, Flutes
20	*O. abyssinica*	Ethiopia	Energy

Sources: BRU (http://bru.fcghana.org); Musau, 2016; Lu, 2018.

The FC projects that 50,000 ha of bamboo plantations will be required to augment the supplies from natural bamboo stands over the next 25 years, i.e. by the year 2040, at a planting rate of 2000 hectares per annum (FC, 2016). However, there is a limited number of commercial bamboo plantations in Ghana. Notable ones established mainly by private companies range from 10 to 920 ha for multiple products

for both domestic and export markets (Table 3). The establishment of commercial bamboo plantations began in Ghana in the early 2000s with the government's interest in bamboo as an alternative material for wood-based applications to address problems regarding wood deficits and deforestation. Among the early commercial bamboo plantations was those established by GBPL in 2003, in the Ashanti and Eastern Regions, for mainly handicraft and culm production with later diversification into charcoal and briquettes (FC, 2015; Obiri *et al.,* 2007).

Table 3. Private bamboo plantations in Ghana.

Company	**Location**	**Species**	**Area of Bamboo Planted (ha)**	**Intended Applications and Products**	**Clientele**
Global Bamboo Products Limited (GBPL)	Mankrang Forest Reserve, Offinso, Ashanti and Eastern Regions	Bambusa vulgaris	300 (expansion to 1,000 planned)	• Charcoal • Briquettes • Treated bamboo culms • Furniture and handicrafts • Bamboo chips • Water and land restoration • Agroforestry for community livelihood resilience	• Charcoal distributors • Hotels • Restaurants • Barbecue sellers • Supermarkets/retail shops • Clean cooking stove producers

Kwamoka Farms Ltd.	Nsuta Kwamang (Jeduako and Drobonso) Sekyere Central District, Ashanti Region	Beema (*Bambusa balcooa*) O. abyssinica	480	• Seedlings • Charcoal • Briquettes • Flooring • Culms (poles) for furniture and crafts • Agroforestry for community livelihood resilience	Domestic and export market
Eco-Planet Bamboo Ghana (EPBG)	North Bandai Hills Forest Reserve, Juaso, Ashanti Region	*Dendrocalamus asper* *Bambusa textilis* *O. abyssinica*	3,400	• Reduce deforestation • Bamboo fibres for toilet paper, packaging materials and textiles • Raw material for construction, crafts and charcoal	Foreign market/exports Domestic market
Ghana Manganese Company (GMC)/ DALOW	Nsuta, Western Region	*Bambusa vulgaris* *Bambusa pervariabilis* *O. abyssinica*	1,000	• Restoration or reclamation of mined-out land • Bio-energy	Company's use
Bamboo for Integrated Development Ghana (BIDG)	Sekyere Afram Plains District	*Dendrocalamus asper*	1,000 ha planned plantation	• Culms • Agroforestry for rural livelihood climate resilience	-

Sources: FC, 2015; FAO & INBAR, 2018; www.bambooid.org; www.globalbambooproducts.com; www.kwamokafarms.com

In November 2014, the FC, in partnership with a private company, EPBG signed a lease based on a public-private partnership (PPP) agreement to establish approximately 3,400 ha of bamboo plantations in the North Bandai Hills Forest Reserve in the Juaso Forest District in the Ashanti Region. An initial planting of 923.4 ha has been established (FC, 2015). EPBG is entitled to 80% of the standing tree value of the bamboo plantation, while the FC, landowners and forest fringe communities share the remaining 20% (FAO and INBAR, 2018). EcoPlanet, a US-based company with bamboo plantations in Nicaragua, South Africa and Southeast Asia, is the first to develop commercial plantations of clumping bamboo on a global scale. The company has, in addition, developed associated technology and market demand for bamboo fibre as an alternative raw material among industries that currently rely on timber harvested from natural forests (FC, 2015).

EPBG planned to establish species within two genera – *Bambusa* and *Dendrocalamus* – with clumping (sympodial bamboo), and it engaged 500 paid workers from the forest fringe communities involved to establish a bamboo nursery (FC, 2015; FAO and INBAR, 2018). The nursery engaged a predominantly female workforce of about 250 people, drawn mainly from the Nkansaso, Mankala and Sempoa communities.

Interest in bamboo plantations has increased over time in terms of providing quality raw material for industrial use. However, there is limited information on the silviculture, productivity and economics of plantation-grown bamboo in Ghana to guide prospective investors. According to Addo-Danso and Bulkan (2019), the profitability or lucrativeness of bamboo plantations and the financial and technical support, as well as the high market demand for bamboo products and secure land tenures, will be critical incentives in promoting the development of commercial bamboo plantations in Ghana. *Bambusa balcooa* (*Beema* bamboo) in agroforestry and monoculture experiments on smallholder croplands in a semi-deciduous environment in Ghana yielded a clump density of 40-50 culms per clump, with an average of 10 new shoots emerging annually after 4 years of establishment. Culm and charcoal production were reported to be financially viable from this experiment, retuning Net Present Values (NPVs) ranging from GHC 46,000 to GHC 126,000 per hectare. The high profitability was a result of the high frequency of harvesting bamboo culms once the clumps are established after three years (Obiri, 2018).

4. Bamboo value chain in Ghana

4.1 Overview of the bamboo value chain in Ghana

Ninety-eight per cent of bamboo is extracted from wild stocks, predominantly community and private lands including farmlands and fallows as well as government forests in the Ashanti, Central, Eastern Volta and Western Regions of the country (Obiri and Oteng Amoako, 2007). It is estimated that 60% of the bamboo extracted is from forest reserves (FAO, 2016). Locally, males in communities in the resource areas are involved in the harvesting, collection and distribution to commercial centres in Kumasi, Koforidua, Accra, Cape Coast, Takoradi, Tema, etc. Ninety-two per cent of the raw culms are supplied directly to clients at these centres through orders or on demand, while eight per cent are processed for use by rural households and supplied to rural markets. Sixty per cent of the 92% of the external/contract supplies are delivered directly to raw culm traders, usually located in wood markets, with 98% purchased for use as props in the building industry and 2% by artisanal processors in the cities of Accra, Kumasi and Takoradi. Twenty per cent and 12% of the remaining 32% of the external supplies are supplied directly to urban artisans and large-scale factory processors, respectively, for the manufacture of key products, including bamboo ply, furniture, handicrafts (wall hangings, toys, blinds, jewellery, etc.), charcoal and briquettes, bicycles, household utensils and barbecue skewers and sticks as well as toothpicks. Vinegar and tar are by-products from the carbonisation of bamboo into charcoal. Thus, overall, 58% of the raw culms from resource areas are supplied for props, 22% are used by artisanal processors/manufacturers, 12% are used by large-scale industries and 8% in rural construction (roofing, fish traps, television aerials, etc.)

Ninety-seven per cent of the products are consumed locally, whereas 3% may be exported to other countries in the West African Sub-Region, Libya and Europe. Seventy-five per cent of the consumers in the domestic market are individual prospective buyers who purchase these products mainly for domestic use (70%) and sometimes for use in offices, hotels, restaurants and shops (30%). Some bamboo jewellery (e.g. bangles and necklaces) may be purchased by tourists, although this proportion is insignificant. Twenty-two per cent of domestic consumers purchase products through contract orders. Usually, the 3% that is exported is also through contract production. Figure 4 illustrates the composite map of the bamboo product value chain in Ghana, adapting Hellin and Meijer's (2006) and Murererehe and Richter's (2011) flow models. The bold arrows indicate the major pathways through which the raw bamboo culms (stems) are distributed from the extraction area through value addition (i.e. processing and product manufacture) into finished products for marketing and consumption.

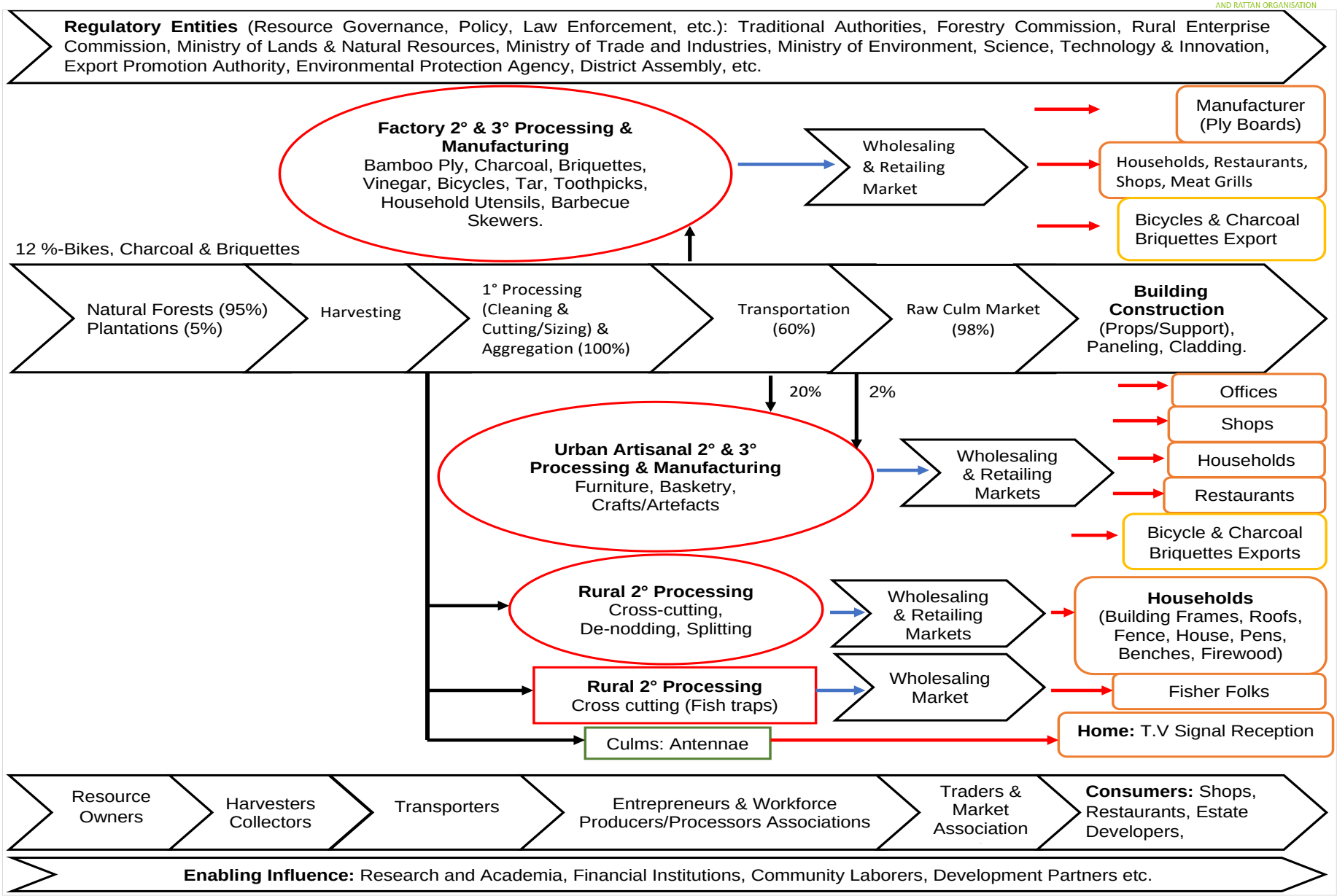


Figure 4: Value chain map/flow model for the Ghanaian bamboo industry.

4.2 Bamboo value chain actors, roles and influences in production and the supply chain

4.2.1 Profiles of actors in the Ghanaian bamboo value chain

Usually, the main actors in the bamboo value chain are the producers, transporters, processors, wholesalers and retailers till the product reaches the end users or the final consumer (Greijmans *et al.,* 2007; Gauli *et al.,* 2018). In Ghana, however, there are 10 distinct groups of actors operating and interacting in the Ghana Bamboo Value Chain (GBVC). Eight groups are the core actors operating at the main nodes in the chain, including resource owners, harvesters/collectors, middlemen/transporters, raw culm traders, large-scale factory processors, artisanal processors (rural and urban), manufactured product traders and consumers. The two remaining actors are comprised of regulatory bodies and other institutions that influence operations in the value chain (Figure 4). The bamboo sector is dominated by males, mostly youths aged between 18 and 60, although some resource owners, transporters and processors/manufacturers are much older (Table 4).

Except for 9% and 7% of resource owners and harvesters, respectively, who have no formal education, all the others interviewed have primary to tertiary education with 40%-80% having attained a junior/middle school leaving certificate. The actors have varying years of experience with bamboo, ranging from 7.5 to 13 years on average. Processors/manufacturers have the most (13) years of experience on average and a range from 1 to 35 years (Table 4).

Processors/manufacturers are entirely engaged in their bamboo enterprises as their principal occupation, whereas it is a secondary occupation for the other actors. Resource owners are typically farmers who have wild bamboo stocks on areas of their lands. They often regard bamboo as a nuisance, and thus may seek to clear it to make way for the production of other crops. Hence, they do not recognise its potential as a livelihood option (Table 4).

Processors/manufacturers are the only group of core actors with organised bamboo associations, which have memberships of 52 people on average but with ranges from 3 to 120 people. The associations have been formed primarily for the welfare purposes of their members but also to facilitate the acquisition of both financial and technical support from relevant institutions (Table 5). Overall, 70% of the core actors interviewed along the GBVC perceived the demand for bamboo products to be high. Also, 84% of them perceived the availability of bamboo to be high. *Bambusa vulgaris* is the only species that all the actors interviewed use in their business operations (Table 4).

Table 4. Profile of core bamboo value chain actors interviewed and their perceptions

Parameter	Resource owners	Harvesters/ Collectors	Trans-porters	Processors/ Manufacturers	Traders	Consumers
	(*n* = 11)	(*n = 17)*	(*n = 8)*	(*n = 48)*	(*n = 21)*	(*n = 5)*
Gender (%)						
Male	54	55	100	94	84	100
Female	46	45	0	6	16	0
Age						
Mean	58.3	28	43.5	48	42	37.4
Range	39-86	18-45	29-64	26-71	23-60	23-51
Educational status (%)						
Primary	18.2	21.4	17	8.2	12	0
Junior Secondary/ Middle School	45.5	50	66	65.3	41	80
Secondary/ SSS	18.2	7.1	17	20.4	29	20
Tertiary	9.1	14.3	0	6.1	18	0
None	9	7.2	0	0	0	0
Experience with bamboo (years)						
Average	-	11.4	9.2	13	7.5	8.8
Range	-	2-27	3-23	1-35	1-24	1-30
Primary occupation (%)						
Bamboo business	0	43	17	100	57	-
Other (farmer, artisan, etc.)	100	57	83	0	43	-
Bamboo association (%)						
Yes	-	7	0	84	0	-
No	100	93	100	16	100	-
Membership size						
Mean	-	-	0	52	0	-
Range	-	-	-	3-120	0	-
Purpose of the association (%)						
Welfare	-	-	-	58	-	-
Seeking support (government, loans)	-	-	-	33	-	-
Raw material acquisition	-	-	-	6	-	-

Capacity building (Training)	-	-	-	3	-	-
Bamboo species (%)						
Bambusa vulgaris	100	100	100	100	100	100
Perception of demand for bamboo and products (%)						
High	50	77	67	70	71	-
Low	50	23	33	30	29	-
Perception of bamboo availability (%)						
High	90	86	80	96	80	-
Low	10	14	20	4	20	-

4.2.2 Actor transactions and interconnections

The relationships or linkages among actors in the bamboo economy of Ghana are purely based on business transactions that permit the flow of bamboo raw material from resource areas for its transformation into products for consumption. Due to transportation difficulties, harvesters, transporters and middlemen often mediate to buy bamboo culms from resource owners at cheaper prices and convey them to clients in raw culm trading, the building/construction industry and processing/manufacturing. Culm traders in wood markets sometimes pre-finance the harvesting and transportation of the culms supplied.

Several regulatory entities influence the performance of the bamboo value chain, although many of these institutions may be weakly connected to the technical and commercial activities in the chain. At the resource areas, traditional authorities, particularly the chiefs, may give out community lands to be harvested at a fee or may impose regulations in terms of the quantities of bamboo to be harvested to protect the resource. The Forest Services Division (FSD), in the Ashanti, Eastern, Western and Central Regions, issues permit for bamboo harvesting from forest reserves and conveyance certificates for the transporting of the product to clients. Other public sector institutions, such as the District Assembly, Energy Commission, Environmental Protection Agency (EPA), FC, Ministry of Education (MoE), Ministry of Environment, Science, Technology and Innovation (MESTI), Ministry of Food and Agriculture (MoFA), MLNR, MoTI, Rural Enterprises Commission (REC) have oversight responsibilities regarding various segments and operations of the BVC. The District Assembly collects tolls at the forest gate on each load of bamboo being transported to the market. The FSD and District Assembly also monitor the activities of bamboo producers. Business and financial institutions and associations support and facilitate operations along the chain. Further, the industry has been a learning field, providing research,

academia and development entities with learning opportunities and interventions (knowledge and resources) for enhancing productivity along the value chain.

4.2.3 The role of actors and their influences on the supply value chain

Resource owners, the MLNR, and FC traditional authorities have direct control over the rights and access to and the availability, management and production of the bamboo resources or raw material that can potentially be supplied by the value chain. However, with the exception of plantation owners who have invested in the development of the resource, traditional landowners including farmers, the MLNR and the FC have wild bamboo stocks under their jurisdictions, which are seldom managed due to the low value ascribed to bamboo in the country. While currently, harvesters/collectors, transporters and raw culm traders greatly influence or control the prices of raw materials of variable quality, plantation owners may in the future control the prices of raw material production for quality and user-specific species (Table 5).

Table 5. The role of actors and their influences on bamboo production and the supply chain.

Value chain node	Value chain actor	Role/interest	Influence on overproduction and the supply chain
Production and aggregation	Resource owner	**1. Wild stocks owner** • Grants access to the harvesting of wild bamboo resources on their lands for subsistence income **2. Plantation producer** • Investment in the development of bamboo resources • Ensures a sustainable supply of bamboo raw material for commercialisation at a profit	**1. Wild stocks owner** • Has limited influence on the development of the resource • Seldom manages the resource and the regulation of its extraction • Sometimes sees bamboo as a nuisance on their lands and seeks to destroy clumps to make way for farming; hence, sometimes grants access to harvesters at no fee • Has no control over forest/farm gate prices **2. Plantation producer** • Could have a strong influence over the supply of quality raw material from desirable species in the future • Could influence raw material prices in the future
	Harvester/collector	• Extraction of bamboo resources for supply on request • Organised collection/harvesting and primary value addition to bamboo • Familiar with the distribution and availability of bamboo resources in the community and forest areas	• Access to District Forest Office, resource owners and local authorities • Should be knowledgeable in the identification of mature quality culms to harvest for supply • Has the power to dictate the prices offered to individual resource owners at the farm gate for wild bamboo stocks

		• Primary interest is to sustain their livelihood	
	Traditional authorities	• Authorised governmental representation at the grassroots level • Improves the livelihood of local people • Oversees natural resources • Collects royalties from forest resources including bamboo	• May have an influence on the extraction of bamboo resources – May control the extraction of bamboo from community forests and grant access at a fee where bamboo is a commercial good in the rural economy, e.g. Dwira Banso, Western Region – Influences the utilisation of forest revenues for local development
	District/Metropolitan Assembly	• Collection of taxes from forest resources • Tax collection in terms of raw material in markets and finished products in rural and urban areas • Management of space/land areas for artisans to run cottage industries	• Influences local development including roads for the conveyance of culms for supplying markets and producers • Strong influence on the selling of raw bamboo culms, their processing/manufacture and the sale of products – May control spaces in terms of the siting of bamboo enterprises, especially in urban areas – Provides space permits for enterprises to operate in the production and marketing of bamboo products

	Ministry of Land and Natural Resources Ghana	• Policy formulation and reforms for bamboo • Endorses capacity building to promote the bamboo industry • Secures funds and linkages for enhancing research and development concerning bamboo	• Most powerful governmental body • Has control over fiscal and policy measures for the development of the bamboo resource base and industry
	FC/FSD	• Resource management for sustainability • Formulates and implements forest policies • Regulation of the resource/system • Controls the harvesting of bamboo from reserved forests • Fixation of royalties for forest products, including bamboo extracted for commercial purposes • Allocation of degraded land to individuals and corporations for bamboo plantation development under lease-based agreements	• Most powerful governmental body with control over the development, management and access to bamboo resources, particularly on government lands • Provides access through paid permits for the exploitation of bamboo from government forest reserves • Provision of permits for the conveyance of bamboo harvested from forest reserves to markets
	BRU	• Policy implementation • Development and promotion of the bamboo industry • Coordination with stakeholders	• Powerful governmental body • Directly deals with projects and donors interested in the development of the bamboo sector • Has an influence on practitioners

		• Coordination of bamboo projects • Documentation and information about bamboo • Facilitating resource development – Propagation of planting materials (nurseries) – Establishment of demonstration stands • Capacity building (internal and external) for value addition for private bamboo entrepreneurs, including artisans	
Distribution, marketing	Transporter	• Ensures the supply of raw material in the market	• Has control over transport charges on bamboo culm supply that ultimately affect the cost of the raw material supplied to the market
	Raw culm trader/supplier/wholesaler	• Ensures the supply of raw material in the market • Directly and indirectly supports harvesters through the pre-financing of money • Organised marketing	• Access to harvesters, the District Assembly and the municipality of the raw material • Has influence over the final price of the raw material supplied to processors/manufacturers and the building industry
Consumption & marketing	Artisan/processor	• Processing of bamboo directly as a major actor • Creation of jobs (rural and urban) • Supply of the product in the market	• Major unit of the supply chain of bamboo products • Has associations that may influence the price of the raw material supplied and the manufactured products

	Private entrepreneur	• Business development centre of a sub-sector such as bamboo • Provides training/capacity development, jobs and incomes for workers • Linkages with the market and marketing chains	• Access to handicraft producers, market centres and national and international linkages
Institutions	INBAR	• Secures funds for bamboo sector development • Partnering with government for bamboo-based livelihood development • Provides technology, funds and forums for discussions on bamboo • Disseminates research findings through publications, workshops and the web • Coordinates the interests of bamboo stakeholders and promotes capacity building (training) to upgrade the activities of bamboo entrepreneurs	• Access to donors and technology and coordinates with government bodies to enhance the development of the bamboo industry • Has influence over the promotion of higher value addition and efficiency in production, especially for manufactured products
	Ministry of Works and Housing	• Promotes the use of bamboo as engineering material in building and construction	• Can influence demand for bamboo culms in the building and construction industry
	Ministry of Science and	• Regulates environmental pollution, degradation and extractive economic activities	• Most powerful government institution in the environmental sector

	Environment and Innovation Environmental Protection Authority	• Promotes the use of bamboo for environmental restoration	• Can influence demand for bamboo planting material for restoration activities in communities, farms, mining and large-scale extractive industries
	Academia Kwame Nkrumah University of Science and Technology (KNUST) University of Energy and Natural Resources University for Development Studies (UDS) Kumasi Technical University	• Teaching and research in natural resources management, including bamboo resources • Teaching and research in bamboo applications in engineering and architecture • Rural Art department at KNUST trains students in the processing and manufacturing of bamboo products	• Promotion of technical knowledge and skills in the management and applications of bamboo • Innovation and incubation centres for product development

Currently, the MLNR, FC and BRU are the most powerful government institutions that are fostering the development of the bamboo industry, although there is no clear policy direction or legislative instrument to guide their efforts. The MoWH, MESTI as well as EPA have shown interest and are promoting the use of bamboo for construction and environmental restoration. Although they do not have direct influence on official developments, they can potentially influence demand for bamboo for use in built-up and spatial developments. The District and Metropolitan Assemblies permit spatial allocations for site processing and marketing centres for bamboo products and collect associated taxes/fees for the use of space and enterprise production. Hence, they could have a strong influence on spatial provision in appropriate areas within towns and cities for the aggregation of producers, wholesalers and retailers in transactions with consumers.

4.3 Value chain activities

4.3.1 Raw material production

Resource location, tenure and acquisition

Bamboo is currently sourced or harvested from four main land-use types. Across the Ashanti, Western and Eastern Regions, it is commonly owned and harvested from lowlands/marshy areas and along rivers/streams and from farmlands. Ninety-four per cent of resource owners (individuals, chiefs and families) have their bamboo resources in lowland marshy areas and on farms, while 6% have theirs on plantations (Figure 5). Due to ease of accessibility, 95% of harvesters acquire bamboo for trading from swamps and farmland belonging to resource owners in off-reserve areas, while 5% harvest from reserved forests (Figure 6). Sixty-four per cent of harvesters travel over long distances to acquire bamboo. An average distance of 7 km (ranging from 1 to 18 km) is travelled to harvest bamboo for sale, with the furthest distance being that to travel to forest reserves.

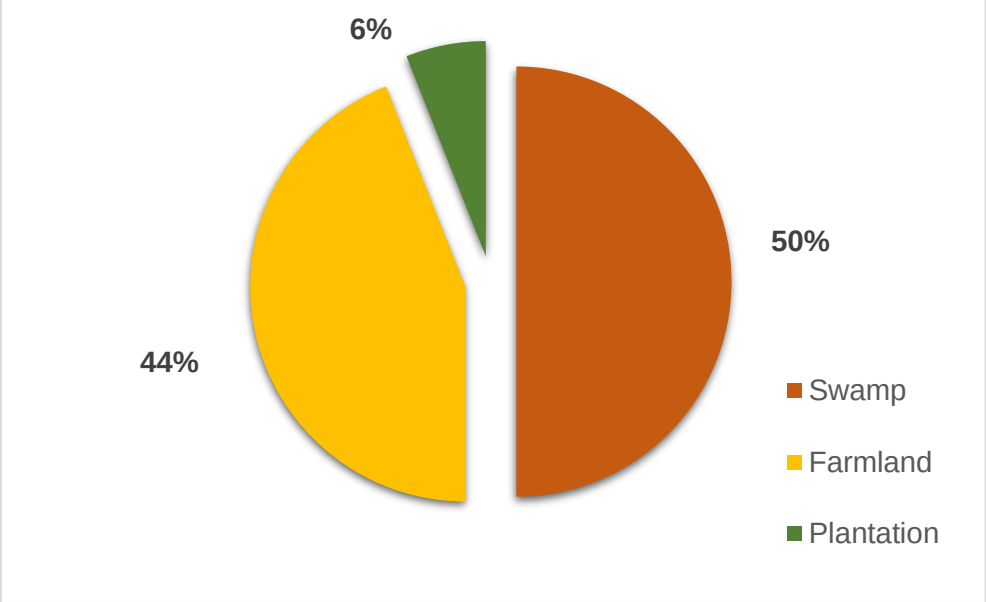


Figure 5: Land-use types in terms of owned bamboo resources.

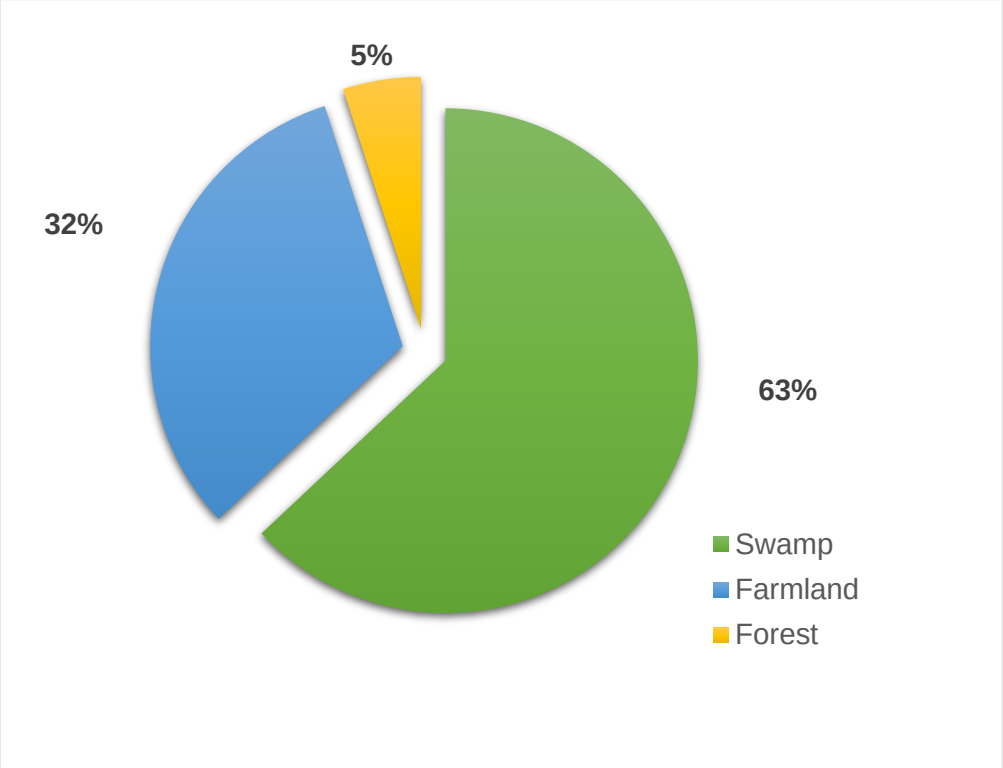


Figure 6: Land-use types where bamboo is harvested.

Eighty-four per cent of harvesters pay for the culms harvested. Commercial bamboo culms from forest reserves are acquired through paid permits from the FSD of the FC. Outside the reserves, 43% of

harvesters make payments to traditional authorities to acquire bamboo from community lands, mainly swamps, while 29% and 14% do so to the District Assembly and individual landowners, respectively (Figures 7 and 8).

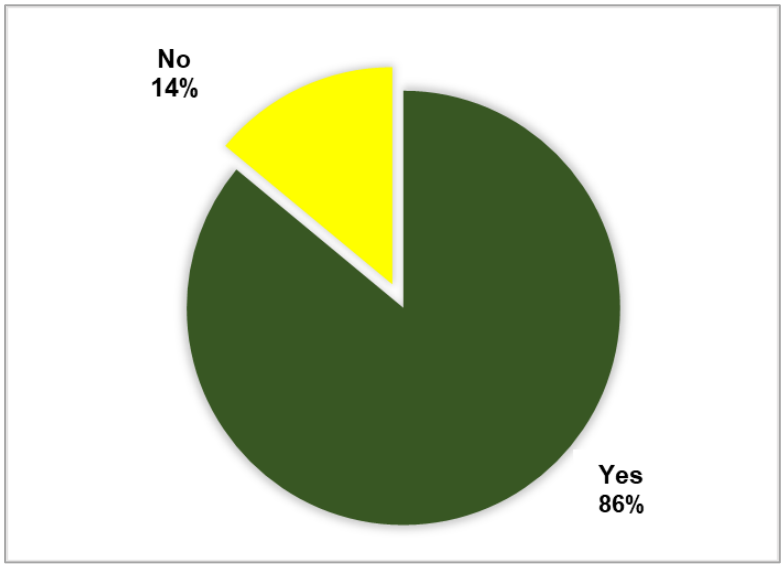


Figure 7: Payment for bamboo harvested.

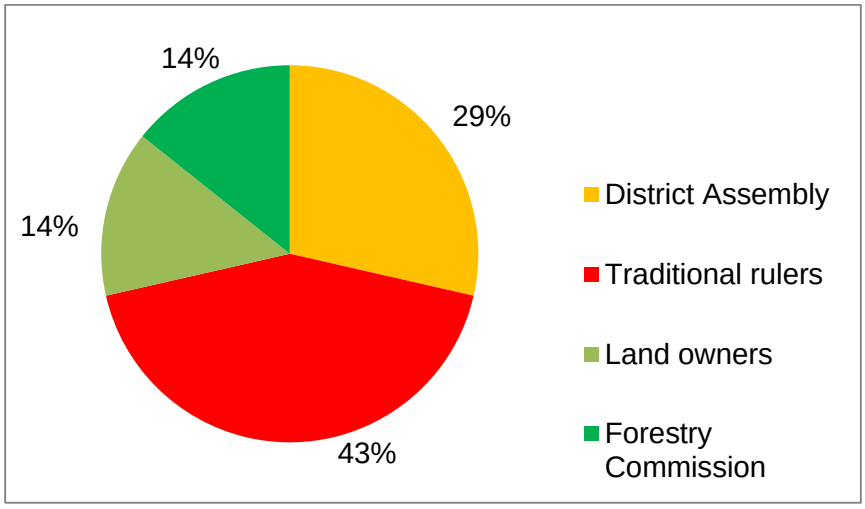


Figure 8: Entities granting permission for bamboo harvesting.

Methods of identification, harvesting, primary processing and aggregation

Mature bamboo is usually identified by its colour (yellowish-brown or green with brownish streaks), culm thickness, the colour of the internal tissue and a whitish fungal covering on the bark of the culms. To

minimise injury and prevent splitting or cracking, the mature culm is cut on the leaning side and then opposite the direction of fall with a cutlass or machete at 1.5 m above ground level on average.
The average length of the culms cut or harvested is 7.5 m long. A hacksaw is then used to crosscut the culm into the lengths required to supply clients. Harvested bamboo is usually aggregated on site where accessible or conveyed by carriers, tractors, tricycles or water (via the Ankobra River and Pra Basin) to roadsides for onward transportation to clients.

The demand for and financing and patronage of harvested bamboo

Bamboo collection is self-financed by harvesters with limited pre-financing from clients. According to 77% of harvesters, demand for their bamboo is high all year round (Figure 9) due to the increasing use of bamboo in the building industry and artisanal processing at urban centres. The major clients patronising direct supplies of bamboo from harvesters are middlemen/transporters (43%), consumers in building/construction and processing/manufacturing (36%) and culm traders (21%).

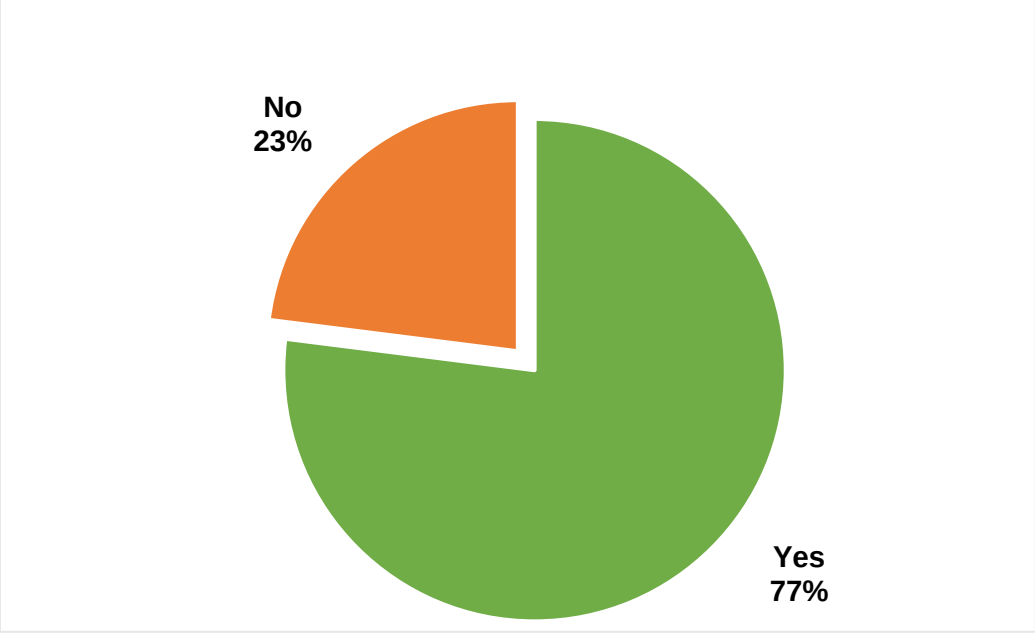


Figure 9: Harvesters' perceptions of the demand for culms.

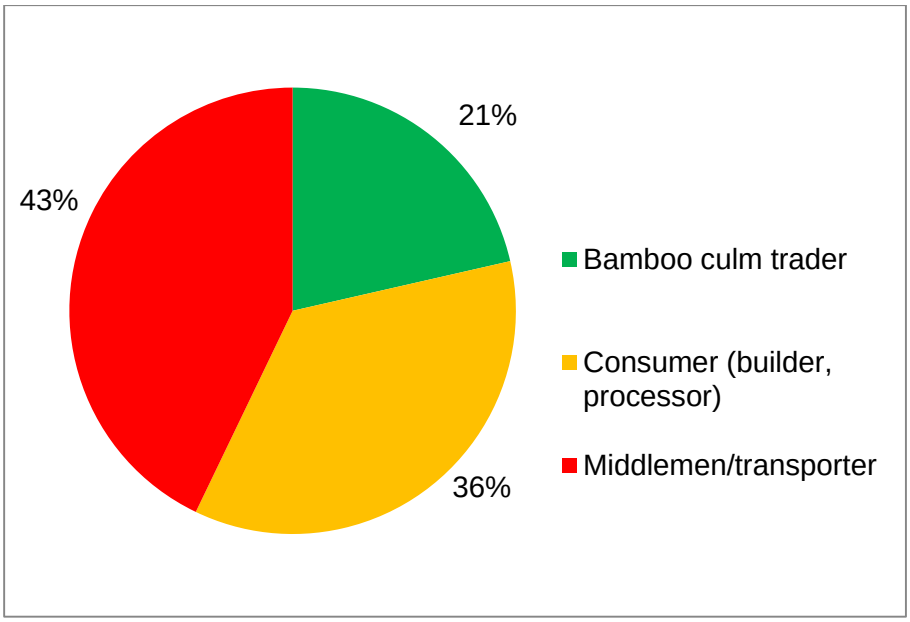


Figure 10: Clients patronising the bamboo harvested.

Conveyance (transportation)

Bamboo culm transporters were encountered while delivering stocks to clients in the Ashanti and Western Regions. Eighty-three per cent of them indicated delivering directly to wholesale and retail culm traders, while 17% deliver to processors (Figure 11). The frequency of haulage varies among transporters, ranging from 2 to 20 times per month in peak demand periods and 2 to 8 times per month in low demand periods. The peak demand period is between December and May when building and construction activities peak before the major rainy season. A Kia single-axle truck with a loading capacity of 550-600 culms per trip is the dominant vehicle used, although a Benz (207) and long vehicle (container) with a higher capacity of up to 1,500 culms per trip may be used. Sixty-seven per cent of the transporters indicated that demand for their services is high all year round (Figure 12), mainly due to the increasing use of bamboo in building/construction and processing. Since transporters are not organised into associations, it is unclear how many of them are in operation. However, assuming that a transporter carries out an average of 10 trips per month, hauling 550 culms per trip, and that demand is high throughout the year, the quantity of culms supplied per transporter is estimated at 5,500 per month and 66,000 per year.

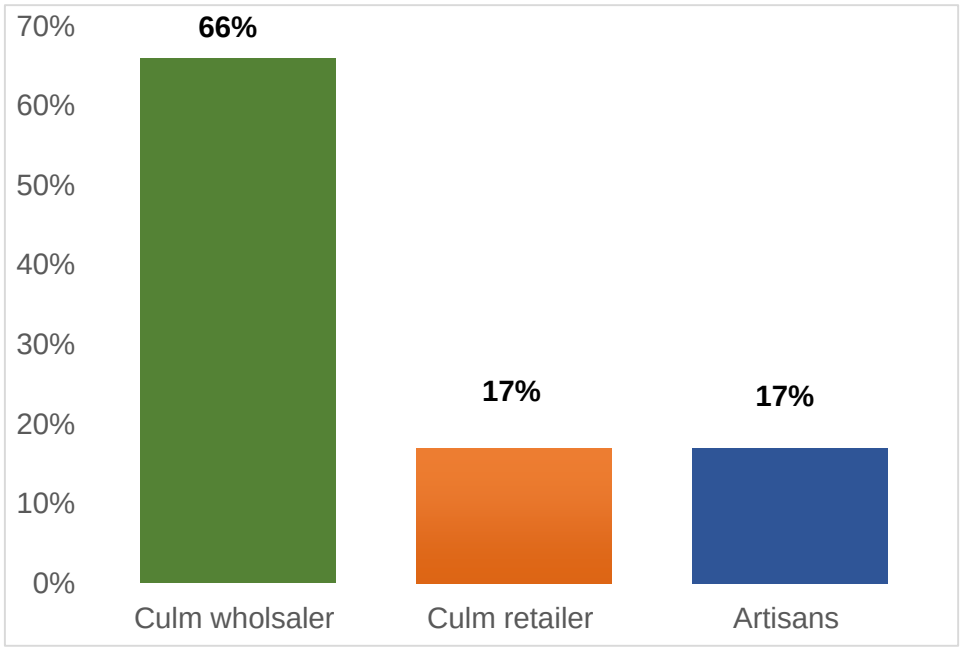


Figure 11: Bamboo culm delivery points.

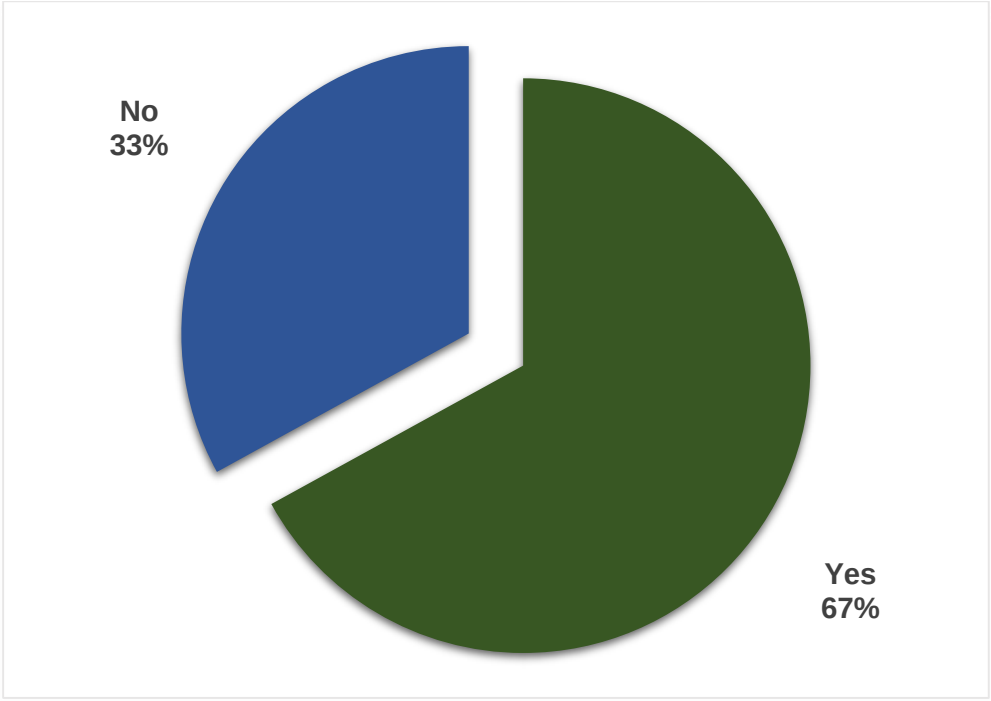


Figure 12: Demand for bamboo haulage services.

4.3.2 Value addition: Processing technologies and equipment and product manufacturing

Sources of skills and design

Approximately 70% of the processing/manufacturing enterprises are based in Accra in the Greater Accra Region, with the majority being artisanal urban producers. Seventy-eight per cent of these acquired the skills needed for processing bamboo through apprenticeships, while 14% acquired them during formal education at the Junior High School (JHS) level, and for 8% of them, it is a family occupation for which the skills have been learnt over time. Further, some processors have enriched their knowledge of product development through Chinese Government-sponsored exposure visits to China as well as International Centre for Bamboo and Rattan (ICBR)-China/MLNR/INBAR capacity building/training in Ghana. A few of them referred to the Internet, magazines and the Youth Employment Agency (YEA) as providing information and designs for producing new products.

Processing techniques and tools/equipment

The processing techniques, tools/equipment and preservation methods used by the two main categories of processors vary greatly. While the large-scale/factory processors use a combination of manual and automated tools and machinery, artisans and rural processors use simple manual tools (Table 6).

Table 6. Equipment and tools used in bamboo processing.

Tool/equipment	**Use**	**Processor/manufacturer category**
Bloom splitter	Splitting of culm	Factory
Bod pin	Making holes	Factory
Brush	Polishing	Artisan & factory
Chisel	Making holes, smoothening edges, drilling	Artisan & factory
Clamp	Clamping	Artisan & factory
Crosscut saw	Crosscutting	Factory
Crosscutter	Cutting culms	Artisan & factory
Cutlass	Cutting of nodes/removing knots, scrapping, peeling	Artisan & factory
Drilling machine	Drilling	Factory
Edge sharpener	Sharpening of tools	Artisan & factory
File	Filing nodes	Artisan & factory
Gorge (G-Clamp)	Bending of culms	Artisan & factory
Gas torch	Shaping and curving, making burning fluffs	Artisan & factory

Hacksaw	Crosscutting, trimming culms	Artisan & factory
Hammer	Nailing	Artisan & factory
Iron rod/bar	Node removal	Artisan
Knife	Cutting, peeling, scraping	Artisan & factory
Nail cutter	Removing nails	Factory
Nail gun	Nailing	Factory
Pincers	Removing nails	Artisan & factory
Planing machine	Planing	Factory
Pliers	Removing nails	Artisan & factory
Pencil & markers	Marking	Artisan & factory
Precision cutter	Cutting culms	Factory
Rip saw	Cutting culms	Factory
Ruler	Measuring	Factory
Sandpaper	Sanding	Artisan & factory
Sanding machine	Sanding	Factory
Screwdriver	Screwing	Artisan & factory
Scroll saw	Cutting	Factory
Sealer	Sealing packages	Factory
Set square	Setting angles	Factory
Sharpening stone	Sharpening of tools	Artisan & factory
Splitting jig	Splitting of culms	Factory
Spokeshave	Sharpening bamboo ends	Factory
Steel tape	Measuring	Artisan & factory
Tape measure	Measuring	Artisan & factory
Tri square	Measuring angles	Factory
Width sizer & slicer	Slicing strips	Factory
Wood planer	Planing	Factory

Factory processing

Processing techniques vary among the factory processors/manufacturers interviewed, depending on the machinery available and the type of end products. Processing primarily entails cutting the culm into the desired pieces after sorting on delivery, cleaning and curing, i.e. chemical and/or non-chemical treatment, and drying. The pieces of processed culms are used in the manufacture of furniture and bicycles, among others.

Bicycles

The manufacture of bamboo bicycle frames involves 6 main steps lasting for 80-90 hours per product. The process is as follows:

1. The harvesting of mature bamboo culms and treatment with chemicals and heat to protect the culms from insects.
2. The selection of dried treated culms to meet weight and strength requirements for a strong frame.
3. The assembly of the frame by cutting culms to the required dimensions and using well-designed jigs to ensure good symmetry and alignment of the frame.
4. The wrapping of the tacked frames with natural sisal fibres soaked in a plant-based eco-resin epoxy to ensure strong joints, stability in the frame and the ability to withstand shocks.
5. The polishing of the fitted frame wrapping by filing and sanding to perfect the finish.
6. Strict three-stage quality control checks at 50 points to ensure the product meets international safety and quality standards, and finally, the spraying of the frame with a high-quality polyurethane coat to protect it against rain and direct sunlight.

Other tertiary products are manufactured by splitting the cut bamboo culm pieces, removing the nodes, cleaning the bark and curing/treating it. The cured bamboo strips are then planed for smoothness, pressed, glued and finally planed for surface uniformity. In the manufacture of products such as toothpicks, the split culms are boiled in water, bleached for uniformity in colour and dried, before being sliced and cut into pieces for packaging. The sliced/split bamboo culms may be processed further into fine strips or flakes for the manufacture of woven products (Plate 1).

Plate 1: From the raw material to its processing and manufacture in Ghana.

The processing stages in a bamboo ply processing factory, Pioneer Bamboo in Assin Fosu, involve sorting the raw bamboo culms on delivery to cull defective ones and crosscutting each of the 14-feet culms into 3 pieces that are 6 ft, 4 ft and 4 ft long. These pieces are split and de-noded, and the bark is cleaned with a jack planing machine to remove roughness before treatment. The split culms are treated by boiling them in water and insecticide (e.g. Dursban) for three hours, or in other chemical mixtures such as water and hydrogen peroxide (expensive but a much more effective method), and then by drying them in a solar-kiln dryer.

The dried treated culms are then smooth-planed, and several pieces are glued together and pressed at a temperature ranging from 90ºC to 100ºC and at a pressure of 200 kg/cm^3 for about 5 minutes for 5 mm thick split strips. The company has also experimented with an Indian technology where the split strips are boiled in water and solar-kiln dried, and the curing process is completed by applying the chemical at the glue line. The output goes through final planing to yield the pre-finished product, e.g. bamboo ply, which is either sold to furniture companies or further processed into finished products, including ceiling panels and flooring

Urban artisanal furniture processing

A range of tools are used in urban small-scale processing (Table 6). The processing of the culms to manufacture products by urban small-scale processors seems laborious. The main stages are as follows:

1. The measuring and cutting of bamboo culms into desired sizes.
2. The peeling off of the smooth/slippery “skin” of the bamboo.
3. Treatment with Dursban and kerosene or Pyrinex 48EC, then drying.
4. Framing or moulding into furniture and artefact designs.
5. Tightening with canes or rattan.
6. The application of varnish or finishing chemicals to the surface of the product.

On acquisition of the raw culms of *Bambusa vulgaris*, straight ones are selected and cut into the required sizes, knots or nodes on the culms are removed and the culms are scraped/peeled and the nodes are planed. The ends of the culms are shaped, and blockages in hollow portions are removed with an iron rod. Holes are then drilled through the nodes, and the culm pieces are treated with chemicals and dried. The pieces are joined through nailing, gluing and tightening, to frame the product. Some weaving may be added in or around the frame depending on the product. Rattan may be used in combination with bamboo in weaving for certain products. In most cases, strips of rattan are used for binding at the joints

for extra support. The product is sanded with sandpaper or a sanding machine and polished by applying vanishes to finish it. It may be stuffed if it is furniture.

Preservation

Product durability is achieved primarily by preservation through both chemical and non-chemical treatments. Large-scale/factory processors usually improve the durability of bamboo by boiling it in water and/or other chemicals or by soaking it in cold water to reduce the starch content in the culms and drying it to prevent shrinking and drying cracks and insect and fungal infestation.

Table 7. Preservation techniques for large- and small-scale bamboo processors.

Processor category	Preservation techniques
Large-scale/factory	-Boiling in water and/or other chemicals (e.g. hydrogen peroxide) or soaking in cold water to reduce the starch content in the culms -Solar-kiln and sun drying
Artisanal	-Application of chemicals (external coating), mainly insecticides, i.e. Dursban and Pyrinex 48 EC, as well as kerosene, diesel, etc. -Sun drying

A range of chemicals are used in urban artisanal processing (Table 8) for treatment against insect borers and fungal growth. Chemical treatment is performed by dipping the bamboo in Pyrinex 48EC and drying for three days or by using Dursban and kerosene and then sun drying.

Table 8. Chemicals used for preservation and finishing in artisanal processing.

Chemical	Use
Dursban	Preservative
Pyrinex 48 EC	Preservative
Gasoline (diesel)	Preservative
Salt	Preservative
Kerosene	Preservative – mixed with Pyrinex 48EC
Petrol	Diluting vanish
Thinner	Diluting vanish, polishing
Glue	Gluing
Paint	Painting

Lacquer	Polishing
Varnish	Polishing

Product design, innovation and competitiveness

Generally, 11 major product lines are manufactured. These include furniture, baskets, fashion accessories including jewellery, bicycles, charcoal, briquettes, toothpicks and artefacts. The designs for manufacturing products are usually derived from catalogues and magazines. Albums of photos of product designs previously made by artisans are also kept to aid prospective customers in making their desired choices in terms of production. It was observed that, generally, the same types and ranges of products are manufactured across sites. However, peculiar designs and some innovation are found in particular locations. Bamboo is generally combined with rattan for the manufacture of artisanal products.

The competitiveness of most products manufactured by artisans when compared with other products from Asia is low. Factory manufacturers that use a range of automated machinery in addition to manual tools produce more appealing products compared with those of artisans. Competition among artisans is also low as most of them tend to produce similar products using the same procedures. Differences in product quality, design and innovation tend to depend on the skill of individual artisans.

Plate 2: Furniture made by artisans during a bamboo product development training in Ghana (2019)

Product manufacturing standards, grading and pricing

Except for specialised products such as bicycles (Booomers) that are manufactured according to ISO standard EN420 (tested in Germany), and possibly charcoal, briquettes, toothpicks, furniture and other products produced by factories, 78% of the manufacturers, mostly artisans, do not produce to any standards, particularly in the Western and Central Regions (Figure 13). The 22% that do consider standards in production do not conform to internationally acclaimed standards but rather to size measurements, as well as relying on testing by the Ghana Standards Board.

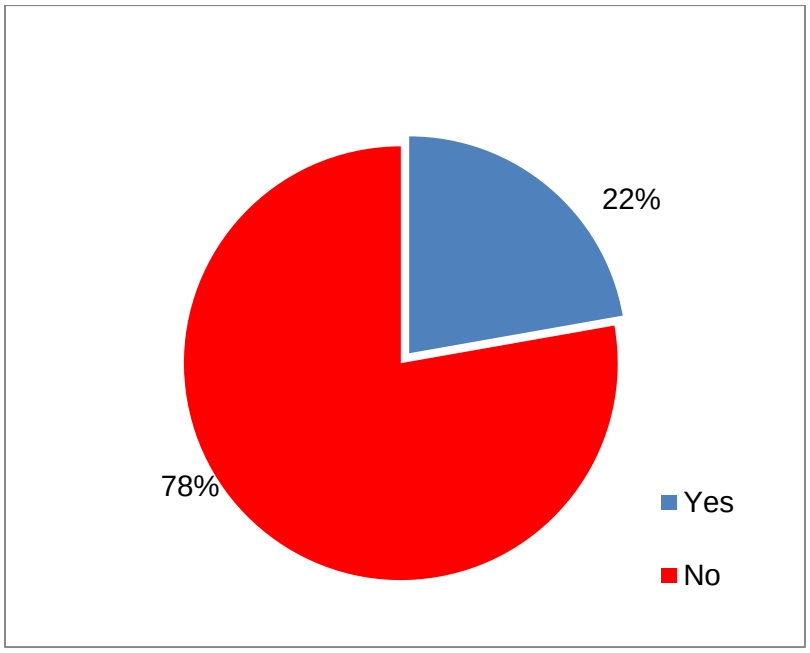


Figure 13: Use of standards in product manufacture.

Similarly, the majority (84%) of artisanal manufacturers do not grade their products (Figure 14). The remaining 16% perform some visual grading based on the quality and quantity of the bamboo used and style and design, as well as on the costs involved in the manufacture of the product.

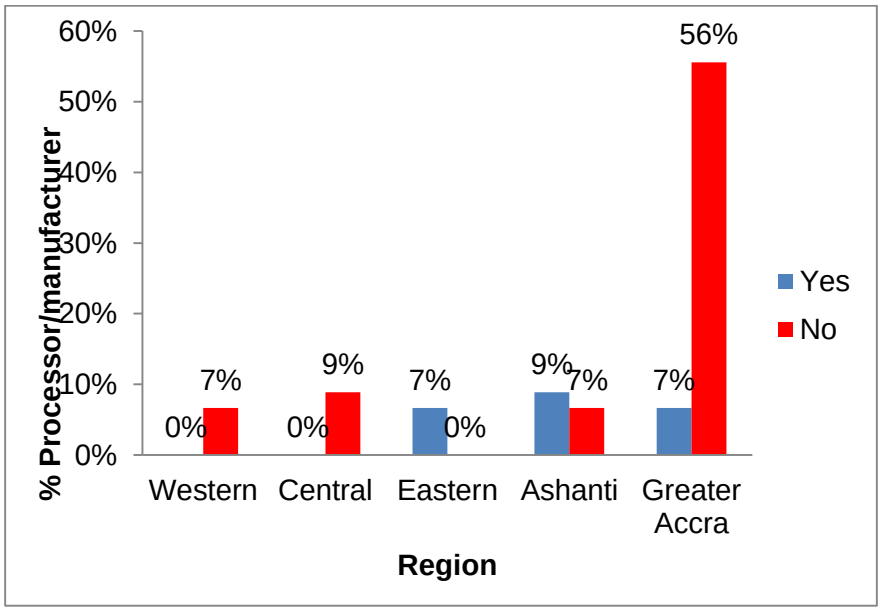


Figure 14: Grading of manufactured products.

Artisans usually set prices for their products using the following criteria: (1) the quality and quantity of material used, (2) beauty and elegance, (3) the cost of the raw materials and (4) the amount of time and work (labour hours) used in manufacturing the product. However, the final price paid depends on bargaining with customers.

4.3.3 Product distribution, marketing and consumption

Raw culms/poles

A high proportion of people involved in trading bamboo products deal in unprocessed bamboo culms, mainly sold along major roadsides or at timber markets and points of sale. The raw culms are usually used for scaffolding in building construction. The quantity of raw culms sold ranges from 80 to 10,000 pieces (average: 2,300) per month per dealer, with a culm selling for between GHC 2.0 and GHC 2.50 and the most expensive being in Accra.

Manufactured products

The general marketing and consumption pathways for manufactured products are shown in Figure 1. Manufactured bamboo products are marketed or sold, in most cases, directly to local end-users (50%) and tourists (31%) by processors/manufacturers, although contract production, in a few cases, for product dealers in Accra is also honoured for retailing. Essentially, there are usually limited cases where intermediary clients (retailers (18%) and middlemen (1%)) purchase manufactured products from artisan producers for sale to end-users in the domestic market (Figure 15), except for occasional export contracts that may involve bulk supply for retailing in a particular foreign market in Europe or in other African countries. It was observed that, in the domestic market, artisans do not pursue any vigorous marketing strategies and leave patronage to local prospective buyers or customers.

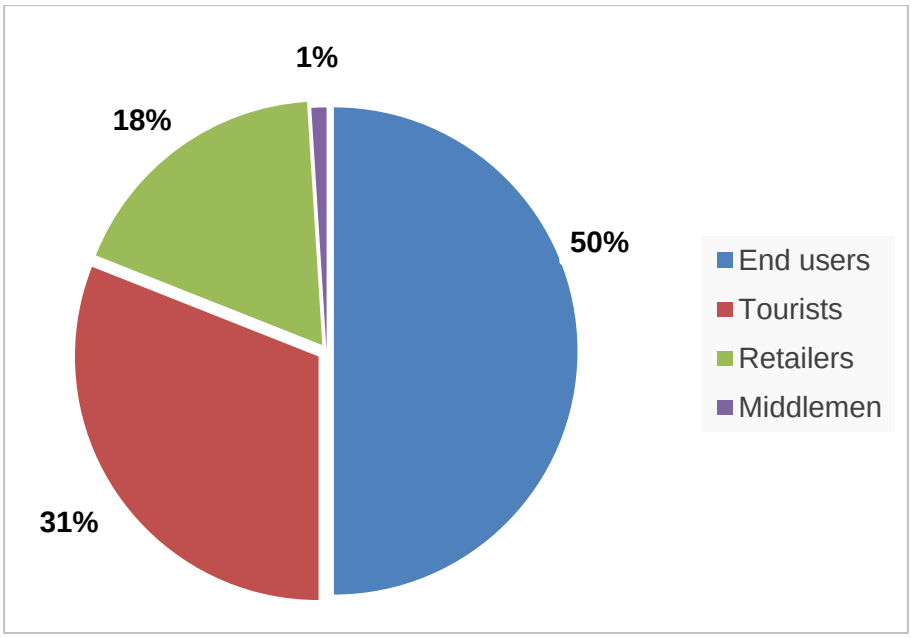


Figure 15: Major clients of manufacturers.

Products manufactured for sale by artisans are often displayed on the floor/ground along the roadside and under tree canopies near workshops, while those made in factories are displayed in designated showrooms on factory premises (Plate 3).

Plate 3: Artisanal products displayed for sale on the roadside and under tree canopies near workshops.

Factory manufacturers of bicycles, charcoal and briquettes often aim their products at export markets with some limited supply to domestic retailers and consumers due to the generally low demand for these products in the domestic market.

4.4 The market demand for and comparative advantage of selected bamboo products

4.4.1 Bamboo product value chain

Thirty-four bamboo products categorised under eleven product VC were enumerated during the survey. Furniture is the most frequently produced, accounting for 60% of the products reported (Table 9).

Table 9. Frequency of production among producers.

Bamboo product value chain	**% Production cases (Frequency of production)**
Furniture	60
Accessories (handicrafts/artefacts – bags, stands, fans, mats, jewellery, hangers, etc.)	13
Poles (raw culms/props)	8
Utensils (cups, spoons)	7
Basketry	4
Housing & construction (summer huts, fences, roofs)	3
Musical (flutes)	2
Energy (charcoal & briquettes, vinegar, tar)	1.5
Seedlings	1.5
Accessories (toothpicks, spoons, skewers, etc.)	1
Bicycles	0.5
Bamboo ply	0.5

Fifty-eight per cent of the production was recorded in the Greater Accra Region where there is the largest concentration of artisanal producers and culm traders (Table 10). Obviously, the demand for bamboo products is highest in the city of Accra due to its cosmopolitan nature and the fact that it is home to the largest population of the country's elite, who often desire bamboo products for use in their homes and offices and in the service industry.

Table 10. Bamboo product value chains.

No.	Product category/ value chain	Product	Region/number of respondents producing the product					Total	%
			Greater Accra	Ashanti	Western	Central	Eastern		
1	Furniture	Beds	22	2	3	4	-	31	15
		Sitting room chairs	21	5	3	2	1	32	16
		Dining chairs	13	-	2	4	-	19	9
		Wardrobes	8	4	1	-	-	13	6
		Bookshelves	9	1	1	1	-	12	6
		Garden chairs	5	2	2		-	9	4
		Kitchen cabinets	1	1	-	-	-	2	1
		Cots	2	-	-	-	-	2	1
		Drawers	1	-	-	-	-	1	0.5
2	Accessories	Hangers	7	-	-	-	-	7	3
		Curtains	2	3	-	1	-	6	3
		Table mats	2	2	-	1	1	6	3
		Calabash stands	1	1	-	1	-	3	1
		Bag stands	1	-	1	-	-	2	1
		Wine holders	-	-	-	-	1	1	0.5
		Bags	-	-	-	-	1	1	0.5
		Open fans	-	-	-	-	1	1	0.5
		Toothpicks	1	-	-	-	-	1	0.5
		Barbecue skewers/sticks	1	-	-	-	-	1	0.5
3	Basketry	Hamper baskets	3	-	-	1	1	5	2
		Baskets	4	-	-	-	-	4	2
4	Housing/building & construction	Summer huts	3	-	2	-	-	5	2
		Fences	1	-	-	-	-	1	0.5
		Roofs	-	-	1	-	-	1	0.5
5	Musical	Flutes	2	2	-	-	-	4	2
6	Utensils	Cups	8	4	-		-	12	6
		Spoons		2	-	-	-	2	1
7	Mobility	Bicycles	1	1	-	-	-	2	1
8	Energy	Charcoal (byproducts: vinegar & tar)	-	-	1	-	1	2	1

		Briquettes	-	-	-	-	1	1	0.5
9	Poles	Culms (natural/wild)	-	5	5	-	5	15	7
		Culms (plantations)	-	-	-	-	1	1	0.5
10	Planting material	Seedlings	-	2	-	-	1	3	1
11	Boards	Bamboo ply	-	-	-	1	-	1	0.5
Total			118	34	21	16	15	203	100
%			58	17	10	8	7		

4.4.2 The market demand for and comparative advantage of the market for bamboo products

The average demand for products produced and stocked by processors/manufacturers is medium (2) but ranges from medium to high for 82% of the products. The average monthly sales as a percentage of stocks produced is high (96%). Furniture, the most frequently produced, is one of the most highly patronised by the local market after bicycles, which are mainly exported. Eighty-four per cent of artisans produce and sell an average of two sets of sitting room chairs per month, with forty-nine per cent producing and selling one set per month. An average of 2 dining sets may be produced per month, but 67% produce and sell only 1 set per month (Table 13). Producers' perceptions of individual product demand are presented in Table 13. Comparatively, bicycles, seedlings, furniture, basketry and raw culms are the fastest moving products by producer ranking, followed by handicrafts, toothpicks, flutes and summer huts, while bamboo ply, charcoal and briquettes are the least in demand (Table 11).

Table 11. Status of demand in bamboo product value chains.

Bamboo product value chain	**% Production cases (Frequency of production)**	**Perception of demand for products (Average scores) (3 = high, 2 = medium, 1 = low)**	**% Sales per month**
Furniture	60	2.6	96
Accessories (handicrafts/artefacts – bags, stands, fans, mats, jewellery, hangers, etc.)	13	2.1	89
Poles (raw culms/props)	8	2.5	100
Utensils (cups)	7	1.5	95
Basketry	4	2.5	85
Housing & construction (summer huts)	3	2	100
Musical (flutes)	2	2	100
Energy (charcoal & briquettes, vinegar, tar)	1.5	1	-
Seedlings	1.5	3	100
Accessories (toothpicks, skewers, etc.)	1	2.1	-
Bicycles	0.5	3	-
Bamboo ply	0.5	1	-
Overall average demand		2	96

Table 12. Perception of demand for manufactured bamboo products.

No.	Product category/value chain	Product	Demand status
1	Furniture	Beds	Medium
		Sitting room chairs	Medium
		Dining chairs	High
		Wardrobes	Medium
		Bookshelves	Medium
		Garden chairs	High
		Kitchen cabinets	High
		Cots	High
		Drawers	High
2	Accessories	Hangers	High
		Curtains	Medium
		Table mats	Medium
		Calabash stands	High
		Bag stands	Medium
		Wine holders	Low
		Bags	Medium
		Open fans	Low
		Toothpicks	Medium
		Barbecue skewers/sticks	High
3	Basketry	Hamper baskets	High
		Baskets	Medium
4	Housing/building & construction	Summer huts	Medium
		Fences	-
		Roofs	-
5	Musical	Flutes	Medium
6	Utensils	Cups	Medium
		Spoons	Low
7	Mobility	Bicycles	High
8	Energy	Charcoal (by-products: vinegar & tar) (tons)	Low
		Briquettes	Low
9	Poles	Culms (natural/wild)	High
		Culms (plantations)	Medium
10	Planting material	Seedlings	High
11	Boards	Bamboo ply	Low

4.5 Costs and benefits of bamboo product value chains

The reported figures indicate that the bamboo industry is generally profitable for many of the items manufactured. The undiscounted revenue-cost ratios of products range from 1.2 for summer huts to 25 for the production of culms from wild stocks (Table 13). The supply of raw culms from wild stocks is the most profitable because of the very low price offered to resource owners at the farm gate. Summer huts are the least profitable probably due to the high labour and material inputs required for their construction.

Table 13. Economics of production and sales across selected product value chains.

Product value chain	Product	Quantity produced per month	Quantity sold	Unit cost price (GHC)	Unit sale price (GHC)	Profit/gross margin per unit (GHC)	Revenue/cost ratio	% Sales	Net income/revenue per producer (GHC)
Furniture (Per month) (Average (Range))	Sitting room chairs	2 (1-6)	2 (1-6)	736.4 (100-2000)	1153 (200-2500)	417 (100-1000)	1.6 (1.1-4)	97 (33-100)	730.00 (100-3000)
	Beds	2 (1-4)	2 (1-4)	390 (120-650)	710 (400-1000)	320 (100-500)	1.8 (1.2-3.8)	93 (50-100)	505.40 (100-1200)
	Wardrobes	1 (1-2)	1 (1-2)	420 (300-600)	720 (500-1200)	300 (200-600)	1.7 (1.3-2)	100	420.00 (200-1200)
	Dining chairs	2 (1-4)	2 (1-2)	506.3 (400-800)	873.5(600-1500)	331.3 (150-700)	1.7 (1.3-2)	79 (25-100)	387.50 (150-1000)
	Cots	1	1	200	500	300	2.5	100	300
	Bookshelves	2 (1-5)	2 (1-5)	73 (40-200)	135 (70-350)	62.5 (20-150)	1.9 (1.3-2.5)	100	82.50 (20-300)
	Shoe racks	1	1	40	50	10	1.3	100	10
Accessories (Per month) (Average (Range))	Hangers	9 (1-30)	9 (1-30)	31.3 (10-50)	58.13	27 (5-35)	1.6 (1.1-3.5)	100	256.30 (5-900)
	Curtains	6 (1-10)	6 (1-10)	30	50	20	1.7	100	110.00 (20-200)
	Calabash stands	20 (10-30)	10	10 (10-15)	20 (20-30)	12.5 (10-15)	2.0	67	125.00 (100-150)
Utensils (Per month) (Average (Range))	Cups	24 (3-50)	21 (3-50)	4.2 (2-5)	11.3 (4-20)	7.2 (1-15)	2.6 (1.3-4)	95 (70-100)	93.00 (20-175)
Basketry (Per month) (Average (Range))	Hamper baskets	93 (2-200)	71 (2-200)	8.3 (3-20)	16.2 (6-30)	7.8 (3-10)	2.3 (1.5-3.3)	85 (30-100)	374.00 (18-700)
Construction (Per month) (Average (Range))	Summer huts	1	1	1300	1500	200	1.2	100	200

Musical (Per month) (Average (Range))	Flutes	300	300	5	15	10	3.0	100	3000
Seedlings (Per cycle = 12 months)	Plantlets	10,000	10,000	1.195	5	3.805	4.2	100	38,050
Poles (wild stocks) Per month), (Average (Range))	Culms	4,000 (40-12,000)	4000 (40-12,000)	0.06 (0.04-0.10)	1.48 (0.80-2.00)	1.42 (0.04-1.90)	25.0	100	3,976 (80-6800)
Energy (Per cycle), (Average (Range))	Charcoal	-	-	-	-	-	-	-	-
Mobility	Bicycles	-	-		-	-	-	-	-

5. National and local level organisations working for selected value chains

A wide range of institutions and organisations are associated with the bamboo sector and product value chains, including local, regional and national governmental organisations, Non-governmental Organisations (NGOs) and others from the private sector. These can contribute to the development of the value chain in various ways from quality raw material production to genetic conservation, policy, research and innovation in product design and manufacture, capacity building and the financing and stimulation of domestic demand to drive competitive commercialisation in the bamboo sector (Table 14).

Table 14. Institutions and organisations working for selected value chains.

Bamboo Product Value Chain	Name of Institution/ Organisation	Category	Nature of its Contribution to BVC Development
Raw material: • Seedlings/ planting material • Plantation production (culms) • Environmental protection • Green space development (eco-tourism)	• Kwamoka Farms Ltd. • GBPL • BIDG Ltd • EPBL.	Private sector	• Establishment of bamboo plantations and nurseries on a medium to large scale • Experience with the mobilisation of rural communities in terms of involvement in plantation production for livelihood enhancement and gender inclusivity
	MLNR/FC	Public sector	• Initiating policy formulation and reforms for bamboo • Propagation of high-quality planting materials (nurseries) • Allocation of degraded forest land to individuals and corporations for bamboo cultivation/plantation
	CSIR-FORIG	Public sector	• Research and development of bamboo resources ➢ Resource inventory ➢ Germplasm conservation and distribution: Bambusetum or in situ collection of bamboo species ➢ Propagation and nursery development ➢ Supply of bamboo plantlets ➢ Establishment of demonstration stands ➢ Plantation establishment and silviculture management

			➢ Integration and management of bamboo in forest and crop production systems
	CSIR-Crops Research Institute	Public sector	• Integration and management of bamboo in crop production systems
	MESTI EPA	Public sector	• Promotion of bamboo usage for the protection of water bodies • Promotion of bamboo usage for the prevention of soil erosion, especially in hilly areas • Promotion of the use of bamboo to create green belts around towns and cities to improve the environment • Promotion of the use of bamboo for the reclamation of degraded land areas
	Minerals Commission	Public sector	• Promotion of the use of bamboo for the reclamation of degraded mine sites
	District/Metropolitan Assemblies	Public sector	• Promotion of bamboo usage for green space development in cities and parks
	MoFA	Public sector	• Promotion of bamboo usage for climate-smart agriculture
	Plantation Development Fund	Public sector	• Possible funding source for improving poor livelihoods and improving the resource base • Support for poor people and rural and natural resource development
Furniture, handicrafts/ accessories, bicycles & bamboo ply	CSIR-FORIG	Public sector	• Research on the anatomical, chemical, physical and mechanical properties of bamboo species to guide their applications • Preservative treatment • Engineering/prototype product development • Characterisation of production-to-consumption system/value chain/market system
	GBPL	Private sector	• Gained exposure and skill in small- to medium-scale processing with higher grade equipment • Experience and the possession of equipment for higher value addition for a wide range of products • Experience with the mobilisation of artisans for production and the aggregation of a wide range of products

	Business Sector Advocacy Challenge (BUSAC) Fund	NGO	• Support for the business development and management skills of bamboo sector entrepreneurs
	Export Development Investment Fund (EDIF)	Public sector	• Support for developing non-traditional products • Enterprise development support • Access to handicraft producers, market centres and national linkages
	MLNR/FC	Public sector	• Policies for sustainable resource development and management, processing and utilisation
	MoTI	Public sector	• Promotion and development of the bamboo trade • Facilitating technology transfer and ensuring the maintenance of quality control • Facilitating access to credit through groups/individuals engaged in processing bamboo and the exporting of bamboo products • Entrepreneur business development policy support • Promoting domestic and external linkages for product marketing
	Ministry of Local Government and Employment	Public sector	• Policies for the enhancement of bamboo sector employment
	Rural Enterprises Commission	Public sector	• Building the technical and entrepreneurial capacity of particular artisanal producers
	Department of Rural Arts and Industry (KNUST)	Public sector	• Developing curriculums and training manufacturers in the use of innovative designs and technology for bamboo products.
	Ghana Export Promotion Authority (GEPA)	Public sector	• Promoting fair trade • Encouraging artisans and small enterprises to export handicrafts to foreign countries • Supporting exhibitions and trade fairs of handicrafts to promote marketing
	NBSSI	Public sector	• Improving entrepreneurial skills • Business advisory service • Enterprise development

	Financial Institutions		• Investment portfolios for micro, small and medium enterprises • Tools for the assessment of the viability of the proposed investment • Could provide start-up capital at affordable interest rates for bamboo entrepreneurs
Bicycles	Booomers International Ltd. Bamboo Bikes Initiative	Private sector	• Experience with the mobilisation of producers for production and the aggregation of bamboo bicycles for distribution and marketing in domestic and international markets • Better business ideas with a profit-making orientation • Resourcefulness with facilities available for higher value addition to meet international standards • Should have the capacity to influence improvements in technical skills, designs, product diversification, marketing products and standards
	Ministry of Roads and Transport	Public sector	• Can promote the production and utilisation of bamboo bikes nationwide
Charcoal and briquettes	Energy Commission	Public sector	• Policy for the promotion of production and the use of bamboo for charcoal and briquettes
	GBPL	Private sector	• Experience with the mobilisation of producers for production and the aggregation of charcoal and briquettes for distribution and marketing in domestic and international markets • Better business ideas with a profit-making orientation • Resourcefulness with facilities available • Should have the capacity to influence improvements in technical skills, designs, product diversification, marketing products and standards
	Netherlands Development Corporation (SNV)	NGO/Development partner	• Project portfolios for the enhancement of the bamboo industry (resources, energy, etc.) • Access to resources/funds • Providing funding for R&D

			• Training and capacity building, human resource development • Studies, research and marketing
Building and construction	CSIR-Building and Road Research Institute	Public sector	• Research and applications on the use of bamboo as an engineering material in buildings/housing and the construction industry
	CSIR-FORIG	Public sector	• Anatomical, physical, chemical and mechanical properties research on bamboo species to guide the application of the species in the Ghanaian environment • Preservative treatment • Engineering/prototype product development
	Department of Architecture, etc.		• Teaching and research on the use of bamboo as an engineering material in buildings/housing and the construction industry
	Ministry of Works and Housing		• Facilitating policies for mainstreaming or promoting the use of bamboo as an engineering material in buildings/housing and the construction industry
Toothpicks and analogous products	• Pamplo Ghana Ltd. • Silverpicks Ghana Ltd. • Nation's Pride Tooth Pick	Private sector	• Experience with the mobilisation of local people for the production and aggregation of toothpicks, skewers and sticks, spoons, etc. and for their distribution and marketing in domestic and international markets • Better business ideas with a profit-making orientation • Resourcefulness with facilities available for higher value addition to meet international standards • Should have the capacity to influence improvements in technical skills, designs, product diversification, marketing products and standards

6. Policy, the institutional and infrastructural framework and the competitiveness of bamboo value chains

Ghana's 2012 Forest and Wildlife Policy (FWP), the 2016 Forestry Development Master Plan (FDMP), the Ghana Forest Plantation Development Strategy (2016-2040), the 2012 National Climate Change Policy, the 2015 Renewable Energy Policy and the 2015 Ghana Housing Policy form the main policy framework for bamboo development in the country. The policy requirements are reviewed below.

The 2012 FWP is the parent sector policy that provides the broad framework for the management of forest and wildlife resources in the country. The policy intention in terms of bamboo development is directly seen in several provisions of the policy. Notable among them are policy objective 3, strategic direction 1.4 and policy strategies 1.4.1 (d) and 3.1.1 (c). The aim of the policy is the conservation and sustainable development of forest and wildlife resources for the maintenance of environmental stability and the continuous flow of optimum benefits from the socio-cultural and economic goods and services that the forest environment provides to present and future generations, whilst fulfilling Ghana's commitments under international agreements and conventions. The policy highlights the importance of Non-timber Forest Products (NTFPs), mentioning bamboo in particular and recognising its importance as a substitute for timber. Specifically, the policy seeks to ensure the sustainable management of bamboo resources and to improve the existing stocks. One of the policy strategies (1.4.1 (d)), under strategic direction 1.4, is to develop a national regulatory framework for the commercial exploitation of defined NTFPs at the district level.

In setting out strategies to achieve policy objective 3 – 'promoting the development of viable forest and wildlife-based industries and livelihoods, particularly in the value-added processing of forest and wildlife resources' – the preamble for strategies concerning a viable forest-based industry provides the context for commitment to the requirements for bamboo development. It states that the 'policy will seek to promote the establishment of a modern efficient timber and non-timber forest products' industry that will maximize the forest and wildlife resources to ensure a balance between the industrial capacity and the sustainability of the resource and contribute significantly to the wellbeing of the rural dwellers. The policy also seeks to facilitate technological improvements and re-tooling to increase competitiveness, reduce waste and promote value addition through high-

quality secondary and tertiary processing. The strategies outlined to achieve the policy objective include advocating for the support of 'specialized training and craftsmanship schemes for processing of bamboo, rubber wood, cane and rattan and lesser-known tree and NTFP species to reduce the reliance on chainsaw lumber' (section 3.1.1 (c)).

In addition to the general policy framework and commitments in the 2012 FWP, the 2016 FDMP recognises the importance of bamboo and has made provisions in its programmes and strategic actions to align with those of the FWP on bamboo development. In addition, the FDMP seeks to develop the capacity of fuelwood-producing communities, NGOs, Community-Based Organisations (CBOs), women's groups and other identifiable groups to establish and effectively manage fuelwood plantations (including bamboo) by 2025.

Ghana's Forest Plantation Development Strategy document confirms that bamboo resources in the country are the largest group of non-timber forest products that are suitable substitutes for timber. These two resources provide a source of livelihood for many individuals in the value chain. However, the industry is clearly threatened by declines in stock and availability.

Ghana's Plantation Strategy (2016-2040) specifically identifies bamboo as one of the priority species for commercial plantations in all the ecological zones of Ghana and projects that 50,000 ha of bamboo plantations would be required to augment the supplies from natural bamboo stands over the next 25 years. In addition to *Bambusa, Oxytenanthera* and *Dendrocalamus* species, the strategy makes a provision that allows for the introduction of beneficial exotic species. It states that there is the 'possibility to procure genetically improved and superior planting materials of species to support efforts at increasing the land area with bamboo plantations in Ghana'. The strategy also aims to provide an enabling environment for the private sector because, to a large extent, large-scale investment in bamboo plantations in Ghana is expected to be implemented through private sector funding.

The 2012 National Climate Change Policy identifies natural resources management as one of the four thematic adaptation strategies for climate change mitigation in Ghana. The policy areas have been sub-divided into ten programmes, and investment in bamboo plantations alone has the potential to aid in addressing as many as six, namely the following:

1. Developing climate-resilient agriculture and food security systems;
2. Building climate-resilient infrastructure;
3. Increasing the resilience of vulnerable communities to climate-related risks;
4. Increasing carbon sinks;
5. Minimising the impact of climate change on access to water and sanitation;
6. Minimising greenhouse gas emissions (GHGs).

The Renewable Energy Act was enacted in 2011 to provide a framework for the development, management, utilisation, sustainability and adequate supply of renewable energy and to increase the proportion of such energy in the national energy supply mix, while contributing to the mitigation of climate change. Bamboo biomass has been indicated to have the capacity to replace coal in thermal applications. Ghana's 2015 Renewable Energy Policy indicates that Ghana is ready to provide an enabling environment for private investment in the energy sector. However, Ghana recognises that the major challenge in the utilisation of its known biomass resources is the uncertainty of an uninterrupted supply of biomass for large-scale energy generation; bamboo plantations have the potential to meet this challenge.

Housing is one of the prime infrastructural developmental needs for the growth of any nation, but the cost of constructing a house is often not affordable to the majority of the population, especially in developing countries. Bamboo is a useful raw material that has the potential to bring down the cost of housing construction. But, bamboo housing in Ghana is often regarded as being that of a 'poor man'. This poor perception of bamboo has limited the extent of its utilisation to mainly rural housing. However, the 2015 Ghana Housing Policy places much attention on the use of local raw materials, including bamboo. The policy states that at least 60% of raw materials used in building and construction should be derived from indigenous materials. Specifically, the policy seeks to *promote* the use of local building materials, such as compressed earth, laterite and bamboo, as alternative building material sources to reduce construction costs and improve access to appropriate housing for lower income households. Increasing the use of local, available raw materials will considerably reduce the import bill for building materials, retain capital and provide employment for youths (Appiah-Kubi *et al.*, 2015).

The National Biodiversity Strategy for Ghana was developed to ensure the sustainable use of the country's biological resources after Ghana signed and ratified the Convention on Biological Diversity in 1992. The objective of the strategy is to conserve the country's biological diversity while

ensuring that the biological resources provide lasting social, economic and environmental benefits to the population through their efficient and equitable use.

The Ghana REDD+ Strategy, 2016 shares the vision of significantly reducing emissions from deforestation and forest degradation by 40% over the next ten years, while at the same time addressing threats that undermine ecosystem services and environmental integrity. The objectives for the REDD+ in Ghana align with key national development plans for green growth. These include reducing emissions from deforestation and forest degradation while preserving Ghana's forest resources (including bamboo) and, at the same time, transforming the agricultural sector, expanding platforms for cross-sector and public-private collaboration and generating innovative, substantial and sustainable economic and non-economic incentives to improve livelihoods across all regions in Ghana.

A well-established land tenure system is a key requirement for the development of the bamboo industry. In Ghana, under customary arrangements, the ownership of NTFPs (including bamboo), wildlife or trees on communal and private lands is based on contracts governed by the kind of tenure system operating in an area (Akapame, 2016). This poses a major challenge for one legal framework to regulate the development of bamboo resources across the entire country. Bamboo charcoal is one important product that can reduce deforestation and thus contribute to carbon sequestration and the creation of jobs. Institutional responsibilities, such as the development of permit regimes for planting, harvesting and the regulation of the production of bamboo charcoal, rest with the FC and, to some extent, the Energy Commission concerning charcoal production. Several other institutions and actors across sectors of the Ghanaian economy have roles and responsibilities in facilitating the development of the bamboo sector.

7. A gender-responsive bamboo value chain

7.1 Gender distribution and bamboo resource ownership

Both male and female respondents were identified as being owners of bamboo resources during the survey. Figure 16 shows the percentage gender distribution of bamboo resource owners. Of those who owned bamboo resources, 55% were male and 45% were female. Table 15 shows resource typology and gender ownership characteristics. All the resource ownership types were reported as being naturally occurring. No plantation establishment was reported by the respondents interviewed.

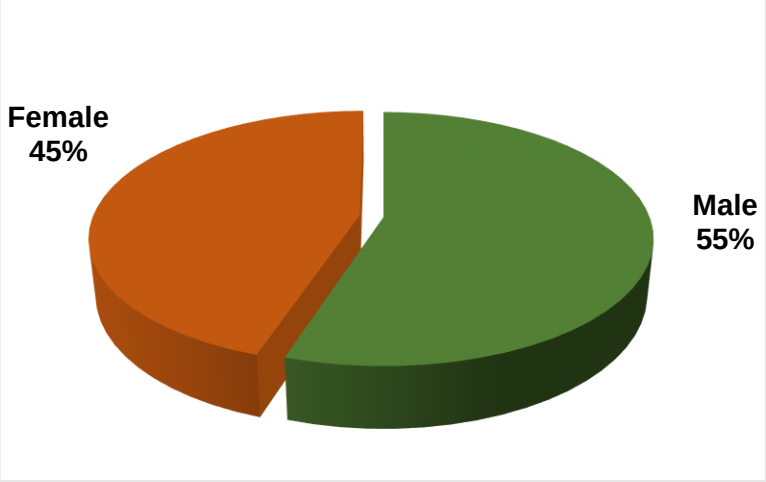


Figure 16: Percentage gender distribution and bamboo resource ownership.

Naturally occurring bamboo was owned by both males (50%) and females (50%). The size of the bamboo resources ranged from 2 to 10 acres. The 10-acre bamboo resources were owned by male respondents, while the female respondents owned resources ranging from 2 to 5 acres. These resources are mostly found on three types of land: farmlands, swamplands and natural forests. The land tenure was mainly family land. However, one respondent reported management ownership on communal land (Table 15).

Table 15. Percentage distribution of gender ownership and bamboo resource characteristics.

Resource characteristics		**Total number of respondents**	**Males**		**Females**	
		Freq (n)	**Freq (n)**	**Per cent (%)**	**Freq (n)**	**Per cent (%)**
Resource Type	Naturally occurring	10.0	5.0	50.0	5.0	50.0
Size/Acreage	2 acres	4.0	1.0	25.0	3.0	75.0
	5 acres	1.0	1.0	100.0	0.0	0.0
	10 acres	1.0	1.0	100.0	0.0	0.0
Type of Land	Low/marshy lands	8.0	3.0	37.5	5.0	62.5
	Farmlands	7.0	6.0	85.7	1.0	14.3
	Natural forests	7.0	6.0	85.7	1.0	14.3
Land Tenure	Family land	6.0	5.0	83.3	1.0	16.7
	Communal	1.0	1.0	100.0	0.0	0.0

7.2 Bamboo culm harvesting and transporting

The bamboo culm harvesting operation was identified as a male-dominated livelihood activity. Out of the 17 bamboo culm harvesters interviewed, no females were identified as playing any key role in the harvesting and transporting operations in the value chain. Figure 17 shows the different activities carried out by male harvesters. Transporting bamboo culms from the resource base sites to points of sale was similarly identified as a male-dominated activity. None of the six transporters interviewed identified the involvement of female counterparts.

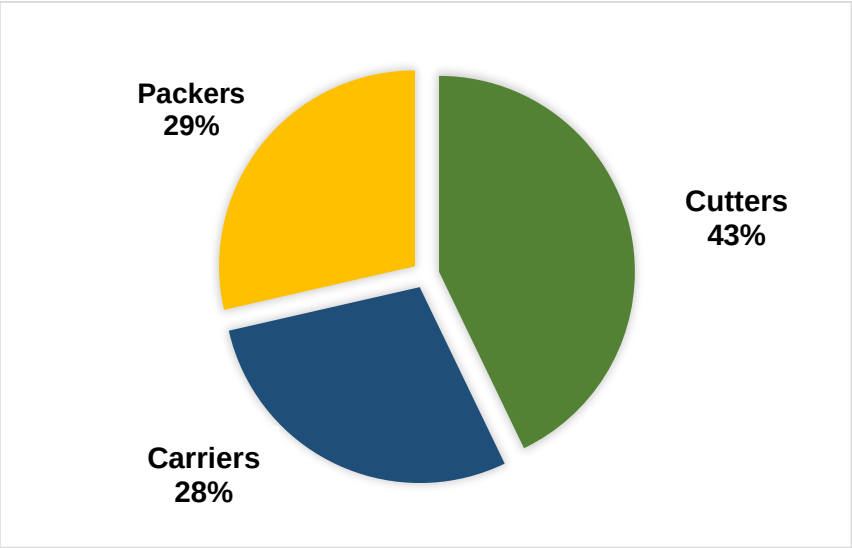


Figure 17: Percentage distribution of activities carried out by males in bamboo culm harvesting operations.

7.3 Bamboo culm trading

Both males and females were identified as culm traders during the market survey. However, female traders were relatively fewer. Of the 21 culm traders interviewed, 16 respondents, representing 76.2%, were male culm traders, while 5, representing 23.8%, were female culm traders. Identifiable roles included loading and offloading and the packing and stacking of culms on shelves. Figure 18 shows the percentage distribution of gender involvement in these activities.

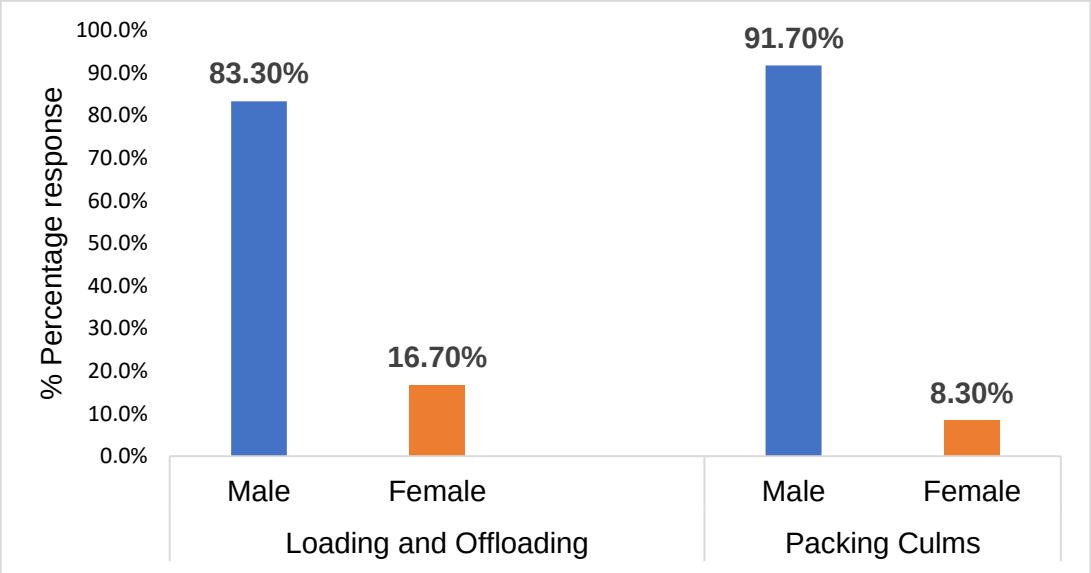


Figure 18: Reported roles and percentage distribution of gender involvement in bamboo trading.

7.4 Gender in bamboo processing

Although bamboo processing seems to be tedious and dominated by men, approximately 6% of processors were identified as being female among the 49 processors interviewed in this study. Generally, processing activities were mainly dominated by men (Figure 19). Compared to all the reported activities, planning, a secondary activity, was the only task that had considerable female involvement (15%).

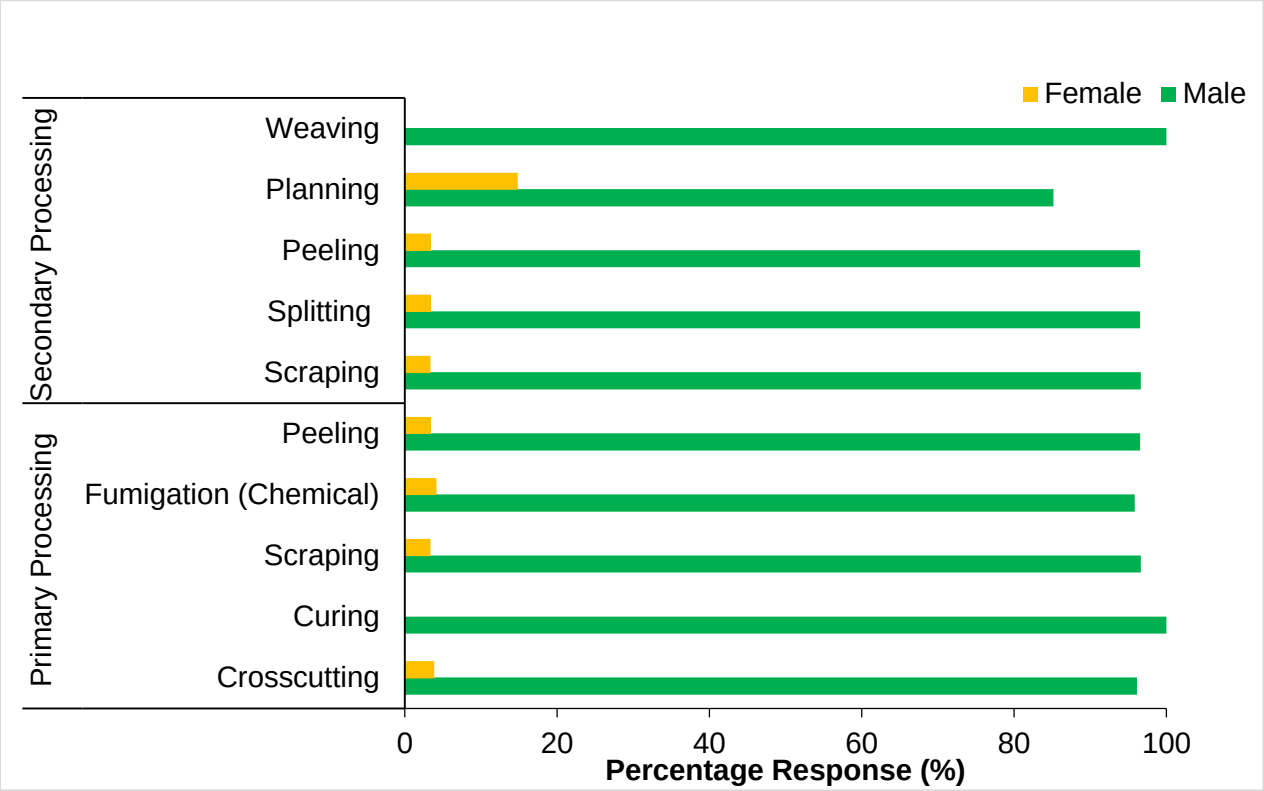


Figure 19: Percentage distribution of gender involvement in bamboo processing activities.

The results regarding gender trends confirmed those reported in other studies. The bamboo industry in Ghana is predominantly dominated by men (Tekpetey *et al.*, 2015; Amoah and Assafuah, 2015). The few women involved in the industry have clearly distinct roles, and these roles often vary from one country to another (Carl and Hartl, 2008). In some cases, women were found to develop products for household use whereas men tended to produce for the market (Carr and Hartl, 2008). In Ethiopia, female-headed households showed reluctance to engage in the bamboo industry compared to male-headed households (Mekonnen *et al.*, 2014).

Kalanzi *et al.* (2017) also indicated that, in Uganda, men dominated the harvesting of bamboo with support from women and children. Processing and marketing were equally dominated by men. Women in Uganda seldom participate in making baskets and trays because the sitting positions involved are not acceptable for women (Kalanzi *et al.*, 2017). In Ghana, females were more likely to be involved in the harvesting and marketing of bamboo products, whereas males were more likely to be engaged in all three activities, i.e. harvesting, processing and marketing (Amoah and Assafuah, 2015). In general, Ghanaian women were more actively involved in the industry during peak seasons like Christmas, when more hands are needed for basket weaving (Pentsil *et al.*, 2016). Amoah and Assafuah (2015) ascribed the reason for the dominance of men in the value chain as being due to gender stereotyping and traditional practices, which greatly minimises the number of women who actively participate in the value chain.

Forest and wildlife policy seek to mainstream gender and vulnerability issues into forestry development planning and management. Generally, there are no gender restrictions to participation in bamboo sector activities. Both men and women have invested in bamboo industry activities, although men tend to be dominant. At the community level, male dominance in household decision-making and the propensity to engage in hazardous as well as labour-intensive jobs dictate the level of involvement in forest product value chains.

Strategies and interventions for the promotion of a gender-responsive bamboo value chain across local and tertiary markets should involve the following:

1. Encouraging bamboo entrepreneurship among youths by promoting apprenticeships and job models that permit both genders to engage in any aspect of the chain as a livelihood option.
2. Promoting start-up models in bamboo entrepreneurship among youths (both men and women), including business management principles that encompass tasks from production to marketing.
3. Increasing technical skill training opportunities among youths (both men and women) in bamboo processing and manufacturing enterprises.
4. Facilitating female-led production, for example, basket weaving and accessory making (jewellery, bangles, bags, wall hangings, slippers), among others.
5. Promoting labour-saving devices for processing to reduce drudgery and the risks associated with the manufacture of bamboo products.

6. Strengthening market linkages in the value chain to involve women in the wholesale and retail of finished products, rather than having male producers/manufacturers market their products. This will create employment and increase potential demand.

8. Growth potential, market trends and competitiveness of the bamboo value chain

Trends in the international market show that woven products from bamboo constitute the largest volume of products traded. The demand for engineered bamboo products has also continued to increase in volume, from 24% in 2009 to 30% in 2014. Statistics also show that while the proportion of bamboo furniture traded continues to decline, the demand for bamboo shoots continues to increase (INBAR, 2016). Although bamboo has traditionally been used in rural applications for centuries in Ghana, its economic potential regarding its use in higher value products is yet to be fully harnessed. There are insufficient statistics or data on the production, trading and consumption patterns of the 11 product value chains identified in this study. Thus, empirical estimates to predict market growth and potential can only be inferred from the limited information available. Specific product value chains with promising market potential and prospects are listed in Table 16.

Table 16. Value chains with market potential.

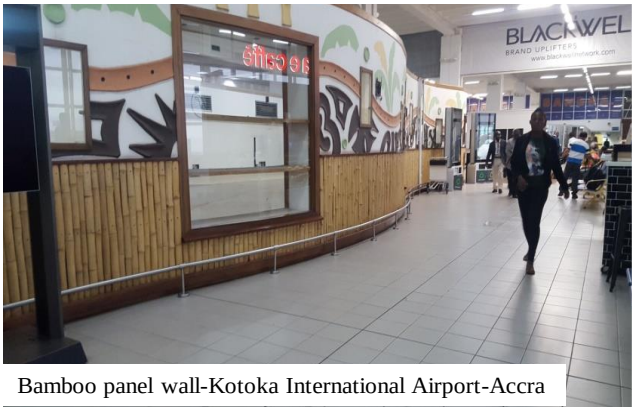
No.	Value Chain	Prospective Market	Growth – Potential Demand/Future Prospects (1 = Low, 2 = Medium, 3 = High)
1	Nursery production for plantlet supply on large, medium and small scales	• Domestic: for plantation production and land restoration	3
2	Plantation production for quality raw material/culms supply	• Domestic • Potential exports to regional and sub-regional and international markets	3
3	Culms production for the building and construction industry	• Domestic • Potential exports to Africa and West Africa of treated culms or poles	3
4	Energy: charcoal and briquettes, including activated charcoal	• Domestic • Potential exports to Africa and West Africa, the Middle East and Europe	2 – Competition from charcoal producers using traditional species
5	Mobility: Bamboo bicycles	• Export • Domestic: for use in the transition and Northern Ghana	3 – Prospects for the premium and green economy
6	Toothpicks, skewers, barbecue sticks	• Domestic and sub-regional and regional markets	3

7	Domestic utensils: trays, spoons, ladles, stirrers, cutlery holders	• Domestic	2 – Competition from products made from plastics, ceramics and melanin
8	Furniture and crafts (picture frames, bags, etc.)	• Domestic • Potential exports to Africa and West Africa	2 – Competition from imports

8.1 Bamboo for building and construction development

The growth in the bamboo sector will be driven by the production of quality raw material and the requisite technology for its efficient application in building and construction. It is anticipated that the bamboo market in Africa will be driven by increasing demand from the construction industry. Apart from props in construction, the building of summer huts, pavilions and rural houses, among others, and the application of bamboo in buildings, particularly for the hospitality industry, are increasing in Accra (Plate 4).

Bamboo fence/wall-Accra



Bamboo panel wall-Kotoka International Airport-Accra

Bamboo house lodge-Accra

Bamboo house lodge-Accra

Plate 4: Bamboo in infrastructure (housing and construction) in Accra.

Untapped product opportunities with potential domestic sales and exports to foreign markets include the use of bamboo in flooring, countertops, veneers for furnishing and beams in construction. The global market for these products is enormous. In 2009, the international export market for bamboo flooring was worth approximately USD 252 million, with China accounting for USD 224 million or 89% of this total value. In 2009, the EU and Canada were the two largest international importers of bamboo flooring, accounting for USD 26 million and USD 18 million, respectively, of the total global import market. The Japan, Mexico, New Zealand, Singapore and USA are the other key international importers of bamboo flooring. Moso Africa Ply Limited in South Africa has established bamboo plantations specifically for the production of flooring, beams, panels and veneers for the European market under the Forest Stewardship Council (FSC) certification. Similarly, Teragren Ltd in Kenya produces flooring, countertops and panels for the international market under the Leadership in Energy and Environmental Design (LEED) certification.

8.2 Basketry and toothpicks

The potential of bamboo basketry is enormous but remains untapped in Ghana. Traditionally, baskets are used for packaging and the nationwide transport of a wide range of products including perishable goods, such as vegetables and fish, as well as gifts and hampers on special occasions (Christmas, birthdays, Valentine's Day, etc.). In the north of Ghana, bamboo is used for making baskets for traditional brewing (Obiri and Oteng-Amoako, 2007). However, in the south, baskets are made from palm fronds and cane/rattan, among other materials. Rattan stocks have dwindled in the natural forests; hence, bamboo, which is readily available, could be managed as a substitute raw material for basket weaving. Trade in woven bamboo products, including baskets, between Asia and the rest of the world, was worth USD 438.2 million in 2012. The demand for cane baskets for Christmas hampers and other uses is declining due to the increasing importation of cheaper attractive bamboo and plastic baskets for gift shops and supermarkets from Asia and, in particular, from China, to Ghana.

Similarly, there is high demand for toothpicks in Ghana. There are at least three Ghanaian manufactured toothpick brands on the market. Pamplo Ghana Limited manufactures 30,000 packages per month to supply the Ghanaian market. Although demand for toothpicks is high, manufacturers have encountered competition from cheaper brands from China.

Plate 5: Toothpick brands made in Ghana.

8.3 Bamboo bicycles

Limited data from Booomers International Ltd. show a steady increase in its bamboo bike production over 10 years (Figure 20). With a high demand for its products in Europe and America, its raw material intake increased from 40 culms to 1,200 culms per annum over a decade, with a commensurate increase in its labour force from 4 to over 40 people. Its production turnover with respect to bicycle frames is currently over 1000 bicycle frames per annum. This clearly indicates progressiveness in the bicycle value chain and prospects for growth over time.

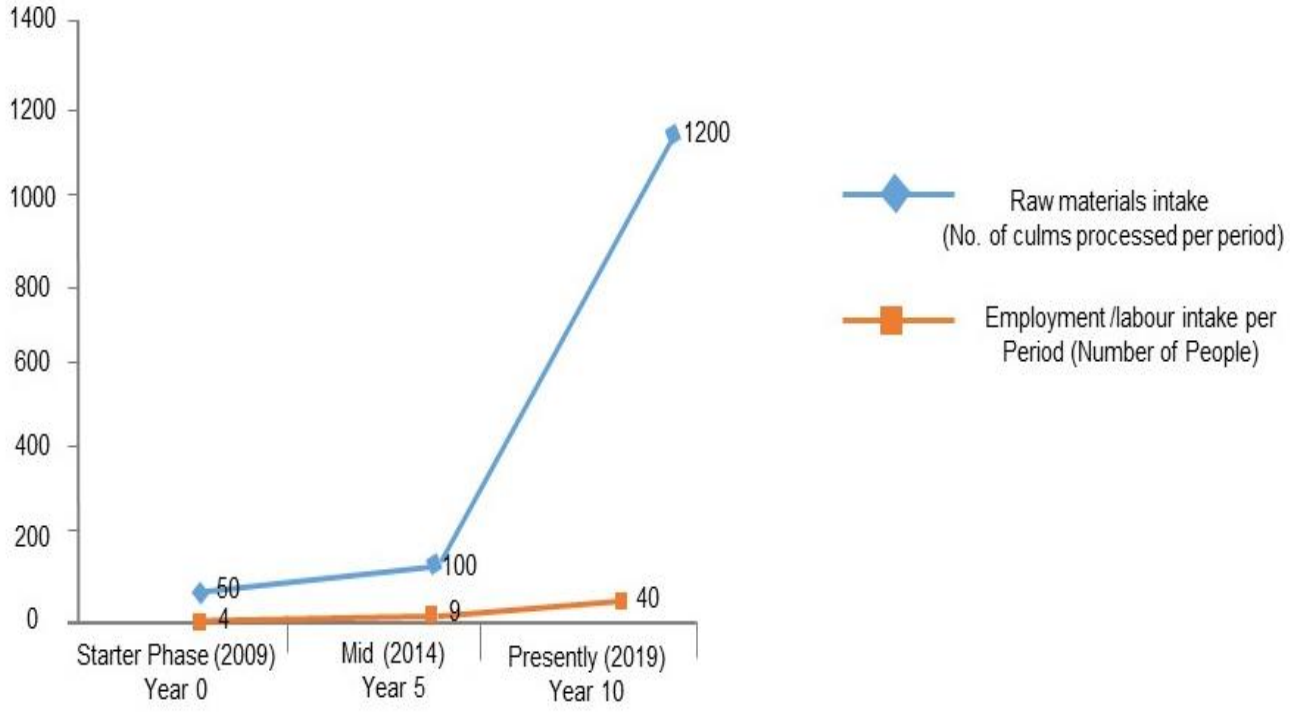


Figure 20: Raw material and labour intake over 10 years for Booomers International bicycle manufacturer.

8.4 Prospects for accessing the international market for bamboo products

According to INBAR (2016), to a large extent, bamboo products are mostly traded within and between Asia and Europe. Globally, the main source of bamboo products is Asia, and the major export market is to destinations in Asia, Europe, and North America. In 2014, the export value of bamboo products from Asia was estimated at USD 1,563 million, meaning that the continent accounted for 85% of world exports. Europe is the second largest exporter, with an export value of USD 197 million, roughly equivalent to 11% of the world total. Of the 85% of exports from Asia, bamboo products from China alone represented 72.6% of this total.

In Africa, the leading exporters of bamboo products are Namibia and Nigeria (INBAR, 2016). Ethiopia has the largest bamboo forest on the continent, but it produces products using traditional and manual techniques, primarily for the domestic market, and its imports of bamboo products far exceeds its exports (Mekonnen *et al.*, 2014). However, in Ghana, although the bamboo industry is not very advanced in terms of the use of modern technology in production, the country still produces for the export market, mainly neighbouring West African countries, but this is not officially documented. A list of some other export destinations mentioned by artisans includes Algeria, Austria, Egypt, Germany, Italy, and Libya (Pentsil *et al.*, 2016). Generally, Ghanaian artisans are unable to access and compete in the export market due to issues with international standards. Even within the West African domestic market, artisans have difficulty with the advertisement and marketing of their products (Tekpetey *et al.*, 2015). A survey on artisans in Accra showed that they all lacked formal training in marketing but that about 45% made use of business cards and websites to help market their products (Pentsil *et al.*, 2016).

Certifications and standards are required to increase the demand for and competitiveness of products in both domestic and export markets. The development of standards is an ongoing process, which ensures that products and services churned out by the market are in conformity with international guidelines. Unfortunately, the manufacture of bamboo products and processing in Ghana are rarely carried out to conform to international standards (Tekpetey, 2011). Over the years, INBAR, in collaboration with partners, has developed standards for bamboo products that are commercially traded on the international market. In China, for example, national standards have been developed for all bamboo products, such as bamboo timber, bamboo shoots, bamboo plywood mats and bamboo flooring. The development of standards for bamboo products for developing countries including Ghana is currently underway with facilitation by INBAR and the

national standard authorities of participating countries. An ISO-accredited wood and furniture testing laboratory has been established at the CSIR-Forestry Research Institute of Ghana in Kunasi. The centre is in the processes of being validated to improve the quality of wood and related products for domestic and export markets. The centre can thus support the development of bamboo products in terms of meeting the requirements of export niche markets.

8.5 Constraints and opportunities for an inclusive and sustainable completive value chain

Seven major constraints characterise the identified product value chain comprising (1) limited diversity in species being produced for raw material, (2) inappropriate harvesting methods, (3) inadequate technical capacity, (4) inadequate equipment capacity for efficient higher value addition, (5) limited financial capacity to invest in the requisite infrastructure and equipment for the production of competitive products, (6) the high cost of capital on the financial market and (7) poor domestic demand for bamboo energy products, in particular (Table 17).

Table 17. Major constraints and opportunities within the selected bamboo product value chains and possible interventions

Bamboo product value chain	**Major constraints**	**Opportunities and interventions for an inclusive and competitive value chain**
Seedlings	• Inaccessibility of a wide range of quality and user-specific parent stocks for multiplication Thus, some firms are importing plantlets of desirable species.	• About 20 species for specific uses available in conservation gardens • Documentation of locations for required access • CSIR-FORIG, INBAR and BRU can facilitate production manuals on techniques for the multiplication and production of parent stocks for supply
Raw culms	• Risky harvesting methods from natural stocks • Poor durability due to immature culm harvesting	• Harvesting methods developed by CSIR-FORIG • Preservation methods developed by CSIR-FORIG • CSIR-FORIG, INBAR and BRU can facilitate production manuals on techniques for sustainable harvesting and management

Furniture (artisans)	• Inadequate technical skill for higher value addition • Inadequate tools/equipment for higher value addition and innovation	• INBAR/MLNR/BRU/MoTI can facilitate dedicated projects and the development of training modules to enhance artisans' accessibility to improved skills • Common facility with requisite machinery for higher value addition • Introduction/promotion of processing techniques and equipment manufacture and engineering and their use in design schools, technical and vocational educational training centres, universities, etc.
Basketry	• Inadequate technical skill for higher value addition • Declining demand due to competition from Asian goods	• INBAR/MLNR/BRU/MoTI can facilitate dedicated projects and the development of training modules to improve weaving techniques • Common facility with the requisite machinery for higher value addition • Introduction/promotion of processing techniques and equipment manufacture, engineering and use in design schools, technical and vocational educational training centres, universities, etc.
Handicrafts/artefacts	• Inadequate technical skill for higher value addition • Inadequate tools/equipment for higher value addition and innovation	• INBAR/MLNR/BRU/MoTI can facilitate with dedicated projects and the development of training modules to enhance the accessibility of improved skills for artisans • Common facility with requisite machinery for higher value addition • Introduction/promotion of processing techniques and equipment manufacture and engineering and their use in design schools, technical and vocational educational training centres, universities, etc.
Bicycles	• High cost of capital for the acquisition of appropriate machinery • Limited domestic demand	• High export demand • MoTI has the financial ability to support industrial entrepreneurs • Need to prepare a dossier on the enterprise profile, business management plan, financial flows, etc., as well as lobbying, among other criteria, will be required to access funds
Toothpicks, spoons, skewers, etc.	• Competition from Asian goods in terms of cost and quality	• Appropriate machinery and technology is available for higher value addition • MoTI has the financial ability to support industrial entrepreneurs

		• Need to prepare a dossier on the enterprise profile, business management plan, financial flows, etc., as well as lobbying, among other criteria, will be required to access funds
Laminated/bamboo ply	• High cost of production • Inadequate technical skill to engage • High cost of capital for the acquisition of appropriate machinery	• Existing enterprise needs to be reviewed • Technical skill available. INBAR/ICBR-China/ MLNR/FC/TIDD and MoTI to facilitate the training of production technicians • Development of dossiers for investor partnerships for the requisite equipment and re-tooling to enhance productivity • Opportunity to supply diversified end uses/applications of furnishings in building and construction. Industry for beams, parquet flooring, panelling, tongue and groove (T&G) ceilings, etc. in addition to furniture for both domestic and export markets
Energy: charcoal and briquettes (vinegar, tar)	• Low local demand	• Potential use in hotels, restaurants and industry but needs promotion • Export potential exists but standards and market niche requirements need to be adopted

The challenge of limited diversity in the raw material and inappropriate culm harvesting methods can be addressed through capacity and skill development by INBAR, the MLNR, CSIR-FORIG and the BRU of the FC. These institutions would need to facilitate the design and delivery of training modules to reach more artisans and other producers needing to upgrade their technical skills for specific product value chains. Setting up a common facility with a pool of relevant machinery for processing to be managed by an entrepreneur as a business will improve efficiency and the quality of products while reducing drudgery.

Generally, there is a growing interest among new investors seeking opportunities in the bamboo industry (Lin, 2018). The MLNR and MoTI need to facilitate the preparation of dossiers of possible bamboo-based investment opportunities, including business models, in the country to encourage partnerships as well as new investments that will provide external finance or capital for the development of industries and to drive the commercialisation of the bamboo sector.

9. Value chains for smallholder incomes and livelihoods

9.1 Contribution of bamboo to household income

Globally, over 2.5 billion people depend on bamboo for survival and their livelihoods (Phimmachanh *et al.*, 2015). Further, bamboo provides various subsistence benefits to many households, such as in the form of furniture, farm tools, construction materials and fodder, the value of which is often not quantified (Mekonnen *et al.,* 2014). But bamboo forests are mostly cultivated as collective forests in the hilly areas of southern China. The huge economic benefits derived from bamboo forest management in China have contributed substantially to rural development and poverty alleviation, and it is estimated to generate approximately 30% to 40% of a farmer's income (Torya Mera and Xu, 2014). Other studies have found that bamboo's contribution to income varies significantly with the landscape and the socio-economic status of the people. Hogarth and Belcher (2013) also showed that in a poor mountainous county in China, the average share of an income that was derived from bamboo was 13.3%, and this varied from 0% to 50% between villages. Also, households with more income had the highest bamboo income in absolute terms, whereas low-income households had the highest dependence.

In West Africa, bamboo resources are seldom cultivated by private individuals and are often collected from the wild. In Ghana, bamboo has enormous potential to support the livelihoods of a wide range of actors, particularly in the private sector. It is the primary source of income for 43% of the core actors in the value chain and 100% of the artisans engaged in its processing and product manufacture. An estimated 15,000 people are employed in the bamboo sector, catering for 60,000 dependents in their households (Kwaku, undated). Kalanzi *et al.* (2017) showed that in forested areas of Uganda where bamboo was accessible, its contribution to household incomes was 55%, followed by agriculture's 29.1%.

9.2 Potential livelihood enhancement with bamboo value chains

Five promising bamboo product value chains with current or potential high demand that are already being pursued by entrepreneurs have been identified during this study. These include bamboo seedlings or plantlets, poles/culms for the construction industry, toothpicks and barbecue sticks, bamboo bikes and furniture. These and a few others have the potential to impact highly on the incomes and livelihoods of smallholder farmers as follows:

1. Large-scale plantation production of bamboo raw material (e.g. EPBG, GBPL, Booomers International Ltd., Kwamoka Ltd., BIDG) where communities are engaged as nursery and

plantation workers or producers and could also integrate food crops into the alleys between bamboo blocks or rows to be used to provide food and income.

2. Bamboo cultivation with appropriate species for specific end uses integrated into smallholder croplands within agroforestry systems or on degraded or idle lands for culm production could provide sustainable sources of income. Bamboo, which is highly productive, and culms, which are in demand throughout the year, could provide intermittent incomes to bridge the gap between the high and low seasonal agricultural income troughs.
3. Culm production or their collection from well-managed wild stocks for the building and construction industry, particularly those on individual lands and farms, will also generate year-round income if resource owners are sensitised to the importance of the bamboo resources and trained in appropriate harvesting techniques to manage them sustainably as part of their production systems.
4. Bicycle manufacturing (Booomers International Ltd., Bamboo Bikes Initiative, etc.) can engage youths of both genders in employment, particularly in rural and peri-urban areas, to reduce rural-urban migration and social vices. Further, engaging smallholders in raw material production for supplies to use in bicycle frame manufacture will provide supplementary incomes to farm households while reducing poverty and providing sustainable livelihoods in communities and ultimately enhancing rural economies.
5. Seedling production, as indicated in Table 14, is highly profitable with a cost return ratio of 4.2. It is an enterprise that can be undertaken by rural and peri-urban women and youths for income if adequately trained to perform off-farm activities in backyards. However, market linkages will need to be created to enhance supply to potential clients.
6. The manufacture of furniture, handicrafts and accessories (artisanal and factory production) is profitable with a revenue-cost ratio of 1.3-2 on average. Improvements in efficiency may be required to increase productivity and quality or promote higher value addition. This will require a commensurate increase in the supply of raw material from resource areas, thus enhancing livelihoods in those areas.
7. Toothpicks (Pamplo Ghana Ltd., Silverpicks Ghana Ltd., etc.) are a fast-moving product with a huge import value. Investments in appropriate processing equipment should be made to improve the product quality and to manufacture them at a competitive cost to be able to compete with Asian suppliers. Increasing demand will require more labour at processing plants with a concomitant increase in employment and incomes dependent on this value chain, including those of raw material producers.

8. Bamboo charcoal and briquette production (GBPL and Silverpicks Ghana Ltd.) could, in the future, provide a sustainable livelihood for fuelwood-dependent communities. Although currently in low demand in the domestic market, the potential for export market production, including diversification to include activated charcoal, is appreciable. Promotion among manufacturing industries, schools and the hospitality industry, which require higher energy content heat for processing and cooking, will stimulate this product value chain in terms of an increasing use of raw material and labour to the benefit of livelihoods in resource areas.

10. Constraints and opportunities in the bamboo value chain

10.1 Challenges faced by core actors in the bamboo value chain

In Ghana, predominant constraints impeding the development of the bamboo industry have been reported to include access to the resource (raw material), the transportation of the raw material, access to the forests, the market for end products and prompt payment for goods and services (Amoah and Assafuah, 2015). However, the key challenges identified in the value chain constraining the developed and commercial potential of bamboo in Ghana from actors' perspectives are summarised in Figure 21.

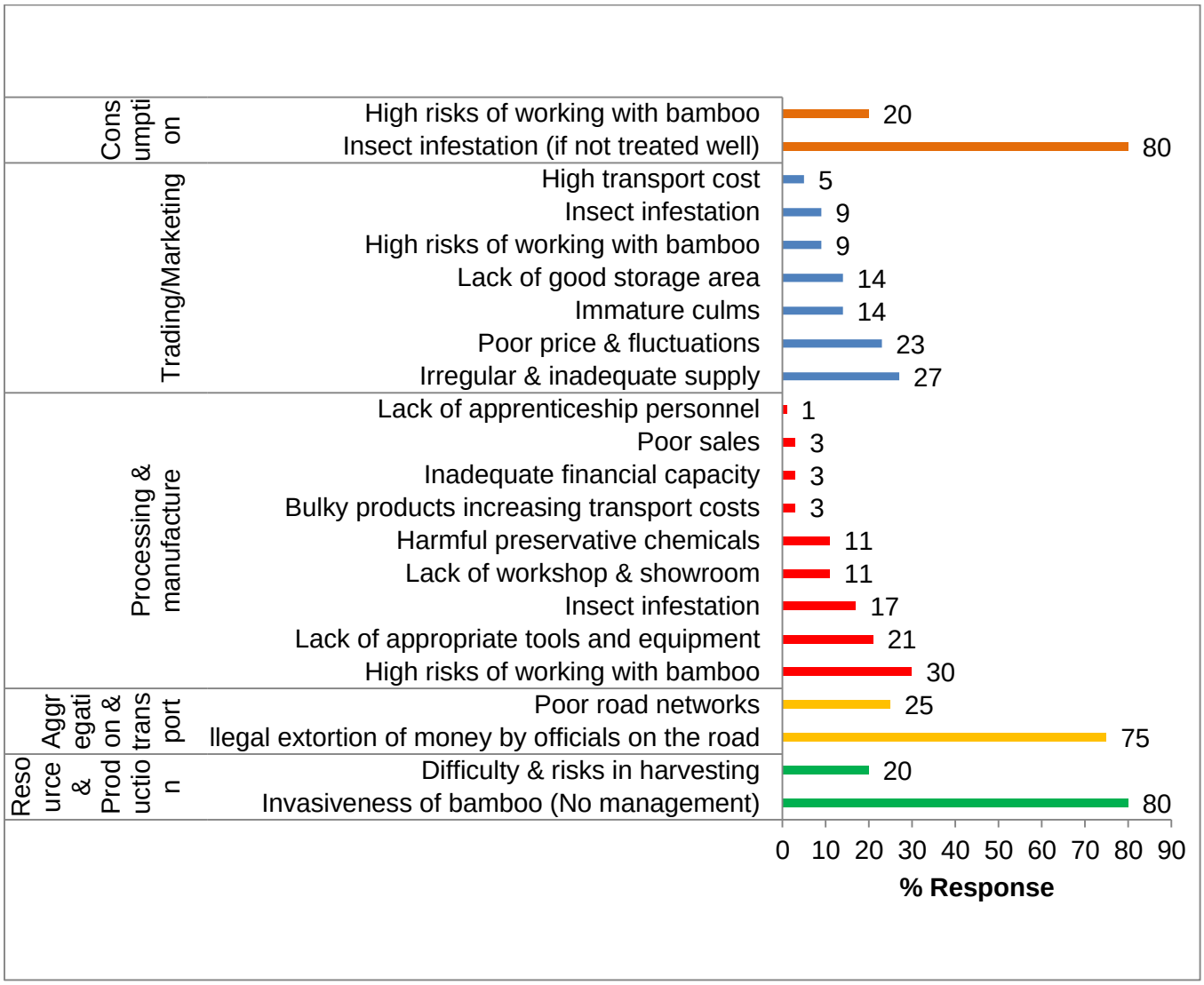


Figure 21: Percent distribution of major constraints encountered at the core nodes of the Ghana bamboo value chain.

10.1.1 Supply of poor-quality raw material and waste during the harvesting of bamboo culms

The lack of management of wild stocks naturally leads to poor clump formation with crookedness in the main stems, producing poor quality raw material. The culms are often not uniform; hence, harvesters cut the first 10-14 m (supposedly straight at the bole), leaving the rest of the culm as residue to rot. The harvesting of mature culms also becomes difficult due to the high clump density. Consequently, harvesters use the most convenient measures to cut the desired culms, often located at the centre of the clump. This often leads to haphazard harvesting and the destruction/deformation of the residual clumps and wastage.

Table 18. Constraints impeding the development of the Ghanaian bamboo value chain, remedial measures and opportunities for sustainability.

Value Chain Node	Constraints	Remedial Measures/Interventions	Opportunity for an Inclusive Sustainable BVC
Resource	• Natural stands unmanaged – poor clump formation and poor harvesting methods • Lack of scientific data on available stocks for industrial planning • Propagation techniques slow seeds, vegetative • Limited research	• Development and dissemination of knowledge on stock assessment, management and harvesting • Development of manuals for natural bamboo silviculture or stock management and to build the capacity of harvesters • Inventory of bamboo stocks to establish the quantity of stocks and profiles of their characteristics	• CSIR-FORIG can provide scientific information on the silviculture of bamboo • INBAR can facilitate a CSIR-FORIG/RMSC-FC bamboo inventory and profiling or characterisation for industry • CSIR-FORIG has developed technology for propagation and has the capacity for mass propagation via seeds, vegetative material and tissue culture

Harvesting/collection	• Improper harvesting • Insect and reptile attacks • Risks and injuries • Poor road infrastructure • High transport costs • Poor pricing	• Training on safe and sustainable harvesting techniques • Training in the identification of mature bamboo • Protective clothing • Formation of an association to regulate prices • Improvements in feeder road infrastructure	• Sound harvesting techniques available and can be adapted from India and China • INBAR can facilitate CSIR-FORIG/RMSC-FC to organise harvesters and build their capacity in terms of using safe environmental and less risky harvesting techniques
Transporting	• Poor road infrastructure • High vehicle running and maintenance costs • Inadequate capital to finance transport operations • Highly risky nature of traction often associated with motor accidents and drudgery • Confrontations with security officials on roads during deliveries	• Secure soft/small loans from rural banks • Group formation and registration to access loans from rural banks • Secure permits from or payments to the District Assembly for conveyance	• Short duration financing available from rural banks for small enterprises • Improvements in feeder roads in harvesting areas to facilitate the haulage of culms.
Processing	• Laborious production process • Less efficient tools/equipment for artisans • Preservation (biggest worry for processors affecting product quality/durability) • Use of harmful chemicals –	**Preservation and product durability** Cost effective preservation methods to enhance product durability and protect human health - **processed products**: prevent borer and fungal attacks, shrinkage and cracking - **raw culms**: primary preservation against	• Technically, the manpower is resourceful, trained and experienced • Can easily be mobilised for entrepreneurship and skill or capacity enhancement • Cooperative skills and marketing

	kerosene, dichlorodiphenyltrichloroethane (DDT) • Ineffective methods leading to reduced shelf lives (insect borers) • Insufficient knowledge regarding product development • The need for proper supply systems • Storage and proper handling and primary processing (drying) required • Inadequate financial capital	borer and fungal attacks, shrinkage, cracking and wastage A need for safer and more environmentally friendly preservatives Training on the safe use of harmful chemicals for small-scale processors	knowledge can be enhanced • Common facility with modern equipment for higher grade processing is feasible
Distribution and marketing	Manufactured products • Short service life due to borer and fungal attacks • Low domestic demand • Limited access to the international market	Production-market linkage and cooperative models Designated city centre area or with ease of accessibility for bamboo products to serve as an aggregation and distribution point Exploration of the use of e-media/platforms for adverts and market transactions	Producer-market linkage models available, e.g. cooperatives Possibility of INBAR/MLNR/BRU-FC/ MoTI and producer associations to consult district and metropolitan assemblies to locate suitable place for bamboo product marketing Ease of access to e-media trading platforms and institutions to foster the promotion of products
Consumption	Poor culm quality -Shrinkage/immature (lack of knowledge in identifying mature	Promotion of appropriate species for specific end use categories	• Physical, mechanical and chemical properties have been identified for some of

	culms or the resource becoming less available nearby) - Cracking - Insect borer and fungal attacks - Crooked culms • Inappropriate culm diameters and internodes • Poor storage	For instance, for use as props in construction, bigger diameters for better support Large-scale processors – bigger diameters and longer internodes to ease splitting and for more splits	them, and CSIR-FORIG can validate appropriate uses • CSIR-FORIG has information on preservation techniques to enhance durability and has the potential for further work to ensure safe use • CSIR-FORIG has the capacity to produce and supply planting material from desired species for specific uses

10.1.2 Poor harvesting techniques

Major constraints in the collection system are injuries sustained and itching experienced during harvesting. These were reported by 83% of the collectors. The itching is caused by bamboo leaves and culm sheath hairs and, in some cases, develops into a skin rash. The injuries and itching from harvesting are because protective clothing is seldom worn, and no proper harvesting techniques are applied. Other constraints reported include inadequate capital to finance harvesting operations and the high cost of transporting culms to the points of delivery. Generally, indiscriminate harvesting and the destruction of whole clumps with fire to make way for farming (bamboo lands fertile for food crop cultivation) are potential threats to the sustainability of the resource base and the bamboo industry. Likewise, the rising demand for the culms, particularly as props in urban construction, is a threat to the resource due to the wastage during harvesting.

10.1.3 Limited product innovation and quality

Limited processing technology and product manufacture

Generally, there is inadequate technical ability and skill for higher value addition in the bamboo industry in Ghana. There is also inadequate suitable machinery for processing and manufacture, including the finishing of products with higher grade quality and to meet international standards. Manual methods and rudimentary tools are employed by over 90% of enterprises, especially those

in the artisanal category in terms of the processing and assembling of products. This is labour intensive, slows output delivery and makes poor use of economies of scale.

Inadequate technological skill for higher value addition and innovation

Officials, industrialists, artisans and other entrepreneurs in the bamboo sector have, over the past two decades, embarked on various trips to China for training, exposure and capacity building to enhance developments in the industry. For instance, in 2006, a delegation from Ghana visited Guwahati for six months at the invitation of the Cane and Bamboo Technology Centre (CBTC) in India to acquire bamboo technology in a bid to develop the bamboo sector in the country. The objective at the time was to learn from CBTC experience regarding the development of a cluster (i.e. bringing artisans together in common facility centres to develop products) in the bamboo industry (FAO, 2006). However, the cluster concept has barely been developed in the country.

Although the government made an attempt to develop a cluster for artisans at Ayi-Mensah in Accra, the centre has not been patronised by artisans for various reasons. The facility is incomplete and seems too remote and too far from the city centre where clients can easily locate producers along major routes and conduct business transactions (Kwaku, 2019). A total of 190 bamboo industry workers received product development and technical skills in 2018 and 2019 under an annual training programme organised by the ICBR and China in partnership with INBAR and the MLNR. However, apart from factory processors, who have some of the required processing machinery and are hence able to apply the skills learnt, artisans lack access to such equipment/tools and, thus, have not been able to put their knowledge into use after the training. Observations made during visits to some of the pioneering bamboo factory processing and manufacturing firms in Ghana showed that their operations have declined. Lin (2018) reports that the lack of adequate or required skills for the manufacture of the target products and expensive working capital may be principal reasons for this.

Poor durability and service life of products

Bamboo has low natural durability. It is susceptible to attacks by decay fungi, such as soft rot, brown rot and white rot (Liese, 1970; Schmidt *et al.,* 2013), and powderpost beetles, particularly *Dinoderus minutes*. (Beraldo, 2015; Casin; Da Silva and Mosreiro, 1970). This is mainly due to the starch and sugars in the parenchyma cells in the culms of the bamboo, with the intensity of the deterioration usually depending on the amount of starch present (Schröder, 2012). Generally, boron-based wood preservatives (e.g. boric acid/borax) can be used to prevent beetle and fungal

infestations in bamboo (Gnanaharan and Mohanan, 2002). Dipping handicraft products made from bamboo in 0.10% of 2-thiocyanomethyl-benzothiozole plus methylene bisthiocyanate for 3-5 minutes arrests fungal growth (Giron, 1992).

To allow for the efficient processing of bamboo for any use, the culms need to be dried properly. The moisture content of the culms should be consistent with the average atmospheric conditions prevailing in the intended place of use. However, most furniture industries, especially the small- and medium-scale and cottage types, lack the facilities to dry or preserve their raw material, which reduces their competitiveness in the export market (Ezenrane, 2013).

Poor work area/environment

Generally, artisanal producers in cities and towns lack well-organised workshops that are centrally located to entice patronage. Artisans often operate under tree canopies on bare ground and along major roads, without proper workshops, infrastructure and tools. This poor workshop infrastructure affects the quality of the raw material and products as production is under trees and at the mercy of the weather. Artisans claim that metropolitan assemblies are not willing to grant permission to enable artisans to erect better structures along the roads for their workshops for fear of turning such areas into slums or living quarters. Again, some of the land areas may already be owned by other individuals or are prospective areas for future city expansion.

Poor demand for bamboo products in the domestic market

There is generally low valuation and appreciation of bamboo and, hence, poor demand for bamboo products in Ghana, primarily due to dependence on traditional wood species for centuries. In addition, there is limited export-oriented production, and it is faced with challenges in terms of access to international markets due to trade restrictions concerning standards, certifications and regulations, as well as the fact that most processors and manufacturers lack adequate resources for higher grade finishing and innovation, meaning that they are unable to meet such requirements (Obiri and Oteng-Amoako, 2007; Pentsil *et al.*, 2016).

10.2 Opportunities: Enabling environmental policy, fiscal and market incentives, institutions and opportunities

10.2.1 The governance environment for the bamboo sector

The Government of Ghana approved the bamboo industry's development programme in 2002 as a national programme to compliment the president's initiative on Forest Plantation Development in Ghana. However, more efforts need to be invested in the development of the industry (GNA, 2018). There is no distinct bamboo sector development policy. The forest and wildlife policy and plantation development strategy seek to promote the development of bamboo resources.

Government industrial policies

According to the MoTI, factors constraining industrial development in the country include the following: (1) the high cost of capital; (2) limited access to medium- and long-term financing; (3) the high cost of electricity; (4) the unreliable power supply; (5) limited access to land for industrial activity; (6) weak logistics and (7) weak infrastructure support for industrial development. The Government of Ghana has thus developed a number of strategic interventions for national industrial revitalisation that could be harnessed as opportunities for enhancing the commercial potential of the Ghanaian bamboo industry. The objectives for this intervention include the following:

1. To create a quick disbursing stimulus fund of up to USD 200 million.
2. To revamp distressed but viable companies.
3. To provide technical assistance to distressed but viable companies.
4. To provide business development services.
5. To facilitate access to markets.

However, accessing and disbursing funding under the programme follows the eight undermentioned steps:

1. The submission of an expression of interest (EOI) to the programme.
2. Completing and submitting a business diagnostic toolkit.
3. Submitting other documentation, such as tax returns and audited accounts.
4. The assessment and shortlisting of applications received.
5. Site inspection and the auditing of shortlisted companies by a group of experts.

6. Referring shortlisted companies to participating financial institutions.
7. The disbursement of funds to shortlisted companies.
8. Monitoring and evaluating the performance and impact of the financing.

The criteria for the identification and selection of the beneficiary companies/enterprises shall include but not be limited to the following:

1. High potential for enhanced job creation. For companies employing 100 people or less, the potential for a 100% increase in employment. For companies employing between 100 and 300 people, the potential for a 50% increase in employment. For companies employing more than 300 people, the potential for a 20% increase in employment.
2. Competent management team or evidence of engaging qualified personnel for key functional areas.
3. Sound financial and accounting reporting system.
4. Good corporate governance including an effective board structure or evidence of board restructuring.
5. Good track record of operational and commercial performance.
6. Clear evidence of existing/available markets for products or services.
7. Interest and willingness of existing shareholders and the Governing Board, including, but not limited to, providing a board resolution to take advantage of the proposed stimulus package.
8. The potential to export products to other markets outside Ghana will be an additional advantage.
9. Locations in peri-urban and rural communities will be an additional advantage.

11. Capacity development needs of the Ghanaian bamboo sector

11.1 Capacity development for private bamboo sector processors

Technical capacity development

All processors/manufacturers interviewed expressed the need for enhancing the technical capacity of their enterprises. Three major areas require urgent improvement, with priority being given to modern tools/equipment for improving efficiency in value addition (59%). Respondents also expressed the need for training in the use of advanced equipment/machinery, modern designs and relevant technical know-how to enhance knowledge and skills (35%) and for decent/permanent workplaces (6%) to facilitate processing, product development and the marketing of their wares (Figure 22). The development of a wide range of quality products for various markets will require appropriate processing machines and technology. Most importantly, the artisanal processors need better basic tools to reduce drudgery and injury. Processors also require the transfer of improved technical knowledge on processing techniques for the development of a wider range of durable attractive products, especially for international markets, as well as knowledge of cost-effective and safe preservation methods to enhance product durability and protect human health.

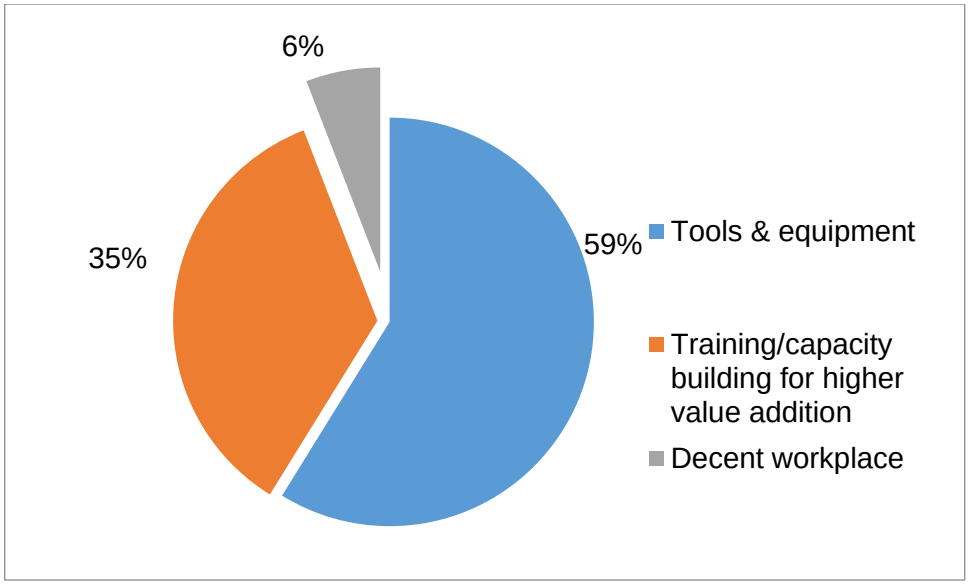


Figure 22: Technical needs among artisanal bamboo processors.

To address this technical logistic shortfall, a common processing facility equipped with appropriate tools and equipment to be operated as a business model is recommended. The Ayi-Mensah

bamboo, cane and rattan craft village in the Ga East Municipality was constructed by the Millennium Development Authority (MiDA) at the cost of USD 416,000 but requires further furbishing to serve this purpose. The facility is incomplete and has been idle for 4 years since its inauguration in 2015. This common facility centre could be enhanced for the transfer of technology to build the capacity of artisans and for the production of higher value products. INBAR is also constructing a common processing facility in Juaso in the Ashanti Region. Some of the artisans already trained in earlier training sessions could provide assistance in knowledge dissemination. A training of trainers' programme needs to be instituted to facilitate knowledge transfer among artisans with improved machinery. Most of the artisans also have a formal education as well as a wealth of skills and experience of up to 30 years in the industry. Hence, this is a sound foundation to build on with improved infrastructure.

In Tripura State in India, where the bamboo sector contributes significantly to the economy, strategies for scaling up the turnover of the sector while increasing livelihood opportunities for local people were sought to be achieved through a comprehensive cluster development approach involving institution building, technological linkages, better markets and credit facilities, coupled with resource upgrading (Bhandari, 2018). The development of the Ayi-Mensah craft village in Accra and the Juaso Common Processing Training Centre (CPTC) with automated machinery as a business cluster will foster this kind of development in the country. This will certainly help aggregate artisans and other manufacturers, thus facilitating their mobilisation for the acquisition of interventions for the growth of the industry.

Bamboo factory processors/manufacturers have generally acquired some requisite tools/machinery/equipment (although some of these are wood processing machinery) for reducing drudgery and enhancing the quality of bamboo products with potential for product diversification. However, the major technical challenge impeding operations is the lack of adequate manpower to skilfully operate the acquired machinery as well as to repair it when it breaks down.

Ninety-two per cent of processors/manufacturers have acquired secondary- or tertiary-level formal education. Consequently, part of the technical training should expose them to modern measures for accessing knowledge from e-media/the internet, particularly YouTube/videos on innovative production processes, equipment/tools and trading pathways. For instance, INBAR has a documentary video on bamboo processing and value addition on the web.

Business capacity development

Enhancing business and entrepreneurial capacity will require developing production-distribution-marketing linkage models that will facilitate production and trade in bamboo products. Due to the remoteness of the Ayi-Mensah craft village from trading centres in the City of Accra, a dedicated rattan and bamboo product market to serve as a receptacle to link producers and consumers at a convenient designated place for both wholesale and retail will be necessary. This could be a location for receiving product flows from around the country for distribution to potential clients and consumers. Competition among manufacturers is quite low. Such a market could foster innovation, competition and the desire to invest in increased value addition for quality and attractive or aesthetic products among producers/manufacturers. National bamboo product trade and exhibition shows will be necessary to promote the industry and the patronage of products in Ghana.

The business capacity of entrepreneurs also needs to be enhanced to facilitate the sustainable management of operations and financial flows. Over 90% of core actors, excluding factory entrepreneurs, have no knowledge of bookkeeping; thus, they seldom keep records on their production operations and financial management requirements. Industrial development institutions, such as the NBSSI and Rural Enterprise Commission, operating under the MoTI, could be engaged to build entrepreneur business management skills, as well as association dynamics and empowerment, for the development of the industry. Further, marketing links with adverts on e-media platforms, such as Instagram, Facebook, Ghana Trade and Tonaton.com, among others, are currently less expensive and will improve the marketing of products.

Increasing financial capacity for investment in modern equipment for higher value addition is urgently needed. Access to low interest loans is required to boost equipment/machinery and infrastructure for higher value addition. The potential for partnerships with appropriate investors to upgrade production in some of the promising product value chains needs to be explored. Ghanaian financial institutions need to be consulted to evaluate the viability of the bamboo sector to design innovative low interest loan schemes for the categories of enterprises in this sector. Also, government support for venture capital and start-up funds will be helpful, especially under the industrial revitalisation programme of the MoTI. The NBSSI has affordable credit facilities accessible to their clientele, particularly youths and women's groups. It also collaborates with other financial institutions to provide tailor-made financial solutions.

Capacity development needs of educational institutions

The capacity of tertiary (universities), technical and vocational training institutions needs to be built on and/or improved in terms of bamboo technology and engineering. This should encompass resourcing these institutions with the requisite machinery/equipment and tools, as well as training their manpower to use, maintain/repair and fabricate these resources.

12. Summary and conclusions

This study covered an analysis of the bamboo value chain of Ghana. Specifically, it entailed mapping the value chain with a description of the actors, processes/activities/transactions and interconnections, costs and benefits, potential demand, growth prospects, gender inclusivity, constraints/challenges and opportunities in the chain, as well as recommendations for enhancing the technical and business capacity of entrepreneurs, in particular, and the bamboo sector, in general.

According to Zhaohua (2001), over 1,500 distinct uses of bamboo have been recorded in the world. Kenya alone has so far documented up to 48 local uses of bamboo (Ongugo *et al.,* 2000). Some common uses and products from bamboo include the following: handicrafts, scaffolding, bamboo ply, panelling, flooring, furniture, baskets, human food, animal fodder, paper, bioremediation, briefcases, clothes, boats, bows and arrows, biomass fuel, ladders, mats, musical instruments, fencing, fibres, fans, spears, spoons, toys, toothpicks and the recycling and filtration of domestic and industrial wastewater (Latif and Liese, 1995; Kigomo, 2007; INBAR, 2006; Kibwage *et al.*, 2008; Tekpetey, 2011; UNIDO, 2001). The leaves of bamboo are used as fodder for animals, whereas the shoots are a good source of human food (Kassahun, 2004).

In Ghana, the bamboo industry is male-dominated and characterised by 11 groups of actors who perform transactions along the value chain. Bamboo is traditionally used across the country, and the resource is fairly abundant in the south, although poor harvesting methods, a lack of appreciation of its economic value and no management threatens the resource base. Generally, the annual volume of bamboo extracted for various purposes is unknown.

Thirty-four bamboo products categorised under eleven product value chains are manufactured and mainly traded in the local market with limited exporting. The average demand is rated as medium, i.e. 2 on a 3-point scale, with 96% sales of the monthly stocks produced. A gross margin analysis of producers reported input-output figures that indicated that production is generally profitable with undiscounted revenue-cost ratios ranging from 1.2 to 25 for summer huts and culm production, respectively. In the domestic market, furniture, handicrafts and culms/poles are the dominant products traded. Culms are used for various purposes in rural economies, including fencing, roofing and housing. The increasing use of bamboo in recent times in urban buildings/infrastructure and construction is gaining prominence. Further, there are immense opportunities for the use of

bamboo species in land reclamation/the restoration of degraded lands and agroforestry for food security, as well as as a substitute for wood in construction (boards, panels, flooring, roofing, etc.), for the production of high-grade furniture, bio-energy, pulp, paper, composites, bicycles and household and service industry utensils and accessories, including toothpicks, barbecue sticks, ice-cream spoons and chopping boards, among others. The use of bamboo for bicycles, charcoal and briquettes, in particular, although not common, has the potential to evolve into a lucrative industry in the future, given the high demand for bicycles and biomass fuel in the country.

The industry is faced with a plethora of challenges. The major ones include the following:

1. The lack of adequate knowledge and skills regarding propagation, harvesting and the preservation of bamboo raw material.
2. The lack of capital to invest in bamboo processing machinery and product preservation by artisanal bamboo entrepreneurs.
3. Poor quality products with limited capacity for innovation.
4. A poorly developed market for bamboo products.
5. The lack of modern skills with regard to the diversified utilisation of bamboo.
6. Inadequate awareness of the potential of bamboo in the development of local communities.
7. Inadequate official policy and fiscal incentives for the bamboo industry.
8. The high cost of capital, discouraging entrepreneurs from borrowing for higher quality value addition.

Generally, there is an absence of records or statistics on production and consumption trends for the advancement of the bamboo sector as producers/manufacturers, the majority of whom are artisans, seldom keep records. Like all non-timber forest products in Ghana, there is rarely any official documentation or data on production and consumption statistics of the bamboo industry to permit projections and planning as well as to guide future investors.

There is no official government policy or legislation for the development of the bamboo sector or industry. However, a permit issued by the FC is needed to harvest bamboo from forest reserves. Harvesting from off-reserves requires no permit, but a fee is paid to the owners. Under this condition, abuse and the indiscriminate harvesting of the bamboo resource is very rampant and hence a threat to its sustainability. However, the government, through the MoTI, is developing a

portfolio for industry revitalisation for businesses in the private sector. The criteria required to access this funding are described in detail in section 11.2.1. However, it is worth noting that artisans in their current state of operations, in workshops under tree canopies, may not be eligible for this government support for upgrading their value addition and product diversification. Perhaps firms such as Booomers International Ltd., which manufactures bamboo bikes for export, or Pamplo Ghana Ltd., Silverpicks Ghana Ltd. and others, which manufacture toothpicks, charcoal and briquettes, may be eligible to acquire the funding.

13. Recommendations

The ultimate goal for the future of the bamboo sector in Ghana is to ensure a modern, efficient, commercialised industry producing quality or high value-added products for both domestic and international markets. Below, some recommendations for the sustainable development of the bamboo sector are made:

1. The MLNR must form a multi-stakeholder bamboo industry development advisory group (BIDAG) to advise sector ministerial representatives on the Industrial Infrastructural and Utilities Sub-Committee on the needs of the bamboo industry. The BIDAG should also lobby for decisions of the Science, Technology and Innovation Sub-Committee towards enhancing Science and Technology (S&T) and Information Communication Technology (ICT) investments in bamboo.
2. The BRU, through the MLNR and FC, should engage with relevant industry stakeholders to explore the use of Chinese-bilateral and other appropriate funds for bamboo industrial re-tooling and modernisation, as well as for supporting curriculum development for bamboo engineering in secondary and tertiary institutions in the country.
3. Bamboo businesses must be developed based on product value chains that have higher domestic and export market demand to drive the bamboo economy in the country. The proposed policy must also place an emphasis on the development of quality and diversified bamboo stocks as well as on supporting the research and development of bamboo resources and innovative transformation processes for high-quality products.
4. The BRU, in liaison with the Ghana Standards Authority (GSA) and other stakeholders, should work to develop standards for bamboo products and build the capacity of the industry in terms of adopting these standards. The ISO-accredited wood and furniture testing laboratory at CSIR-FORIG could be used to facilitate the standardisation of bamboo products.
5. The private sector must be supported with fiscal incentives to play a key role in resource development and innovative transformation for the better utilisation of bamboo. The MoTI and the NBSSI have financial mechanisms for supporting small and medium enterprises.
6. The MoTI must help create market linkages between Ghanaian bamboo companies and external investors to foster south-south cooperation. Participation in bamboo trade exhibitions locally and abroad could enhance the demand for and competitiveness of bamboo products in Ghana.

7. The NBSSI could help promote gender-sensitive bamboo product value chains, including basket weaving, and trade among women and youths.
8. Lastly, the BRU, in collaboration with INBAR, the Timber Industry Development Division (TIDD) of the FC, CSIR-FORIG and the MoTI, needs to put in place an empirical database or statistics on production, trade and consumption trends to establish facts and figures that can guide policy and investment decisions regarding bamboo in Ghana.

Table 19. Summary of issues and recommendations for enhancing the commercial competitiveness of the bamboo value chain in Ghana

Current situation	Reasons/causes	Recommendations
BAMBOO RAW MATERIAL Uncertain bamboo resource status and quality for commercial production	• No silvicultural prescriptions for management of wild stocks of bamboo on public and private lands • Limited species diversity for specific end uses • Lack of information on species available in the country and sources of procurement for plantation development	**<u>Quality raw material for commercialization</u>** **Responsibility of the Ministry of Land and Natural Resources (MLNR)/ Bamboo and Rattan Unit (BRU)/INBAR/ CSIR-FORIG** •Promote plantation development with appropriate species for specific end uses (poles, craft, weaving, furniture, energy, etc.) •Promote the integration of bamboo in agroforestry systems on marginal and idle lands by smallholders for income and poverty alleviation •Development of silvicultural techniques for establishment and management of bamboo plantations of various species in mono-crop and agroforestry systems
TECHNOLOGY & INNOVATION FOR PROCESSING AND MANUFACTURE OF PRODUCTS • Limited higher value addition including product design	• Obsolete & rudimentary equipment • Limited knowledge of bamboo engineering and machinery • Inadequate financing for investment in equipment for higher value addition • Limited technical capacity for processing and preservation of bamboo	**<u>Equipment</u>** **Responsibility of MLNR/BRU/Ministry of Trade and Industry (MOTI)/INBAR** • Task CSIR-FORIG, Forestry Commission Training Centre (FCTC) & Engineering Department of Universities to compile equipment needs to guide equipment capacity development of the bamboo industry • BRU/ INBAR/ MOTI operating through the National Board for Small Scale Industries (NBSSI) to promote bamboo Small and Medium Enterprise (SME) cluster development at appropriate designated site e.g. Ayi-Mensah Craft /Village. Seek

	• Inadequate training and capacity building on bamboo in educational institutions • Inadequate skill/ manpower to train artisans and other producers • Inadequate business development and management skills • Limited research into product development	funding for the development of equipment and infrastructure. Mobilize and train artisans to use the facility to upgrade products **<u>Financing & Business Development Capacity</u>** • MOTI-Ghana Revenue Authority (GRA) to provide subsidies on equipment importation for SME's • MOTI-NBSSI assist bamboo entrepreneurs with financial schemes for modern equipment acquisition for higher value addition • NBSSI-MOTI to improve bamboo entrepreneur business development and management skills as well as efficient use of available financial resources • MLNR/BRU/MOTI must explore opportunities for partnership with external investors for quality raw material and tertiary product development for the export market **<u>Technical Capacity</u>** **Responsibility of MLNR/BRU & FCTC/ CSIR-FORIG /INBAR/Technical &Tertiary Institutions/NBSSI-MOTI** • Promote innovative skill upgrading programmes among artisans for diversification and product innovation • Development of curriculum in bamboo engineering for use in technical and tertiary institutions • Technical manpower development for trainers in technical and tertiary institutions in bamboo engineering including higher grade craft, furniture and other tertiary applications to facilitate knowledge transfer

		• Promote gender-sensitive product value chains increasing women and youth involvement in seedling production, woven/handicraft product manufacture, wholesale and retailing of products **<u>Research</u>** **Responsibility of INBAR/CSIR-FORIG/Technical & Tertiary Academic Institutions** • Promote efficient utilization of bamboo raw material i.e. engineering for higher grade tertiary application • MLNR & INBAR, to seek funds for the establishment of demonstration or Centre of excellence for adaptive research into innovative product development with the appropriate equipment • Research/Academia and private sector to work on the development of bamboo products with high market value (parquet flooring, T & G, etc.) to stimulate widespread downstream processing
MARKETING/ TRADE Uncompetitive bamboo product market and trade	• Limited domestic market niche • Poor standards & quality of products • Poor access to international markets • Competition with cheaper but aesthetic Asian products on the Ghanaian market	**<u>Standardization and competitiveness</u>** **Responsibility of MLNR/BRU-FC/GSA/CSIR-FORIG/INBAR/MOTI** • BRU, CSIR-FORIG & INBAR collaborate with Ghana Standards Authority (GSA) to seek for funds to support the development of standards for tertiary bamboo products to stimulate value added-processing and commercialization • BRU, CSIR-FORIG, INBAR & GSA to build the capacity of private sector or industry to adopt standards for bamboo product manufacture • CSIR-FORIG/GSA/INBAR to assist producers to test appropriate bamboo products under ISO standards at the Furniture and Wood Testing Laboratory at CSIR-FORIG

		• MOTI to promote tax incentives to encourage the production of tertiary products for export • BRU, MOTI & Export Promotion Centre to assist with market intelligence and promote the flow of products (e.g. toothpicks, flooring, etc.) to regional and sub-regional markets • MOTI/GRA to provide tax incentives in favour of locally produced products to compete with imports from Asia • BRU/NBSSI to promote the use of e-media among producers for advertisement and trading/marketing to increase productivity in support of commercialization • BRU/NBSSI/INBAR Facilitate periodic bamboo trade exhibitions to promote locally made high-value products to domestic consumers
POLICY Limited policy interventions for bamboo sector development	• No clear policy document or direction to stimulate holistic bamboo sector development leading to: • No fiscal incentives for investment in the bamboo sector • Weak inter-institutional linkages • Limited bamboo sector development	**<u>Comprehensive Bamboo Sector Policy</u>** **Responsibility of MLNR<u>:</u>** • To work in collaboration with FC/BRU/CSRI-FORIG/INBAR/MESTI/MOTI//Private sector/ Academia and other relevant institutions to produce a holistic Bamboo Sector Development Policy and corresponding Master Plan, White Paper and Blue Print to guide the commercial development of the bamboo sector of Ghana • To form multi-stakeholder Bamboo Industry Development Advisory Group (BIDAG) to advise sector ministerial representative on Industrial Infrastructural and utility sub-committee to articulate the needs of the Bamboo industry. • The proposed BIDAG will perform functions that include: • Lobby decisions of the Science, Technology and Innovation Sub-committee towards

		enhancing S&T and ICT investments in bamboo • Collaborate with relevant industry stakeholders to explore the use of Chinese-Bilateral and other appropriate funds for industry re-tooling and modernization backed by cost-benefit analysis to inform investment decisions • Collaborate with MoTI/NBSSI to facilitate the establishment of venture capital and medium-long term funds to support bamboo industrial ventures • FC/BRU, GSA & CSIR-FORIG develop and integrate project for developing standards for all major uses including artefacts, poles, toothpick, furniture, construction, energy, etc.
INFORMATION/DOCUMENTATION No reliable data for planning and to guide commercial development of the sector	No official statistics or documentation on production, trade and consumption of bamboo products	**<u>Bamboo industry data/statistics</u>** **Responsibility of BRU/FSD/TIDD/CSIR-FORIG/INBAR/MOTI/GSA** • BRU/CSIR-FORIG/INBAR/MoTI Compile production, trade and consumption statistics of bamboo products to develop a database on the sector • BRU/FSD/RMSC/CSIR-FORIG/INBAR produce data on stocks, annual production/supply of bamboo raw material • BRU collaborate with TIDD to capture data on bamboo raw material transported through TIDD checkpoints • BRU/CSIR-FORIG/INBAR to produce facts and figures of Ghana bamboo sector • INBAR to work with GSA and CSIR-FORIG to develop HS codes for bamboo products traded to permit access to regional and international markets

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